AN COIMISIÚN PLEANÁLA
ACP-322787
18 JUN 2025
LTR DATED FROM APPELLANT
LUG. FROM No. 11
ACP.

Tullacondra Turbine Awareness Committee

Planning Application No. 24/5503 by Tullacondra Wind Energy Ltd.

Appeal to An Bord Pleanála

List of Enclosures

1. Receipt from Cork County Council, 12th September 2024
2. Report of Pascal Sweeney of Sweeney Consultancy on Aquatic Ecology
3. Report of Bruno Teillard Aqua GeoServices Ltd on Hydrogeology, 16th May 2025
4. Dr Desmond Leadon, Irish Equine Centre, Expert Opinion Report, 9th September 2024, and Supplemental Expert Opinion Report, 13th June 2025.
5. Group Member Submissions on Specific Topics

5a. Submission on interference with Saorview Television Service

6. Set of Signatures supporting the Committee
7. Submission by Mr William McSweeney BSc MSc MUB to Cork County Council
8. *Webster and Rollo & Shorten and Carty v Meenacloghspar (Wind) Ltd* [2024] IEHC 136
9. *Webster and Rollo & Shorten and Carty v Meenacloghspar (Wind) Ltd (No.2)* [2025] IEHC 300
10. *Byrne & Moorhead v ABO* [2025] IEHC 330
11. Email from Carol Nolan Veterinary Inspector Cork County Council 20 May 2025.
12. Evidence of individual objections and absence of consent:
    a) Land Owner Objections to Turbine Delivery Route Works Option 1
    b) Land Owner Objections to Grid Connection Route Works Option 1
    c) Additional "Dilapidated and Uninhabited" Properties plus New Builds in the area
    d) Letters re surveyed buildings having not consented
    e) Letter from Margaret M. O'Connell re not consented to use of vantage point
    f) Letter from Tim Cronin re planning condition and not consenting
    g) Letter from Francis & Rose Lombard re turbine delivery route
    h) Letter from Catherine Buicke re turbine locations etc.
13. Specification from manufacturers of noise monitoring equipment
14. Technical Note prepared by Sarah Large, Acoustic Consultant, Walker Beak Mason Limited, Acoustic Consultants, dated 20th June 2024
15. Dick Bowdler, ETSU-R-147: Why it is wrong
16. Audible Amplitude Modulation – 5th International Conference – Stigwood and others, Denver 2013
17. Noise Control for Quality of Life, Fukushima and others, Innsbruck, 2013

Binder 2 of 2

Tab

18. Review of Noise Guidance for Onshore Wind Turbines, WSP, September 2023

19. Defra Guidance

20. World Health Organisation Noise Guidelines for European Region, 2018.

21. Selected Health Risks Documents:
    a. Noise Characteristics of 'compliant' wind farms that adversely affect Neighbours, Large, MAS Environmental, Melbourne 2014.
    b. Cotton Farm Long Term Community Noise Monitoring, Stigwood, 2014.
    c. Wind Farm Noise Measurement, Assessment and Control, Hansen et al 2017.
    d. Prevalence of wind farm amplitude modulation at long-range residential locations. Journal of Sound and Vibration, Hansen, 2018.
    e. Audible Thumping from Wind Farms can Travel up to 3.5KM, Hansen *et al*, 2014.
    f. Balter LJT, Axelsson J. 2024 Sleep and subjective age: protect your sleep if you want to feel young. Proc. R. Soc. B 291: 20240171.
    g. Low-frequency noise from large wind turbines – additional data and assessment of new Danish regulations, 15th International Meeting on Low Frequency Noise and Vibration and its Control, 22-24 May 2012.
    h. Noise Could Take Years Off Your Life New York Times 9th June 2023.
    i. Penalties applied to wind farm noise: Current allowable limits, influencing factors, and their development, Alamir *et al*, 2021.
    j. Private Nuisance: Wind Turbine Noise, Francis McManus, Scottish Planning & Environmental Law, 2025.
    k. March 2019 Noise Bulletin (pages 6-7)
    l. Assessment of Infrasound and Low Frequency Noise – Case Study in a Community of Inhabitants Near Wind Turbines, Trigueiro *et al,* 2023.

22. FCN Working Paper No.3/2012

23. Vestas Operation & Maintenance Manual 2005

24. Mechanical Operating & Maintenance Manual 2007

ACP-322787

AN COIMISIÚN PLEANÁLA

18 JUN 2025

LTR DATED ____ FROM APPELLANT NO. 11.

LDG- ~~ACP-32278~~

ACP-



Comhairle Contae Chorcaí
Cork County Council

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AN COIMISIÚN PLEANÁLA
ACP-322787
18 JUN 2025
LTR DATED _____ FROM _____
LDG-

ACKNOWLEDGEMENT OF RECEIPT OF SUBMISSION OR OBSERVATION ON A PLANNING APPLICATION

THIS IS AN IMPORTANT DOCUMENT

KEEP THIS DOCUMENT SAFELY. YOU WILL BE REQUIRED TO PRODUCE THIS ACKNOWLEDGEMENT TO AN BORD PLEANÁLA IF YOU WISH TO APPEAL THE DECISION OF THE PLANNING AUTHORITY. IT IS THE ONLY FORM OF EVIDENCE WHICH WILL BE ACCEPTED BY AN BORD PLEANÁLA THAT A SUBMISSION OR OBSERVATION HAS BEEN MADE TO THE PLANNING AUTHORITY ON THE PLANNING APPLICATION.

PLANNING AUTHORITY NAME **Cork County Council**

PLANNING APPLICATION REFERENCE NO. 24/05503

A submission/observation, in writing, has been received from:

Tullacondra Turbine Awareness Committee
C/o Noonan Linehan Carroll Coffey LLP Solicitors
54 North Main Street
Cork
T12 WY2D

ON 12/09/2024 in relation to the above planning application.

The appropriate fee of €20 has been paid.

The submission/observation is in accordance with the appropriate provisions of the Planning and Development Regulations, 2001 and will be taken into account by the Planning Authority in its determination of the planning application.

Guy Clarke Hurley

Guy Clarke Hurley
Clerical Officer

Local Authority Stamp

Planning Department
Cork County Council
County Hall
Cork

Date: 12/09/2024

We are Cork.
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ACP-322787

Appraisal of Aquatic Ecology Reporting
in
EIAR for Tullacondra Green Energy Ltd.

ACP-322787

Prepared for

Tullacondra Turbine Awareness Community

by

Pascal Sweeney, Sweeney Consultancy, Rahan, Mallow, Co. Cork

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ACP-322787

1. INTRODUCTION

1.1 DOCUMENT ASSESSED

The purpose of the present report, prepared by Pascal Sweeney of Sweeney Consultancy, is the appraisal of aspects of the Aquatic Ecology reporting in the EIAR for Tullacondra Green Energy Ltd. (EIAR Vol II, Chapter 7, Section 7.7.5 and EIAR Vol III Appendix 7.2), completed in 2023 and received by Cork Co. on 09/08/2024 (File No. 245503)

1.2 REPORT AUTHOR, PASCAL SWEENEY

Pascal Sweeney of Sweeney Consultancy is a freshwater biologist, specialising in aquatic invertebrates. Following his B.Sc. degree in zoology, with funding from the National Board for Science and Technology, he monitored biological parameters in the Killarney Lakes. This led to a research M.Sc. on nutrient enrichment impacts on aquatic invertebrates. He is a committee member of the Irish Freshwater Sciences Association. His work is focussed mainly on biological water quality assessments and protected species surveys. Every summer since 2012, he has been contracted by EPA to assess sites throughout Irish river catchments for the National River Monitoring Programme. Pascal Sweeney is issued yearly licences by NPWS for crayfish surveys and Stage 2 surveys of freshwater pearl mussels throughout the state. Clients for these surveys have included NPWS, IFI, Uisce Eireann, OPW, Coillte, Irish Rail, Cork CC, Carlow CC, Tipperary CC, Galway CC, as well as several engineering firms planning infrastructure projects. In recent years, Pascal Sweeney surveyed c.80km of the upper Munster Blackwater, the Owentaraglin and the River Allow for IRD Duhallow and found over 3,400 mussels, many at previously unknown locations for this protected species. He is currently very involved in the rescue of the last few healthy crayfish from the River Awbeg that have not yet succumbed to crayfish plague. He has 21 peer-reviewed scientific publications on aquatic ecology.

2. APPRAISAL METHODS

2.1 USE OF AVAILABLE INFORMATION

The sourses and relevance of available aquatic data was considered.

2.2 FIELD METHODOLOGIES

The stated methologies used in the field were reviewed and their relevance was assessed in terms of accuracy and completeness.

2.3 REPORTING & PRESENTATION OF EIAR RESULTS

Clarity and accuracy of results are of paramount importance in a technical report. These aspects were carefully checked.

2.4 OMISSIONS

Omitted important information was checked for.

2.5 COMPARISON OF EIAR RESULTS WITH A 2025 FIELD ASSESSMENT

To help assess the results presented, a field survey was conducted by Pascal Sweeney on March 3rd and 4th, 2025.

3. APPRAISAL RESULTS

3.1 USE OF AVAILABLE INFORMATION

3.1.1. Biological Water Quality

Historical Q-values from 1990 in the Awbeg (Kanturk) are referred to in EIAR Vol III Appendices, Section 3.2.2, rather than checking the current water quality.

3.1.2. Crayfish

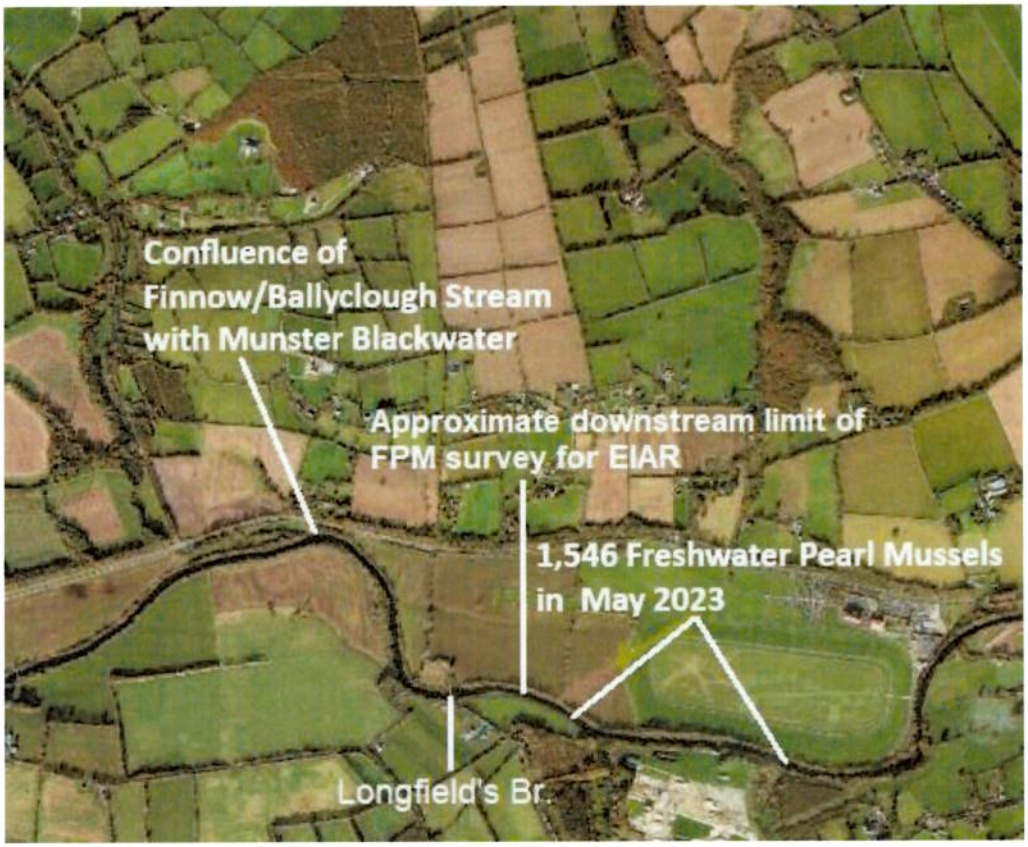
The Marine Institute was not consulted for information on the status of crayfish plague in the Blackwater catchment.

3.1.3. Freshwater Pearl Mussels

EIAR Vol III Appendices, Section 3.2.4 states that two reaches of the Blackwater were surveyed for FPM. Reach 1 is from Roskeen Bridge to 750m downstream, ignoring the 150m between the confluence of the Allow (Kanturk) and Roskeen Bridge. Consultation with NPWS should have brought to light the following important information on the FPM in this stretch of river. In 1994, prior to bridge repair works being undertaken, a team of NPWS staff collected mussels at and downstream of Roskeen Bridge and translocated them to upstream of the bridge (Eva Sweeney, retired NPWS Conservation Ranger, *pers. comm.*).

It is reported that only a single live freshwater pearl mussel was found in the Blackwater from downstream of the confluence of the Finnow/Ballyclogh Stream. With a 300m stretched skipped due to habitat conditions that were deemed unsuitable, the 750m survey would therefore have extended to c.200m downstreamof Longfield's Bridge. A Data Request Form to NPWS prior to submission of the report to Cork Co. Co. would have revealed that a substantial population of 1,546 individuals of this protected species was recorded in a surveyed stretch of the Blackwater, starting 400m downstream of Longfield's Bridge from ITM 552053 597625 to ITM 552785 597424, undertaken by trainees on a course run by Sweeney Consultancy, in May 2023 and supervised by Pascal Sweeney (Fig. 3.1).

Fig. 3.1: Freshwater Pearl Mussel Population downstream of Longfield's Br. (2023)



3.1.4. Fish

EIAR Vol III Appendices, Section 3.2.5 details impacts of two weirs farther downstream on the Blackwater, one at Clondulane and the second at Fermoy, on fish migration. This is despite the readily available information that a large section of Fermoy Weir had collapsed by 2019, opening up a channel for migratory fish.

3.2 FIELD METHODOLOGIES

3.2.1. Q-Values

Section 7.6.3.2.5 of the EIAR Volume II, Main Report, Chapter 7: Biodiversity, refers to the methodology used for Q-value assessments at seven sites following the standard methodology of Toner *et al.* (2005). This methodology has been updated by EPA on several occasions since 2005.

Because the small watercourses at Derryorgan and Kilmaclenine dry during the summer, it is acknowledged in EIAR Volume III, Appendices, Section 7.3.2.2 that the Q-values are likely not a reflection of true water quality. However, Q-values for these sites are still presented in EIAR Volume III, Appendices, Chapter 7, Table 5. By all versions of the Q-value standard methodology, from Toner *et al.* (2005) to EPA (2021, Version 2.2), a Q-value should not be ascribed to either of these watercourses.

3.2.2. Crayfish

EIAR Volume III, Appendices, Section 7.2.2.4, states that the crayfish survey was carried out following the guidance set out by Peay (2003). However, the report results give no indication that this was done, with no mention of five suitable habitat patches per site identified and ten refuges per patch searched for crayfish.

The stated methodology of using the contents of otter spraints to establish crayfish distribution is unreliable, as pointed out by Smiddy and Saich (2005: *Using otter (Lutra lutra) diet to indicate presence of White-clawed Crayfish (Austropotamobius pallipes) populations*. Irish Naturalists' Journal 34: 45-50.), This is because otter spraints can be deposited several kilometres from where the prey was eaten, and the only certain way of determining presence of crayfish is the discovery of living specimens.

3.2.3. Freshwater Pearl Mussels

Within both reaches of Blackwater surveyed for FPM, sections were skipped because the habitat was deemed unsuitable (EIAR Vol III Appendices, Section 3.2.4). The criteria for this decision are not given and doing so is contrary to the NPWS guidelines quoted.

The NPWS guidelines state that either all mussels per 500m stretch be counted or, where populations are dense, there chould be five 2m wide transects in every 100m of river surveyed (10% of the channel). With 20 cross-river transects surveyed in 1.5km of the Blackwater for the EIAR, this equates to 40m of the channel, which is less than 3% of the channel.

3.2.4. Fish

EIAR Volume III, Appendices, Section 7.3.2.5, describes a snorkelling fish surveying methodology, quoting two American papers, rather than the standard electrofishing methodology, as uses by Inland Fisheries Ireland. Furthermore, most of the watercourses in this study are unsuitable for snorkelling, due to size and depth.

3.3 REPORTING & PRESENTATION OF EIAR RESULTS

3.3.1. Locations

Locations referred to are not clearly specified. No grid references are given, as would be expected in a report of this type. This, combined with a lack of photographs to illustrate sampling sites, and only relatively small-scale mapping makes it difficult to re-sample for comparative purposes.

The Ketragh River, as it is named on all Ordnance Survey maps, is called the Lisduggan North in the EIAR, again making locations confusing.

3.3.2. Q-Values

In EIAR Volume III, Appendices, Chapter 7, Table 5. Invertebrate List for Biological Water Quality Sampling, the following errors are made:

Spelling: Seratella should be Serratella

Spelling: Amphinemoura should be Amphinemura

Spelling: Simulidae should be Simuliidae

Spelling: Chironomous should be Chironomus

Spelling: Hirudinae should be Hirudinea

Arachnida are not members of the Crustacea

Seratella sp. is not the Yellow Evening Dun, it is the Blue-winged Olive as subimago and Sherry Spinner as imago. The Yellow Evening Dun is *Ephemerella notata.*

Baetis muticus was moved to the Genus Alainites in 1994 and since then is *Alainites muticus.*

While a single typographical error might be excused, the combination of the above taxonomic errors in one table might suggest a lack of familiarity with aquatic invertebrates.

Although Table 2 in Section 7.6.3.2.5 of the EIAR Volume II, Main Report, Chapter 7: Biodiversity, correctly lists Q3-4 as being Moderate Starus, two watercourses that were assigned Q3-4 in Table 5 of EIAR Volume III, Appendices, Chapter 7, are described as being in Poor Status.

3.4 OMISSIONS

3.4.1 Annex I Habitats

Despite the Annex I habitat "Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation" (Habitat Code 3260) being correctly listed in EIAR Volume II, Main Report, Table 7.7 as a Qualifying Interest of SAC 002170, there is no assessment of this habitat.

3.4.2. Freshwater Pearl Mussels

Sections of the Blackwater were not surveyed, leaving gaps in the information on distribution of this protected species (see Section 3.1.3, above).

3.5 COMPARISON OF EIAR RESULTS WITH A 2025 FIELD ASSESSMENT

3.5.1 2025 FIELD ASSESSMENT

To help assess the Q-value results presented in the EIAR, a field survey was conducted by Pascal Sweeney on March 3rd and 4th, 2025. Seven sites were assessed, six corresponding to sites evaluated in 2022 for the EIAR and one additional site for

comparison to EPA 1990 data. One of the 2022 sites had no water when visited on 3rd March 2025. An additional site, not sampled in 2022, on the upper Awbeg (Kanturk) was sampled in 2025 in order to compare the current status with the las reported status in 1990.

Site details are presented in Tables 1-7, mapped in Fig.3.2, and illustrated in Photos 1-7.

Table 1. Site 1

Site Code	1
Grid Ref (ING)	R45128 06266
Watercourse	Awbeg (Kanturk)
EPA Watercourse Code	18A06
Corresponding to EIAR Site	None. Upper Awbeg (Kanturk) not sampled for EIAR
Description	Just downstream of confluence of unnamed stream flowing from the east, under Sal's Bridge. Between EPA Stations 18A060200 and 18A060500.
Photograph No.	1
Sampling depth (m)	0.1
Flow	Riffle: 100%
Substrate (%)	Cobble 20
	Gravel 70
	Silt 10

Table 2. Site 2

Site Code	2
Grid Ref (ING)	R43349 01061
Watercourse	Awbeg (Kanturk)
EPA Watercourse Code	18A06
Corresponding to EIAR Site	Awbeg (Kanturk)
Description	Upstream of Ketragh confluence
Photograph No.	2
Sampling depth (m)	0.4
Flow	Riffle: 100%
Substrate (%)	Cobble 50
	Gravel 30
	Sand 20

Table 3. Site 3

Site Code	3
Grid Ref (ING)	R44241 01630
Watercourse	Ketragh
EPA Watercourse Code	None
Corresponding to EIAR Site	Ardine Bridge
Description	20m upstream of bridge
Photograph No.	3
Sampling depth (m)	0.4
Flow	Fast glide: 100%
Substrate (%)	Cobble 50
	Gravel 40
	Silt 10

Table 4. Site 4

Site Code	4
Grid Ref (ING)	R43466 01096
Watercourse	Ketragh
EPA Watercourse Code	None
Corresponding to EIAR Site	Lisduggan North
Description	Upstream of confluence with Awbeg (Kanturk)
Photograph No.	4
Sampling depth (m)	0.5
Flow	Fast glide: 100%
Substrate (%)	Gravel 100

Table 5. Site 5

Site Code	5
Grid Ref (ING)	R49009 08133
Watercourse	Unnamed tributary of the Awbeg (Buttevant)
EPA Watercourse Code	None
Corresponding to EIAR Site	Lisgriffin
Description	Stream flowing east just south of Lisduggan Crossroads
Photograph No.	5
Sampling depth (m)	0.03
Flow	Riffle: 100%
Substrate (%)	Cobble 40
	Gravel 40
	Silt 20

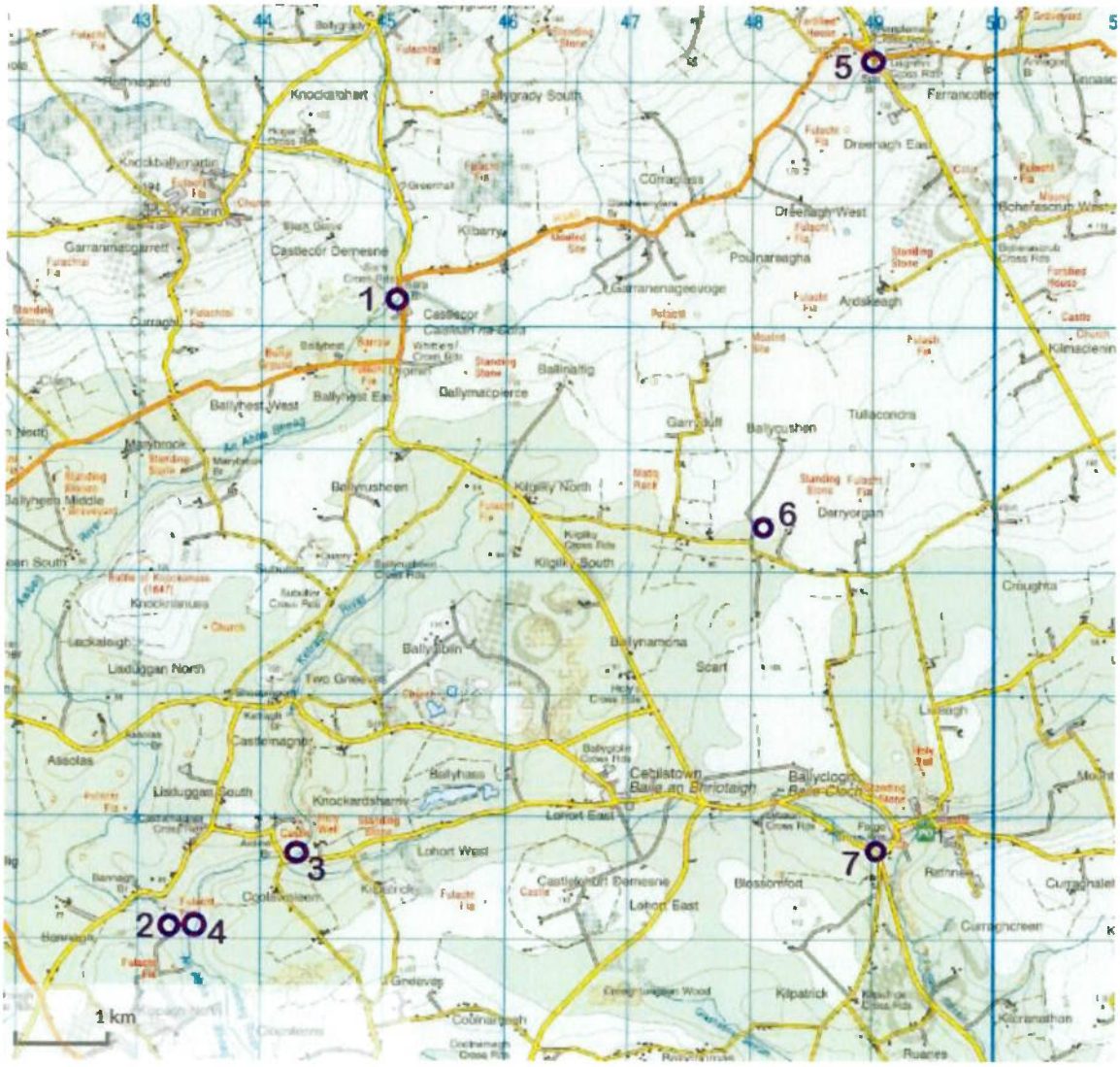
Table 6. Site 6

Site Code	6
Grid Ref (ING)	R48048 04387
Watercourse	Unnamed watercourse flowing southwest from Tullacondra proposed wind turbine site.
EPA Watercourse Code	None
Corresponding to EIAR Site	Derryorgan
Description	Small watercourse that dries in summer
Photograph No.	6
Sampling depth (m)	0.02
Flow	Riffle: 100%
Substrate (%)	Cobble 20
	Gravel 70
	Silt 10

Table 7. Site 7

Site Code	7
Grid Ref (ING)	R49096 01677
Watercourse	Unnamed tributary of the Ballyclough/Finnow Stream
EPA Watercourse Code	None
Corresponding to EIAR Site	Ballyclogh
Description	Upstream of confluence with Ballyclough/Finnow Stream
Photograph No.	7
Sampling depth (m)	0.1
Flow	Riffle: %
Substrate (%)	Cobble 40
	Gravel 40
	Silt20

Fig.3.2 Map of Sampling Sites 2025



Sampling Site 1 Photo



Sampling Site 2 Photo



Sampling Site 3 Photo



Sampling Site 4 Photo



Sampling Site 5 Photo



Sampling Site 6 Photo



Sampling Site 7 Photo



3.5.2 RESULTS OF A 2025 FIELD ASSESSMENT

The invertebrate taxa collected at all seven sites sampled are presented in Table 8.

Table 8. Invertebrate Fauna

Relative abundance expressed as D: Dominant; N: Numerous; C: Common; F: Few; SS: Single Specimen

TAXON	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	Site 7
Group A (Sensitive)							
Isoperla sp.	F						
Protonemura sp.	F				F	F	
Brachyptera risi	F				SS		
Ecdyonurus sp.	C	F					
Rhithrogena sp.	N	D		F			
Group B (Less Sensitive)							
Leuctra sp.	F						
Glossosomatidae			F				
Goeridae			F				
Limnephilidae	F			F	F		
Odontocera albicorne		SS					
Sericostoma personatum	F	F	F	C			F
Group C (Relatively Tolerant)							
Tricladida			SS				
Lumbricidae		F					F
Lumbriculidae	SS		F	F			
Potamopyrgus antipodarum			F				
Planorbis planorbis						C	
Potamopyrgus antipodarum		F	F				SS
Ancylus fluviatilis							
Hydrachnidae							F
Gammarus sp.	C	F	D	N			D
Baetis rhodani group		F	F		N	C	
Serratella ignita				SS			
Hydropsyche sp.	SS	C	F	F			F
Rhyacophila sp.		F					
Polycentropus sp.		F		F			
Holocentropus sp.		SS					
Elmis aenea		F	F	F			F
Limnius volckmari	F	SS	F	F			SS
Gyrinidae	SS			F			
Haliplidae				F			
Hydraenidae						C	
Dicranota sp.	SS		F				
Tipulidae				SS			
Simuliidae		F			F	F	
Ceratopogonidae							SS
Procladius sp.						F	
Cryptochironomus sp						SS	
Other Chironomidae					F	F	

Table 8 continued

TAXON	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	Site 7
Group D (Very Tolerant)							
Enchytraeidae						SS	
Helobdella stagnalis			SS				
Erpobdella sp.	SS				SS	F	F
Glossiphonia sp.							F
Pisidium sp.			SS				
Ampullaceana balthica					F		
Physa fontinalis					SS		SS
Asellus sp.	SS			SS	F		
Group E (Most Tolerant)							
Tubificinae			SS		SS		
Q-value	**Q4-5**	**Q4**	**Q3**	**Q3-4**	**Q3-4**	**N/A**	**Q3**

3.5.3 COMPARISON OF INVERTEBRATE RESULTS

Due to the lack of clarity around the locations of the sampling sites in the EIAR (see 3.3.1, above), it is likely that some of the 2025 samples were not taken at exactly the same point in each watercourse, but they were taken in at least close proximity.

46 invertebrate taxa were recorded six sites sampled in March 2025 (excluding Site 1 which had not been sampled in 2022), compared to 30 taxa reported in EIAR Volume III, Appendices, Chapter 7, Table 5 for all seven sites sampled in summer 2022. This increase of over 50% in 2025 can be partly explained by seasonality, with three species of stoneflies being at adult stage in summer. As these are EPA Group A (Pollution Sensitive) species, this affects the Q-value. It is not understood why, with other surveys being carried out for the EIAR at other times of year, the aquatic invertebrates were not sampled between September and April as well.

In EIAR Volume III, Appendices, Chapter 7, Table 5, the Family Chironomidae are divided into *Chironomus sp.* (Bloodworms) and "green chironomids". This suggests that all red chironomids were counted as *Chironomus sp.*, which is in EPA Class E. This genus was recorded as Numerous in occurrence at the Derryorgan site in 2022, which affects the interpretation of the biological water quality status. However, in 2025, a different red chironomid, *Cryptochironomus sp.* (EPA Class C), was found to be common in this watercourse.

Diving beetles (Dytiscidae) were recorded at the Derryorgan site in 2022, despite the fact that this small shallow temporary watercourse would not be suitable habitat this family of beetles. In 2025, crawling beetles of the family Hydraenidae were found to be common in this watercourse.

All riffle beetles (Elmidae) are listed as *Elmis sp.* in EIAR Volume III, Appendices, Chapter 7, Table 5. In 2025, a second similar species of riffle beetle, *Limnius volckmari*, was widely recorded.

The status of the upper reaches of the Awbeg (Kanturk) was found to have improved very significantly, with Q4-5 recorded near Sal's Bridge, in contrast to the poor quality in 1990, referred to in the EIAR.

4. ADDITIONAL COMMENTS

4.1.1. Crayfish

No reference is made to crayfish plague, which was recorded by eDNA analysis in water samples taken in the Blackwater and Awbeg (Buttevant) by the Marine Institute in October 2022 and in dead crayfish from the Blackwater in May 2023. This information would have readily been available via a query to the Marine Institute. There is currently an ongoing effort to capture and protect any remaining healthy crayfish from the Awbeg (Buttevant) until the plague has run its course. It will be important that no additional pressures are placed on this river when these crayfish are reintroduced.

In EIAR Volume III, Appendices, Chapter 7, Table 3, it is reported that one dead crayfish was found in Reach 2 of the Blackwater. This specimen, which was found just a few months earlier than the first record of crayfish plague in the Blackwater was not sent to the Marine Institute to be checked. If it had been found to have succumbed to crayfish plague, warnings to anglers and other river users would have been issued earlier, slowing the progress of the disease. Furthermore, the only references to biosecurity in the EIAR refer to invasive non-native species, not diseases. Without taking adequate biosecurity measures against the spread of crayfish plague, the researchers for the EIAR could themselves have been vectors for its spread.

4.1.2. Freshwater Pearl Mussels

As the current full extent of the freshwater pearl mussels population in the Blackwater downstream of the confluence of the Awbeg (Kanturk) and the Finnow/Ballyclogh Stream is not known, applying the Precautionary Principle, the likely presence of FPM should have been presumed in the unsurveyed stretches.

5. CONCLUSIONS

With the use of outdated, unreliable field survey methods, deviations from standard methodology, inexact invertebrate data, incomplete FPM surveying, and no assessment of a relevant Qualifying Interest of SAC 002170, the Aquatic Ecology Baseline Report for the Tullacondra Green Energy Project is not adequate for accurate determination of potential impacts on aquatic habitats and species.

Aqua GeoServices
Your Partner in Geology, Environment & Water

Aqua Geoservices Ltd.
Wavecrest House,
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Ireland.

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REPORT ISSUE FORM

Review of the hydrogeological information

submitted as part of

Planning Application No. 24/5503

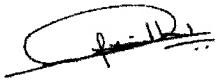
for the development of a nine-turbine Windfarm

near Tullacondra,

Co. Cork.

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* Where it is a requirement that this report be issued to a regulatory or other authority, then the client should sign the appropriate place in the above table and, unless specifically agreed in writing to the contrary, forward copies to the appropriate authority (e.g. EPA etc.)

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LIST OF ABBREVIATIONS

The following abbreviations are used in this report:

Abbreviation	Full Form
AGS	Aqua GeoServices Ltd.
BH	Borehole (e.g., BH-T01, BH-T05)
CEMP	Construction Environmental Management Plan
EIAR	Environmental Impact Assessment Report
EPA	Environmental Protection Agency
ESBN	Electricity Supply Board Networks
EurGeol	European Geologist (certification by European Federation of Geologists)
GCR	Grid Connection Route(s)
GSI	Geological Survey of Ireland
IGI	Institute of Geologists of Ireland
IAH	International Association of Hydrogeologists
M.Sc.	Master of Science
PGeo	Professional Geologist
RFI	Request for Further Information
RKd	Regionally Important Karstified (Diffuse) Aquifer
S.I.	Statutory Instrument (e.g., S.I. No. 113 of 2022)
TTACG	Tullacondra Turbine Awareness Community Group
ZOC	Zone of Contribution

I. INTRODUCTION

I.1 Background

Tullacondra Green Energy Ltd. has submitted a planning application (**No. 24/5503**) to Cork County Council for the construction, operation, and decommissioning of a wind energy development. The proposed project comprises nine wind turbines, a meteorological mast, an associated substation, and underground cabling to connect to the Electricity Supply Board Network (ESBN). The development is located around Tullacondra and adjacent townlands in Co. Cork, with two proposed options for Grid Connection Routes to the main substation in Mallow, Co. Cork.

An Environmental Impact Assessment Report (**EIAR**), prepared by RSK (Ireland) Ltd., accompanies the application.

I.2 Scope of Appointment

Aqua GeoServices Ltd. (**AGS**) were appointed by the Tullacondra Turbine Awareness Community Group (**TTACG**) to independently review the hydrogeological information submitted in the EIAR, including the applicant's responses to the Request for Further Information (**RFI**) issued by Cork County Council.

This report presents the findings of that review, focusing on the adequacy and reliability of the hydrogeological data provided to date.

I.3 Qualifications

This review was prepared by Bruno Teillard, a highly experienced hydrogeologist holding a French M.Sc. in Hydrogeology (with Distinction) and over 27 years of professional experience in Ireland and internationally. His professional certifications include:

- Professional Geologist (PGeo) with the Institute of Geologists of Ireland (**IGI**) since 2004
- European Geologist (EurGeol) with the European Federation of Geologists (**EFG**) since 2005

Mr. Teillard is also a member of the International Association of Hydrogeologists (**IAH**), a professional member of the Irish Association of Economic Geology, an associate member of the Geological Society (NI Regional Group), and is part of the panel of independent hydrogeologists approved to work on Irish Water projects.

He has extensive experience contributing to Environmental Impact Statements (**EIS**) and EIARs related to soils, geology, and hydrogeology dating back to 2000.

II. DOCUMENTS REVIEWED

To undertake the review of the hydrogeology chapter, the following documents and sections were examined:

- EIAR Volume II – Main Report Chapter 1: Introduction and Background
- EIAR Volume II – Main Report Chapter 9: Hydrology and Hydrogeology
- EIAR Volume II – Main Report Chapter 10: Land, Soils, and Geology
- EIAR Volume II - Chapter 20: Schedule of Mitigation Measures
- EIAR Volume III – Appendices for Chapter 9: Hydrogeology
- EIAR Volume III – Appendices for Chapter 10: Soils and Geology
- EIAR Relevant Drawings

All documents were obtained from the Cork County Council ePlan online inquiry viewer. It is important to note that no site visit or independent field verification was carried out as part of this review. Consequently, this assessment relies solely on the accuracy, completeness, and adequacy of the information provided by the applicant.

Additionally, the review included relevant sections of the applicant's response to Requests for Further Information (**RFI**) relating to geohazards and ground stability, as well as the proposed Construction Environmental Management Plan (**CEMP**) described in EIAR Volume III Appendices Chapter 5 – Project Description.

The response to the RFI was provided by the Tullacondra Turbine Awareness Community Group, while the CEMP was accessed via the Cork County Council ePlan online inquiry viewer.

III. PROJECT DESCRITION

The proposed project includes:

- The construction of nine wind turbines (three blades, type Vestas V-150) with a blade tip height of 175m, rotor diameter of 150m and hub height of 100m providing a power rating of 4.5MW each.
- Turbine foundations and crane pad hardstanding areas and associated drainage. It was noted that the turbine foundation would not extend deeper than 3.0m
- Upgrade of existing site tracks and construction of new site tracks and associated drainage.
- Access from the local public road L5302 at Croughta consisting of a new site entrance for the construction phase and upgrade of an existing entrance for the operational phase.
- An on-site 38kV electrical substation to Electricity Supply Board Networks (**ESBN**) specification to include control building with electrical infrastructure, welfare facilities supplied by rainwater harvesting and storage tank, a wastewater holding tank, car parking, security fencing and lighting, and all associated infrastructure services, and site works including a temporary construction compound.
- All associated underground electrical and communication cabling connecting the turbines to the proposed on-site electrical substation.
- A temporary construction compound and associated ancillary infrastructure including welfare services, office accommodation, parking, fencing, lighting etc.
- Areas for temporary storage of excavated materials.
- A permanent meteorological mast of 100m height above ground level on a concrete base.
- Installation of 38kV underground electrical cabling, mainly within the public road, between the proposed on-site windfarm substation to the Mallow 110kV substation boundary at St Joseph's Road, Mallow.
- All associated site works, including site clearance and ancillary development including site drainage, security gates, fencing, permanent and temporary signage and biodiversity mitigation and enhancements, including hedgerow planting.

The application is for a 10-year duration planning permission and a 35-year operational lifespan from the date of commissioning of the entire wind farm.

IV. HYDROGEOLOGY REVIEW

IV.1 Geological and Hydrogeological Setting (Baseline).

The baseline conditions relevant to the hydrogeology of the site are presented in Section 9.4 of the EIAR. The assessment methodology described in Section 9.2 indicates that a desktop study was undertaken using online sources (e.g. Geological Survey of Ireland, Environmental Protection Agency, Teagasc, Ordnance Survey of Ireland etc.) combined with site specific information obtained from a series of field inspections (reportedly carried out in June, September and October 2022) and a geophysical investigation consisting of 2D resistivity surveys conducted at selected locations (Full report contained in EIAR Volume II, Appendix 10.1).

The desktop study content and figures were compared to the online sources and no fundamental discrepancies were noted between online sources and the information presented in Chapter 9 of the EIAR.

The subsoil deposits (when present) do not hold any aquifer potential. Therefore, it is the bedrock aquifers that are considered to be the main receptors potentially at risk.

The Northernmost portion of the proposed windfarm site (encompassing T1, T2 and T3) is underlain by Waulsortian Limestones, which are classified as a "Regionally Important Karstified (diffuse) Aquifer (**RK_d**)".

The Southern portion of the proposed windfarm area is underlain by the following formations:

- Limestones of the Ballysteen Formation (T4, T5 and T6),
- the Lower Limestone Shale Formation and,
- the Old Red Sandstones Formation (encompassing T7, T9 and the substation).

In this later portion, the Lower Limestone Shale Formation has been classed as "Poor aquifer, bedrock which is generally unproductive except for Local zones" while all other formations have been classed as "Locally important bedrock aquifers, which are moderately productive only in local zones".

IV.2 Drainage and Water Features

Based on the information presented in the EIAR, the assessment of drainage channels and existing and proposed watercourse crossings appears sufficiently detailed. The consulting team has demonstrated a good understanding of the precise locations of these hydrological features, which is essential for designing and implementing effective mitigation measures during the construction phase.

A key feature of concern is a drainage channel previously identified as a "sinking stream[1]", highlighted in red on Figure 9.10a and discussed in Section 9.4.8.3 (Aquifer Vulnerability) of the EIAR.

This drainage feature, which encircles T1, T2, T3, and T4, should be regarded as a potential preferential pathway for the direct discharge of contaminants into the underlying groundwater system.

IV.3 Groundwater levels, flow direction and groundwater hydrochemistry

The development area is geologically complex, having experienced significant faulting and deformation over the geological times. Of particular concern is the Kilmaclenine Anticline, a prominent structural feature that "probably acts locally as both a groundwater and surface water divide[2]". Consequently, groundwater flow in the region is likely influenced not only by the dip of bedding planes but also by north–south trending faults, which could act as preferential flow paths if hydraulically active.

Further complexity arises from the karstic nature of the Waulsortian Limestone Formation, which underlies the locations of turbines T1 to T3. In karst terrains, groundwater flow is often disconnected from surface topography and can occur rapidly through solutionally enhanced features. The presence of numerous observable surface karst features strongly suggest the potential for fast groundwater movement through the bedrock, significantly increasing the risk of long-distance contaminant transport in the event of a pollution incident.

Despite these well-established hydrogeological sensitivities, Section 9.4.11 of the EIAR ("Groundwater Levels, Flow Direction & Groundwater Hydrochemistry") fails to provide any site-specific information on groundwater levels, flow direction, or hydrochemical baseline data. Notably, **no groundwater chemistry data is presented whatsoever.**

Instead, this section relies on a regional groundwater study undertaken 12 to 13 years ago, originally prepared for a different purpose, namely the delineation of groundwater protection zones for the Mountnorth Regional

[1] Source: EPA, Establishment of groundwater source protection zones Mountnorth Regional Water Supply Scheme, Mountnorth Spring and Borehole, December 2012.
[2] Source: EPA, Establishment of groundwater source protection zones Mountnorth Regional Water Supply Scheme, Mountnorth Spring and Borehole, December 2012

Water Supply Scheme. While some aspects of that study may offer limited relevance to the Grid Connection Routes (**GCR**), which cross the Zone of Contribution (**ZOC**) for the two local Public Supply Source Protection Areas, they are not applicable to the proposed turbine locations for the following reasons:

- The wind farm site lies in a different hydrogeological catchment;
- The referenced study was conducted for a different purpose, unrelated to this development;
- The study provides no site-specific hydrogeological data relevant to the proposed turbine area.

Furthermore, the boreholes drilled in response to RFI Item 2 (BH-T01 near T1 and BH-T05 near T5) did not provide any information regarding the depth to the water table. This was partly due to the rotary core drilling method employed, which used a water-based flush system. Without drilling supervision by a trained hydrogeologist, no valuable information would therefore be obtained. This shortcoming reflects a lack of foresight in the investigation strategy, as evidenced by the absence of provision to convert these coreholes into dual-purpose installations - for example, by retaining them as monitoring wells. Instead, they were backfilled shortly after drilling, precluding any opportunity for groundwater levels, future groundwater sampling, long-term observation, or hydraulic testing.

Significantly, the lithological description from BH-T01[3] indicates the presence of "brownish white mottled grey crystalline vuggy coarse grained dolomitised limestone". This rock type is associated with moderate to high secondary permeability, due to the presence of vugs, coarse grain size, and dolomitization - especially if the vugs are interconnected. The decision not to retain or test these coreholes as monitoring wells represents a missed opportunity for further hydrogeological investigation, including hydraulic testing.

This lack of fundamental site-specific hydrogeological data represents a substantial omission in the EIAR. A clear understanding of groundwater levels, flow direction, and baseline chemistry is essential for:

- Identifying potential groundwater receptors at risk during both construction and operational phases;
- Designing appropriate mitigation measures;
- Establishing an effective groundwater monitoring programme, if required.

Given the scale of the proposed development and the documented karst vulnerability of the underlying geology, this absence of such data is both concerning and unacceptable. The failure to conduct and present site-specific hydrogeological data undermines the integrity of the groundwater impact assessment and leaves critical risks unquantified.

IV.4 Wells

In rural areas such as Tullacondra and the surrounding townlands, which predominantly consist of agricultural land, it is reasonable to expect that most farms—and possibly some households—maintain private wells for domestic and/or commercial use.

While many homes may be connected to the local watermain where available, it cannot be assumed that all properties are connected. The potential reliance on private wells as a primary source of drinking water must therefore be fully considered in any environmental assessment.

Section 9.4.10 ("Wells") of the EIAR appears to rely solely on the Geological Survey of Ireland (**GSI**) well database. This database is widely acknowledged to be incomplete and is not an adequate substitute for field verification. The EIAR only refers to a small number of mapped wells in the vicinity and concludes that "any potential effect from the development is low risk for wells in the immediate vicinity, **although there is potential for farmyards and local dwellings to have private wells.**" This statement is contradictory and highlights the uncertainty created by the absence of direct investigation.

[3] Source: Drillhole log BH-T01, Tullacondra Wind Farm, Ground Investigation contract factual report, Irish Drilling Ltd. dated 23/01/25.

Furthermore, Section 9.4.14 ("Receptor Sensitivity") states that "no wells have been identified within the 250m buffer zone of shallow excavations along the Grid Connection Route (**GCR**), using the GSI database." Again, this offers no assurance regarding the true extent and location of potentially vulnerable groundwater receptors.

Given the scale of the proposed development, and the documented extreme vulnerability of certain areas—particularly those underlain by karstified limestone—this issue should have been properly addressed through dedicated field surveys. A targeted well survey should have been undertaken to identify all active domestic and agricultural wells in the vicinity of turbines, substations, haul roads, and cable routes. Disused wells should also have been recorded, as they may act as preferential pathways for groundwater contamination and, subject to landowner consent, could be repurposed for monitoring.

Where access is granted, representative wells should be instrumented for groundwater level and water quality monitoring. Such data would significantly improve confidence in determining groundwater flow direction and establishing baseline hydrochemical conditions prior to the commencement of construction works. The selection of water quality parameters should be risk-based and agreed with the local authority—e.g., including indicators relevant to oil and fuel spill risks.

Depending on the outcomes of a hydrogeological risk assessment, ongoing monitoring may be required at wells identified as being at higher risk from construction or operation of the proposed windfarm. The duration and frequency of such monitoring should also be determined in consultation with the local authority.

Finally, to ensure impartiality and technical integrity, all monitoring results should be reviewed by a Chartered Hydrogeologist or suitably qualified Water Engineer. Should any indication of groundwater contamination arise during the project, additional mitigation measures must be implemented without delay and verified by further sampling and analysis.

In summary, the EIAR's approach to identifying and assessing private wells and groundwater receptors is inadequate and does not meet the standard of environmental due diligence expected for a development of this magnitude. The omission of a comprehensive well survey introduces significant uncertainty and undermines the reliability of the groundwater impact assessment.

IV.5 Assessment of likely significant effects

The assessment of potential effects on hydrogeology is presented in Section 9.5 of the EIAR, with Subsection 9.5.2 focusing on specifically addressing likely significant effects during the construction phase.

It is acknowledged that the construction phase will involve only shallow excavations (approximately 3 metres in depth at turbine bases) and confirms that no dewatering or groundwater abstraction for potable supply is proposed.

However, the reliability of the impact assessment is fundamentally undermined by the lack of essential baseline data. The EIAR fails to establish the groundwater flow direction, nor does it provide site-specific information on groundwater depths. Furthermore, the identification of potentially affected domestic and farm wells relies entirely on desk-based analysis using the GSI database, without any field verifications or well survey. Given the known limitations of the GSI well database, and the vulnerability of karst aquifers present on site, the conclusions drawn in Section 9.5.2.11 regarding impacts on local groundwater supplies are unsubstantiated and must be revisited once appropriate field data has been collected.

Additionally, the EIAR refers to "Governing Industry Guidelines" in Subsection 9.2.2, citing a required 100m buffer between shallow excavations (e.g. site access tracks and cable trenches) and wells used for drinking water abstraction. The source cited for this buffer is EPA Water Advice Note No. 11: Technical Assessments and Prior Investigations. However, this reference is misleading and inappropriate in this context. EPA Advice Note No. 11 pertains to setback distances for landspreading of organic fertilisers and soiled water, which is unrelated to the nature of the works or the types of contaminants potentially arising from wind farm construction (e.g. hydrocarbons, concrete washout, sediment-laden runoff). Furthermore, the referenced statutory instrument (S.I. No. 610 of 2010) has since been superseded, with the most current version being S.I. No. 113 of 2022.

While the mitigation measures proposed (such as bunding, spill response planning, and surface water management etc.) generally align with industry good practice, their adequacy cannot be properly assessed in the absence of a robust risk assessment. Such an assessment would require at a minimum:

- Installation of a series of groundwater monitoring wells at strategic locations;
- Seasonal measurements of groundwater levels, determination of flow directions and hydraulic properties of the underlying bedrock aquifers;
- A comprehensive well survey to identify all domestic and agricultural wells within the proposed development's zone of influence, which shall be informed by field investigations and not standard buffer zones as these latter generally do not apply to karstic environments;
- Establishment of baseline groundwater quality and water table levels prior to construction;
- Continuous groundwater quality monitoring during the construction phase, with parameters tailored to the site-specific contaminants (e.g. hydrocarbons, concrete leachate, suspended solids), in consultation with the local authority.

In the absence of these essential data and monitoring provisions, the EIAR's assessment of likely significant effects on groundwater during construction remains incomplete, unverified, and of limited utility for an informed decision-making.

V. CONCLUSION

The hydrogeological assessment presented in the Environmental Impact Assessment Report for the proposed wind farm development is fundamentally inadequate and fails to meet the level of rigour required for a project of this scale, complexity, and environmental sensitivity. While the EIAR outlines the general hydrogeological context using publicly available data, it does not provide sufficient site-specific baseline information necessary to identify and evaluate the potential risks to groundwater receptors.

Key data gaps include the absence of direct measurements of groundwater levels, flow direction, and hydrochemistry, particularly within the highly vulnerable karstified Waulsortian Limestone aquifer. The reliance on outdated, regional-scale studies, carried out over a decade ago for unrelated purposes, further undermines the credibility and relevance of the conclusions drawn.

The EIAR also fails to properly address the presence and vulnerability of private wells. No targeted well survey was conducted, despite the rural, agricultural nature of the area and the known limitations of the Geological Survey of Ireland's well database. This omission renders the assessment of potential effects on groundwater-dependent receptors (such as domestic and/or agricultural wells) both speculative and unreliable.

Moreover, the mitigation strategy presented cannot be deemed robust or effective, as it is not based on a proper understanding of site-specific hydrogeological conditions. Without groundwater monitoring wells, verified receptor locations, and established baseline groundwater quality data, the proposed mitigation measures cannot be validated, and compliance with environmental protection standards cannot be assured.

Given the karstic geology (presence of many karstic features surrounding the proposed turbine locations), structural complexity, and documented extreme groundwater vulnerability of parts of the proposed site, the deficiencies in the EIAR's hydrogeological assessment represent a potentially serious and unacceptable risk to local water resources. These shortcomings render the EIAR's conclusions on likely significant effects incomplete and unreliable.

In light of these fundamental weaknesses, it is respectfully submitted that the planning authority should not grant permission for this development unless and until a comprehensive, site-specific hydrogeological investigation is undertaken, and a revised assessment, based on proper field data, is made available for public review.

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Expert Opinion re Letter of Instruction Ref 23408-24/JN/PW

This expert opinion is based on my qualifications, my experience of the national and international Thoroughbred industry (as attached in my outline CV) and on my professional roles as an expert witness in Court (including the High Courts of Ireland and the UK and in the Supreme Court in Australia) and in particular as an expert witness in many planning objections and appeals in Ireland, in Co Tipperary, in Co Meath and in Co Kildare.

The potential aversive effects of noises emanating from wind farms have been the subject of legal cases throughout the Western world where proprietors of horse facilities adjacent to wind farms attest that the sound (as well as the flicker of moving turbine blades) is aversive to horses and has safety ramifications for horse riders and handlers. In this context it is important to recognise that the scientific literature shows that the sensory abilities of horses differ from those of humans in a number of aspects in that horses can see almost a full circle around themselves, see better in low light than humans and can hear sound frequencies that humans cannot [1]. It is therefore inappropriate to attempt to simply extrapolate between human perceptions and those of horses. Noise and extraneous movement thresholds for horses are significantly lower than those for humans.

"Noise aversion" or "noise anxiety" are terms used when an animal over-reacts to noise and unpredictable noise cause the greatest cause the greatest fear reactions. These noises can have long lasting effects and have been reported to adversely affect food intake, growth and production rates[2],[3]. Severe noise anxiety is reported to cause serious welfare consequences, impacting both physiology (e.g. gastrointestinal signs, sweating) and behaviour (e.g. running, collisions with and breaking fences) of the horse[4]. Very anxious horses showed signs of noise reactivity frequently and their reaction did not improve with time (they do not habituate to these stimuli).

[1] Sensory abilities of horses. Rorvanq et al. Front Vet Sci. 2020; 7: 633.

[2] Tracey J.P., Fleming P.J.S. Behavioural responses of feral goats (*Capra hircus*) to helicopters. *Appl. Anim. Behav. Sci.* 2007;108:114–128

[3] Head H.H., Kull R.C., Campos M.S., Bachman K.C., Wilcox C.J., Cline L.L., Hayen M.J. Milk Yield, Milk Composition, and Behaviour of Holstein Cows in Response to Jet Aircraft Noise Before Milking1. *J. Dairy Sci.* 1993;76:1558–1567

[4] Maria Giorgia Riva, Francesca Dai, Mirja Huhtinen, Michela Minero, Sara Barbieri, and Emanuela Dalla Costa. The Impact of Noise Anxiety on Behaviour and Welfare of Horses from UK and US Owner's Perspective. Animals 12(10), 1319, May 2022

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Because they are a prey species, sensory systems of horses evolved to enable a prompt detection of potential danger, throughout a combination of visual, auditory and olfactory cues[5] [6] and unexpected and hitherto unknown noises elicit rapid flight reactions more frequently[7]. Horses are most easily scared by noise that arises outside their field of binocular vision[8]. Light flashes and unknown odours have also been reported to be potent inducers of fear reactions. It is noteworthy that compared to visual and olfactory stimuli, unexpected unknown noises (and movements) seem to elicit rapid flight reactions more frequently.

There is a high rate of incidence of injury (26%) among horses, rated as either anxious or very anxious, in the face of noise and / or light related flashes and simply moving horses to adjacent paddocks was found to be ineffective in 37% of cases. Noise has also been shown to elicit restlessness, vocalisation and colic / gastrointestinal disturbances[9] [10].

Many management strategies used in efforts to control the effects of noise have been shown to be ineffective. Placing horses in stables to try to prevent adverse effects is also unsatisfactory as those in single stables exhibit even stronger reactions to unknown stimuli, with an increased risk of accidents and adverse effects on welfare, which can include long term behavioural abnormalities[11]. Sedation can often give disappointing results and cause undesirable side effects and long term sedation is impractical and inhumane.

Injury to those persons who work with horses is a significant occupational hazard and can extend to thousands of accidents with associated fatalities[12] [13].
Very many high value Thoroughbred horses are insured through underwriter syndicate members of the Lloyds Livestock Committee in London. Many of these horses, singly or collectively, are insured for substantial seven figure sums. The Lloyds Livestock Committee have advised, through personal communication, that the normal terms and conditions of their all-risks mortality policy are null and

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[5] Christensen J.W., Keeling L.J., Nielsen B.L. Responses of horses to novel visual, olfactory and auditory stimuli. *Appl. Anim. Behav. Sci.* 2005;93:53–65

[6] Saslow C.A. Understanding the perceptual world of horses. *Appl. Anim. Behav. Sci.* 2002;78:209–224

[8] Algers B. A note on behavioural responses of farm animals to ultrasound. *Appl. Anim. Behav. Sci.* 1984

[9] Gronqvist G., Rogers C., Gee E. The management of horses during fireworks in New Zealand. *Animals.* 2016;6:20

[10] Dai F., Rausk J., Aspegren J., Huhtinen M., Cannas S., Minero M. Use of Detomidine Oromucosal Gel for Alleviation of Acute Anxiety and Fear in Horses: A Pilot Study. *Front. Vet. Sci.* 2020;7:573309

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void if horses are knowingly maintained or placed in situations of risk. They have advised that policies for horses on studfarms immediately adjacent to industrial scale solar plants may be subject to significant additional charges and exclusions or may be forfeit altogether.

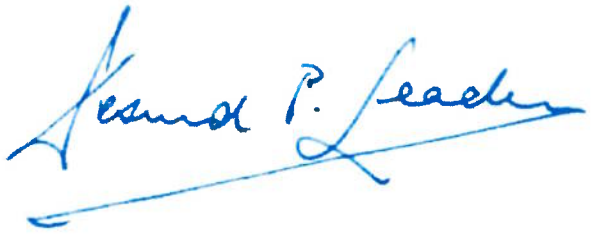
It is therefore entirely reasonable to state as in the Letter of Instruction Ref 23408-24/JN/PW that major wind farm proposals and adjacent viable thoroughbred breeding enterprises are incompatible land uses. I am in full agreement with the need identified in same, for a carefully evaluated buffer between these entities.

In this context I would cite the following from Whisperview Trading and Carriganog Racing, Carriganog, Owing Hill, Piltown, County Kilkenny, in response to Kilkenny County Council's notice pursuant to Section 12(1)(b) of the Planning and Development Acts 2000 (as amended), inviting submissions to the Draft Kilkenny City and County Development Plan 2021-2027 (the Draft Plan):

> *"Given the importance of the bloodstock industry nationally, regionally, and locally, and the sensitivity of equine facilities to environmental change and impacts, a specific policy should be included in the Renewable Energy Strategy that requires any renewable energy proposal within the County to include a detailed assessment of potential impacts on equine facilities within a 5 km radius. Any proposed development that has the potential to adversely impact the industry or the perception of the industry, will not be permitted."* (my underlining).

This is an eminently reasonable reconciliation of the needs for preservation of one of Ireland's premier industries and national assets, and the needs for the creation of renewable energy.

Signed and dated Monday 9th September 2024



Dr D.P. Leadon
MA MVB MSc FRCVS DipECEIM, European College and RCVS registered Consultant in Equine medicine

Abridged Curriculum Vitae

Dr Desmond Leadon MA, MVB, MSc, FRCVS, DipECEIM, European College & RCVS registered Consultant / Specialist in Equine Medicine

Qualifications

- Fellow of the Royal College of Veterinary Surgeons with more than 40 years of clinical veterinary experience. Diplomate of the European College of Equine Internal Medicine.
- Registered Consultant in Equine Medicine from both the RCVS and the European College of Equine Internal Medicine.

Positions Held

- Head of Equine Clinical Pathology at the Irish Equine Centre for 30 years. Current position there is that of Clinical Consultant.
- President British Equine Veterinary Association (1993-1994)
- President World Equine Veterinary Association (2001-2006)
- Founding Diplomate and former Vice-President of the European College of Equine Internal Medicine (2002 to 2008).
- International Director of the American Association of Equine Practitioners (2009 to 2012)
- Past Presidents Advisory Committee of the World Equine Veterinary Association (2006 to date).
- Chairman – Veterinary Advisory Committee - European Federation of Thoroughbred Breeders Associations.
- Chairman – Veterinary Advisory Committee - International Thoroughbred Breeders Federation

Presentations and Publications

- More than 200 presentations to national and international meetings and 80 contributions to the scientific literature.

Expert Advice

- Member of the International Movement of Horses Committee of the International Federation of Horseracing Authorities.
- Pre-movement inspector for the International Racing Bureau, the Hong Kong Jockey Club and the Saudi Cup.
- Commissioned to travel with horses to the 2020 Tokyo Olympics.
- Expert Advisor to the FVO of the EU on the transport of Horses.
- Member of the EFTBA delegation to EU Commissioner Phil Hogan and his officials at the EU Commission on the movement of horses
- Pre-Auditor (with Professor W Bayly) for South Africa's bid for the resumption of direct horse exports to the EU (2019).
- Expert Veterinary Advisor to the Lloyds Livestock Committee.
- Member of International Horse Sport Council Task Force on the Transport of Horses post Brexit and on the 2021 EU Animal Health Laws (2020 to present).

Awards

- Presented with the « Outstanding Contribution to the Thoroughbred Industry Award » by the Irish Thoroughbred Breeders Association (2014)

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Supplement to Expert Opinion Report

Re. Letter of Instruction 23408-24/JN/PW dated 11th September 2024

Date 13th June 2025

This supplementary report has been prepared at the request of Noonan Linehan Carroll Coffey LLP and is based on the Decision issued by Cork County Council on 22nd May 2025, the letter issued by Carol Nolan, Veterinary Inspector, for appeal to An Bord Pleanala.

Planners report and conclusions

1. Equine Welfare Assessment

The Planners report refers to a report commissioned by the developers. Its title is Equine Welfare Assessment. Its author lists 19 previous reports all of which were produced for developers and none of which were commissioned by members of the equine industry. This report consistently refers to the absence of refereed journal publications on the adverse impacts of wind turbines on equine welfare. It makes no reference to the need for application of the "Precautionary Principle" where this type of information does not exist viz; "In essence, it means that if a potential risk exists, action should be taken to prevent or mitigate it, even if the full extent of the risk is not yet known." The report also fails to acknowledge the fact that any study that sought to impose and measure adverse effects on animals would never be licensed and would contravene every animal welfare guideline consideration and legislation. The only certain means of ensuring that there are no adverse animal welfare impacts from these developments is not to place them in the immediate locale of the NSR's (Noise Sensitive Receptors) that are represented by Thoroughbred racehorses and breeding stock – as cited in the final para of my report of 11th September 2024, with reference the Whisperview Trading and Carriganog Racing to response to the Draft Kilkenny City and County Development Plan. This report is also factually incorrect. It states that "there is no evidence of a gallop or fences in the paddocks closest to the wind turbines". In reality Plot 5 is within some 75 metres from Turbine no 3. Furthermore all areas of Ballycushen are used in conjunction with the training of racehorses and the associated breeding enterprise. This report is highly selective in its references to published material and for example refers to a conference proceedings presentation on noise levels at the Melbourne Cup – which is in no way analogous to the proposed development and whose authors never intended it to be used for this purpose. It also repeatedly refers to a British Horse Society document, without acknowledging the importance of its statement that 20% of riders had experienced an adverse reaction to wind turbines. This is not compatible with the conclusion that "no medium to long term impacts are anticipated from

IRISH EQUINE FOUNDATION CLG, TRADING AS IRISH EQUINE CENTRE AND REGISTERED IN IRELAND. • **REGISTERED OFFICE:** JOHNSTOWN, CO. KILDARE • **REGISTRATION NUMBER:** 82008

the proposed development". Adverse reactions to wind turbines are an ever present and enduring hazard to horses, particularly for volatile Thoroughbreds and those who ride and work with them.

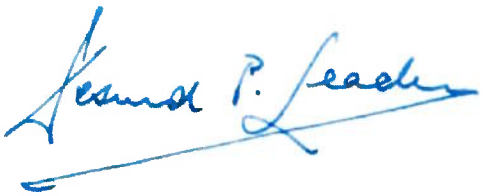
2. Planners report – further information assessment

The Planners report itself cites the 2006 Wind Farm Guidelines as making "no reference to livestock equine establishments, or bloodstock activity and that the current iteration makes no reference to same". Furthermore it states that there is an absence in the absence of national, regional or local policy in the present context. Irelands bloodstock industry is a national asset and the deliberate absence of policy as a means to facilitate these developments, while placing these assets at risk, is wrong and very damaging to the industry as a whole and to its individual stakeholders.

3. Carol Nolan, Veterinary Inspector, Cork County Council.

I note the email issued by Carol Nolan, Veterinary Inspector, Cork County Council and her conclusion that there are significant implications for personnel and equines arising from this development and I am in full agreement with her.

Signed;



.....

Dr Desmond Leadon MA,MVB, MSc, FRCVS, DipECEIM,
European College and RCVS registered Consultant in Equine Medicine
Clinical Consultant and Head; Clinical Pathology,
The Irish Equine Centre.

1. TITLE

Group Member Submissions on Specified Topics.

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2. Subject Application

TO:
Planning Department
Cork County Council
Carrigrohane Road
Cork

Planning reference No. 24/5503

Tullacondra Green Energy LTD.

The Applicant is seeking permission for the construction, operation and decommissioning of a Wind Energy Development including: . 9 wind turbines each with a blade tip height of 175 metres, rotor diameter of 150 metres, hub height of 100 metres and a rated output of .5 megawatts.
An on-site 38 kilovolt electrical substation.
Permanent meteorological mast of 100 metres height above ground level on a concrete base.
Installation of approx. 13.5 kilometres of 38kilovolts underground electrical cable, mainly within the public road between the proposed wind farm substation to the boundary of Mallow 110 Kilovolt substation at St Josephs Road Mallow

3. IMPACT ON EQUINE INDUSTRY

Ireland's racing and breeding industry is of international significance and is of disproportionate importance to its small population size. A report prepared by Deloitte entitled Economic Impact of Irish Breeding and Racing 2017 found that Ireland is the world's second largest producer of bloodstock by value and third largest producer of foals. Breeding and Racing activities in Ireland are the most prominent and important of any country on a per capita basis. By illustration there are over 50 thoroughbred horses per 10,000 of population in Ireland, compared to between three and five for Great Britain, France and the USA, with Australia the nearest at 28 horses.

The industry is a leading foreign-exchange earner and directly employs in the order of 15,200 full time equivalent staff in core Breeding and Racing industry and directly related industries and many thousands more indirectly. The equine industry made a direct economic contribution of €1.84 billion to the Irish economy in 2016. The Deloitte Economic Impact Report provides the following summary of the value of the industry to the national economy:

'The total direct and stimulated expenditure of the Irish Breeding and Racing industry is estimated as €1.84 billion in 2016, the core industry comprising €914m of this with secondary expenditure of €927m as the initial expenditure filters through the economy through business to business and induced consumer expenditure. The core Breeding and Racing industry is estimated to generate €1.05 billion gross expenditure, which results in economic input of €914m into the Irish economy....'

Safety Concerns associated with Wind Turbine Development.

Significant concerns in respect of the safety of both thoroughbred horses and personnel due to the risk associated with horses being spooked by noise and particularly shadow flicker associated with wind turbines due to their highly evolved flight response has been well documented by highly regarded industry sources.

The British Horse Society has issued advice on wind turbines which notes that 'horses are most likely to react to the noise made by wind turbines, the movement of blades, or movement of shadows cast by the blades'.

The BHS issued Advisory Statement No. 20 which states that 'the natural instinct of a horse when faced with perceived danger is flight so its reaction depends very much, on, in that first split second, the horse's perception of the hazard, and equally as important the riders ability to handle the horse...when faced with unexpected circumstances.' The BHS Advisory Statement relates to horses generally as opposed to thoroughbred horses. It is noted that the 'flight' reaction is especially heightened in thoroughbred horses. Thoroughbred horses are

highly strung and are more easily "spooked" than other horses as they have been bred to accentuate the 'flight' reaction and consequently, they are, and must be treated as, highly sensitive animals.

It is clear from the BHS Advisory Statement that sudden and unpredictable noises (in some instances accompanied by a continuous noise) are those which may result in potentially dangerous reactions from horse. Specifically, it advises that:

'A horse and rider unfamiliar with the area may react in a potentially dangerous manner to any of the following characteristics which can arise from the operation of a wind turbine:

'The low frequency noise emitted by the turbines punctuated by the "whoomph" as the blades pass the nadir point and sometimes said to be felt rather than heard,

'The unexpected starting up of the turbine if the wind builds up as a horse approaches.'

There are three aspects of wind energy developments which have the potential to result in significant risks to the safety of horses and personnel:

1. the movement of blades when they suddenly come into view
2. flicker which has been known to spook horses and is particularly pertinent in thoroughbred horses
3. the noise, particularly at start up.

Any of these characteristics could potentially trigger a 'flight' reaction in any of the thoroughbred horses/equines at surrounding equine facilities/farms.

It is not possible to provide specific thoroughbred horse based studies or reports in respect of these harmful effects. This is due to a combination of obvious animal welfare and financial factors. It is unacceptable on simple animal welfare grounds as well as completely impractical and uneconomical for any risk to be taken in respect of such high value bloodstock

A precautionary approach must be taken as even a perception of risk to the safety of thoroughbred horses, and the equine industry in general, can have an enormously damaging impact and such risk is therefore completely unacceptable to the equine industry.

As well as the significant safety concerns, the visual encroachment of wind turbine developments on stud farms and training yards has the potential to result in a flight of investment from Irish studs and stables. The visual context and presentation, perception and image of stud farms, training stables and associated lands are highly significant. A submission to the Targeted Review of the Wind Energy Development Guidelines by the Irish Thoroughbred Industry (Joint submission made 17th April 2014 by the Irish Thoroughbred Breeders' Association, the Irish Jockeys Association, the Irish Racehorse Trainers Association and the Association of the Irish Racehorse Owners, states that:

'Foreign and national investors and clients associated with the thoroughbred industry expect properties to have a rural idyll landscape, with highly maintained lush green pastures and high quality amenities to support the facilities' brand and reputation for providing elite thoroughbred horses. Investors, clients and visitors to Irish stud farms and training stables are

greeted with manicured grounds, high quality facilities and picturesque rural views and the national and international reputation and brand recognition of Irish Stud Farms and training stables is reinforced by the undisturbed rural landscape. This combination of elements is critical at an enterprise level and this rural image is highly sensitive to landscape changes of an incompatible nature, such as the proposed new generation of massive industrial and wind turbines. Any decline in the visual amenity of the surrounding rural area has the potential to negatively affect how stud farms and training stables in Ireland are received nationally and internationally. In other words, stud farms in Ireland, as well as our competitors abroad, make use of the scenic amenity values of the surrounding landscapes as part of their business image. The landscape of stud farm and stables is of special and possibly unique sensitivity to impacts on the scenic values of their settings and the pastoral image of stud farms and training stables is highly valuable to redirect and indirect visual impacts.'

Other factors to consider include

- Contamination of groundwater. The RSK report points out that groundwater vulnerability in the vicinity of Turbine 2 and Turbine 7 are extreme, and vulnerability in the vicinity of Turbine 1, Turbine 5 and Turbine 8 are high. Many equine farms (as well as dairy and mixed farms) in the area source their water from wells. These wells will no longer be able to provide a clean source of water. This will have a detrimental effect on these farms.
- Employers have an obligation to provide a safe place of work. In their position as employers the owners of equine premises have an obligation to conduct risk assessment studies under Health and Safety Legislation to provide a safe place of work. This will not be possible in the vicinity of wind turbines, whether they are under construction or fully commissioned.
  Equestrian consultant and former Irish Olympian John Watson has warned "that while private individuals can take their own chances on horseback, employers have statutory obligations to staff and cannot reasonably send out employees on horses where there is an identifiable risk that a horse might spook, its rider fall off, or cause an injury."
  Providing a safe place of work can also be extended to agricultural contractors who need to work the land on equine premises in the vicinity of wind turbines. Crops will have to be grown and harvested to feed the equines. Blade failure, noise and turbulence are only three risks that these contractors will encounter.
- Concerns regarding fertility in mares, and physical and mental development of young stock is also going to have an impact on equine premises. It is not uncommon for equines to develop stable vices such as wind sucking, box walking, weaving as a result of stress. This stress will be caused firstly during the construction stage of the wind turbines, and then from flicker and noise, and in particular Amplitude Modulation noise. This will have a massive impact on equine farms in the area.

ITBA Report on Wind Power on Thoroughbreds.

The following is a report undertaken by the ITBA (Irish Thoroughbred Breeders Association) on wind power developments in the vicinity of equine premises.

There is a concern for the safety of Ireland's primary resource, the thoroughbred horse, due to the very real risk of thoroughbreds being adversely affected by turbines being directly located within their range of vision. This is grounded by the fact that horses utilise what is termed the "flight response "in response to stimuli. Thoroughbreds are bred to accentuate this flight response and are less able to acclimatise to such a stimulus. The startled reaction of flight response can lead to serious injury to horses and people working with them. Injuries to young horses impact on their physical development and subsequent athletic performance.

Foreign investment is attracted to Ireland because of the quality of our land and the green approach. Any turbine development could risk the financial viability of the industry in its current form, resulting in a flight of capital from Irish studs and stables. It may also be a deterrent to future funding and support by overseas investors, who are integral to the industry. The imposition of these turbines on the community would seriously affect the value of bloodstock property in the area.

The health concerns raised focus on sleep disturbance as a result of noise and infrasound on the flicker of light reflecting off the rotating blades during periods of low sun and on the shadows of the blades during daylight hours are shared by many horse owners. Horses, in particular high value thoroughbreds are housed in order to prevent negative impact on thoroughbred operations.

Thoroughbred horses, horse racing and the industry itself are an integral part of "Irishness", not only for us as a country but also for millions of people the world over who place Ireland as industry leaders in our field. While the ITBA and indeed the bloodstock industry at large is supportive of all forms of renewable energy, including wind, for breeders in the locality there is the threat of disruption/annoyance to people and horses, the likelihood of lower property values and the long term transformation of our rural landscape.

The Irish bloodstock industry is under threat by a new generation of massive wind turbines which are an incompatible land use with established bloodstock industry. Revisions to the 2006 Wind Energy Development Guidelines should not facilitate clear threats to the viability of the thoroughbred industry in Ireland.

(a) Targeted revisions to Wind Energy Guidelines should prevent the potential negative impact of wind farm proposals on the safety of thoroughbred horses and personnel, in particular ridden horses, because of the risk of thoroughbreds being spooked as a result of seeing or

hearing the turbines (noting thoroughbred horses' highly evolved flight response and their particular sensitivity to perceived visual or auditory threats), and

(b) Targeted revisions to Wind Energy Guidelines should prevent the visible encroachment of wind turbine developments on the undisturbed rural landscape of stud farms and training yards which will result in a flight of investment from Irish studs and stables, particularly by overseas investors in our industry.

Therefore,

- *thoroughbred breeding facilities, such as stud farms, stables, training yards and gallops, should be added to the Wind Energy Development Guidelines' definition of 'Noise Sensitive Property', at Section 5.6.6 of the amended text to acknowledge the specific vulnerability of the industry to incompatible land uses such as wind farms,*
- *Additionally, noise limits referenced in Section 5.6.8 should be amended to apply at the boundaries of these thoroughbred breeding facilities.*
- *Separately, the definition of 'other affected property (e.g. existing work places or schools)' in Section 5.12.1, relating to Shadow* Flicker,

We would also highlight that the proposed windfarm is contrary to policy which seeks to recognise and support the development of the Irish sport horse industry, including breeding, competing and training. The proposed development will have a material impact on the ability of our members to continue to attract foreign direct investment to the country due to the potential impacts of shadow flicker and noise on the breeding and training by our members on day to day activities. Thoroughbred horses are recognised as 'flighty' and more highly strung than most horses and are more sensitive to the environment. While the Wind Industry might consider that some horses might become accustomed to the potential impacts, it is the case that horses are brought in from abroad on a temporary basis for breeding.

As such they do not have time to become accustomed to such impacts as shadow flicker and noise. This places the breeding aspects of our members under threat as the costs involved are very high. If it became the case that international breeders were of the view that a series of incompatible windfarms were impacting on the ability of horses to be 'covered' successfully then one of the pillars of the industry would be under serious threat.

Section 11.4.5 of the EIAR prepared by the applicant provides views in respect of the potential impact of windfarms on the bloodstock/equine industry. It is noted the assessment was as a result of a request at pre-application stage by Kildare County Council on foot of concerns expressed. The EIAR highlights that there is no reference to wind turbine effects on bloodstock activity in the Wind Farm Planning Guidelines. The ITBA made a submission on the concerns of the bloodstock Industry to the Targeted Review of the Wind Energy Guidelines in December 2014. It is hoped that the recommendations made by the ITBA are taken on board by the Department when the updated Wind Energy Guidelines are eventually adopted.

The EIAR purports to include relevant examples by Marshall Day Acoustics in relation to the potential impacts to horses. In response however, while proponents of wind farms might

argue that horses could gradually become accustomed to any visual or acoustic impacts from wind farms over time, this does not take into account the complexity of thoroughbred stud farm and thoroughbred training operations, especially those larger operations with international connections, as some stallions may be transported back and forth from the northern hemisphere to breeding facilities in the southern hemisphere for each breeding season and would therefore need to become re-accustomed to the presence of a wind farm each season in Ireland.

Furthermore, a significant component of stud farm operations relates to the covering of mares, many of which are short term visitors, attending the stallion's stud farm for a matter of just hours. There would be no opportunity for these visiting mares to become accustomed to the noise and potentially erratic movement of wind turbines in that short period.

In addition to this, new-born thoroughbred foals are easily startled, and it seems reasonable to expect that any real or perceived additional risk to the foals, or to mares or stallions, will be avoided by owners and managers alike.

There is a high turnover of horses in "breaking", pre-training and training stables. Horses in such facilities are particularly vulnerable to noise and visual distractions. Young thoroughbred horses being ridden in the vicinity of turbines would be exposed to unacceptable levels of risk – as would their riders.

The combined risk to horses and breeding operations from wind turbines' noise and potentially erratic sweeping movements are considered to represent a real concern for the stud farms, training stables and their clients and are viewed as a real safety risk to thoroughbred horses and to stud farm and training stable personnel.

Safety Issues – UK Case

With regard to safety issues, a recent planning appeal decided by the UK's Secretary of State for Communities and Local Government acknowledged, in one of the reasons given for refusing permission for a proposed development of 9 wind turbines, that the proposed development would have a potential significant adverse impact on three nearby equine businesses (stud farms) and that "considerable weight should be attached to this".

The Planning Inspector who reported to the Secretary of State on this case noted that: "There are 3 particular aspects of wind turbines that have a very significant detrimental effect on horses and riders compromising their safety. Firstly, the movement of the blades when they suddenly come into view from the road, the gallops or a paddock. The second is flicker which has certainly been known to spook a horse. Lastly, the noise of a group of very large turbines, particularly at start up and on a crowded site such as the southern group of 6, could have a very serious effect."

The Planning Inspector's report acknowledged that thoroughbred horses are "high value, highly strung and volatile" and that "where turbines would suddenly appear in the view" or

where shadows thrown by turbines are visible "there is the potential for spooking of highly strung and volatile horses".

The Planning Inspector's report for the Secretary of State continued by stating that: "*Whilst not every horse would be startled and as a result injure itself or its rider some would. In my view, the risks of this happening would exist over and above the normal risks these stables experience in dealing with this type of horse. These horses represent a significant investment. Thus, every horse owner who uses these stables and every potential client will believe that their valuable investment will be at risk and as such will go elsewhere. The horse racing industry is highly competitive and one where perception and reputation are significant drivers in choosing a trainer and yard. Thus, it strikes me as inevitable that the businesses would decline and given the particular impact of the wind farm would unlikely be replaced with anything similar.*"

Precedent

As a specific example of an industrial development proposal which threatened not only the operation of an internationally recognized stud farm in County Tipperary but also a wider confidence in the industry, it is noted that An Bord Pleanála refused planning permission for a biogas and biodiesel production facility at Castleblake, Rosegreen, Co. Tipperary, for the following reason:

'The site of the proposed development is located in open countryside in an area of national importance for the bloodstock industry alongside a major horse training establishment. It is the policy of the planning authority, as set out in the current South Tipperary Development Plan, to support the equine industry. It is also the policy of the Government to support the equine sector. It is considered that the proposed development of this large scale industrial type facility at this location, employing the particular technology on the scale proposed, having regard to its nature, scale and visual impact, would be incompatible with equine related activities in the vicinity and ***would be prejudicial to the viability of the equine industry in this area (including undermining confidence therein).*** *Notwithstanding the desirability of providing such facilities, it is considered that the proposed development would seriously injure the amenities of the area and property in the vicinity, would be incompatible with the surrounding land uses, and would, therefore, be contrary to the said Development Plan objectives and to national policy and to the proper planning and sustainable development of the area'. (emphasis added).*

In this case, the Planning Inspector's report for An Bord Pleanála stated that:

"The equine industry and in particular the bloodstock industry is a highly competitive commercial industry, which needs a high quality in relation to environmental standards and what could best be described as a clean image. This area of County Tipperary has developed a niche industry comparable with other bloodstock areas as for example Newmarket and Kentucky with major financial benefits to the area and any consideration of permitting

development must have to consider policy ENV 11, for proposals for non-agriculture related development."

The Planning Inspector noted that it could be necessary and appropriate to invoke the precautionary principle *"as we are not talking about just any agricultural operation, but one of the international leaders, a business that carries Ireland's reputation in the blood stock industry worldwide and one from which the local economy benefits well beyond the level were it to be of only local, or national standing".*

The Planning Inspector's report for An Bord Pleanála also noted that it should be a consideration in the planning process if one successful enterprise of benefit to an area's economy is placed at risk by a development, which is not by its nature locationally tied to the area. Therefore, the Planning Inspector's report stated that *"the onus is on any new development in the rural area and in particular non-agricultural development, which for reasons already outlined is not specifically locationally dependent to a rural area to demonstrate that it will not have a negative impact on the viability of existing stud farms or stables and that it is reasonable to consider the development in this context".*

When the real and perceived safety risk to thoroughbred horses and stud farm personnel is combined with the visual perception impacts, it is considered that there is a genuine risk that if these impacts become unacceptable to stud farm operators, especially major international operators with alternative breeding facilities abroad, these significant rural businesses may choose to move their operations abroad thereby drastically impacting on the entire Equine Industry in Ireland, and particularly on the Equine Industry Cluster identified with the midlands. The proposed development would undermine the current 'ecosystem' of premier equine operations and supporting rural enterprises which the County Development Plan is seeking to protect.

The attempt to locate this proposed development in close proximity to an incompatible land use such as the equine Industry should be a material factor in the determination of the proposal. Therefore we ask The Council to refuse permission for the large scale industrial windfarm.

Incompatible land-uses:

It is our considered view that major wind farm proposals and viable thoroughbred breeding enterprises are incompatible land-uses.

If large wind farm proposals are allowed to encroach upon established thoroughbred breeding facilities in Ireland without regulation or guidance, the country's high calibre of bloodstock would be directly and immediately threatened by real or perceived equine health impacts, caused by noise, vibration or visual stimuli, and the national and international reputation and brand recognition of Irish stud farms and training stables could be permanently damaged, which could in turn threaten Ireland's status as an international centre of thoroughbred breeding excellence in the world. This would pose a major systemic threat to the long

established thoroughbred breeding industry in Ireland and the many ancillary rural industries that have grown around it.

A common planning response to incompatible land uses is to demarcate buffer zones to keep them apart. Defining an adequate buffer distance between thoroughbred stud farms and wind turbines is not simple and no minimum buffer distance is proposed because not every wind turbine will have the same potential impacts on adjacent land uses, especially taking into account the specific topography and land-cover in between. With this in mind, acceptable levels of impacts from wind turbines on stud farms and training stables should be variable, not fixed, and therefore should be determined carefully on a case-by-case basis. However, a buffer between wind farm proposals and existing stud farm and training stable facilities should be sufficiently sized to prevent and avoid all potential impact on the continued operation of these thoroughbred breeding businesses. It is possible that an adequate buffer distance in this instance could be measured in kilometres, not hundreds of metres. No alternate mitigation measures could suffice.

Therefore, any wind farm proposal contemplated in the vicinity of an established stud farm or training stable should be required to demonstrate that its impacts will not affect the viability of the stud farm or training stable. Considerable buffering will be necessary to shield the thoroughbred facilities from the visually perceptible elements of a proposed wind turbine, taking into account both distance and topography between the established facilities and the proposed wind turbine. It is submitted that the planning application material accompanying the proposal does not fully appreciate or assess the potential impacts on the Bloodstock/Equine Industry.

Conclusion.

The development of a wind farm by Tullacondra Green Energy Limited would have devastating and detrimental effect on the families and farms in the area that generate income from the various equine industries. It would make handling equines unsafe, from the amateur setup of parents and children using the roads to exercise their ponies, to the more professional setups of individuals training well bread highly valuable thoroughbred racehorses, to international eventers and showjumpers.

The breeding of all equines in the area would also be compromised. There are several individuals in the area breeding highly valuable flat and national hunt foals, and sport horses.

In some instances turbine blades would be within touching distance of the boundary fences of racing business, equine businesses and premises where equines are kept, and others would be far less than the recommended distance.

This would lead to a situation where it would be very difficult and expensive, or impossible, to get employer and public liability insurance. Businesses cannot operate without adequate insurance cover, therefore making it impossible to continue their business models. This would impact negatively on several levels: staff redundancies, indirect employment (vets, farriers, transport companies, local shops, fuel companies, horse feed suppliers and small businesses in the local community) and personal income and revenue streams would stop. This will have catastrophic impact on the local community.

Attached are letters from Dr. Des Leadon FRCVS head of Clinical Pathology at the Irish Equine Centre and Ryan McElligot of the Irish Racehorse Trainers Association supporting such views.

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Expert Opinion re Letter of Instruction Ref 23408-24/JN/PW

This expert opinion is based on my qualifications, my experience of the national and international Thoroughbred industry (as attached in my outline CV) and on my professional roles as an expert witness in Court (including the High Courts of Ireland and the UK and in the Supreme Court in Australia) and in particular as an expert witness in many planning objections and appeals in Ireland, in Co Tipperary, in Co Meath and in Co Kildare.

The potential aversive effects of noises emanating from wind farms have been the subject of legal cases throughout the Western world where proprietors of horse facilities adjacent to wind farms attest that the sound (as well as the flicker of moving turbine blades) is aversive to horses and has safety ramifications for horse riders and handlers. In this context it is important to recognise that the scientific literature shows that the sensory abilities of horses differ from those of humans in a number of aspects in that horses can see almost a full circle around themselves, see better in low light than humans and can hear sound frequencies that humans cannot [1]. It is therefore inappropriate to attempt to simply extrapolate between human perceptions and those of horses. Noise and extraneous movement thresholds for horses are significantly lower than those for humans.

"Noise aversion" or "noise anxiety" are terms used when an animal over-reacts to noise and unpredictable noise cause the greatest cause the greatest fear reactions. These noises can have long lasting effects and have been reported to adversely affect food intake, growth and production rates[2,3]. Severe noise anxiety is reported to cause serious welfare consequences, impacting both physiology (e.g. gastrointestinal signs, sweating) and behaviour (e.g. running, collisions with and breaking fences) of the horse[4]. Very anxious horses showed signs of noise reactivity frequently and their reaction did not improve with time (they do not habituate to these stimuli).

[1] Sensory abilities of horses. Rorvanq et al. Front Vet Sci. 2020; 7: 633.

[2] Tracey J.P., Fleming P.J.S. Behavioural responses of feral goats (*Capra hircus*) to helicopters. *Appl. Anim. Behav. Sci.* 2007;108:114–128

[3] Head H.H., Kull R.C., Campos M.S., Bachman K.C., Wilcox C.J., Cline L.L., Hayen M.J. Milk Yield, Milk Composition, and Behaviour of Holstein Cows in Response to Jet Aircraft Noise Before Milking1. *J. Dairy Sci.* 1993;76:1558–1567

[4] Maria Giorgia Riva, Francesca Dai, Mirja Huhtinen, Michela Minero, Sara Barbieri, and Emanuela Dalla Costa. The Impact of Noise Anxiety on Behaviour and Welfare of Horses from UK and US Owner's Perspective. Animals 12(10), 1319, May 2022

IRISH EQUINE FOUNDATION LTD. TRADING AS IRISH EQUINE CENTRE IS REGISTERED IN DUBLIN, IRELAND • REGISTERED OFFICE: MERRION SQUARE • REGISTRATION NUMBER: [illegible]

Because they are a prey species, sensory systems of horses evolved to enable a prompt detection of potential danger, throughout a combination of visual, auditory and olfactory cues[5] [6] and unexpected and hitherto unknown noises elicit rapid flight reactions more frequently[7]. Horses are most easily scared by noise that arises outside their field of binocular vision[8]. Light flashes and unknown odours have also been reported to be potent inducers of fear reactions. It is noteworthy that compared to visual and olfactory stimuli, unexpected unknown noises (and movements) seem to elicit rapid flight reactions more frequently.

There is a high rate of incidence of injury (26%) among horses, rated as either anxious or very anxious, in the face of noise and / or light related flashes and simply moving horses to adjacent paddocks was found to be ineffective in 37% of cases. Noise has also been shown to elicit restlessness, vocalisation and colic / gastrointestinal disturbances[9] [10].

Many management strategies used in efforts to control the effects of noise have been shown to be ineffective. Placing horses in stables to try to prevent adverse effects is also unsatisfactory as those in single stables exhibit even stronger reactions to unknown stimuli, with an increased risk of accidents and adverse effects on welfare, which can include long term behavioural abnormalities[11]. Sedation can often give disappointing results and cause undesirable side effects and long term sedation is impractical and inhumane.

Injury to those persons who work with horses is a significant occupational hazard and can extend to thousands of accidents with associated fatalities[12] [13].
Very many high value Thoroughbred horses are insured through underwriter syndicate members of the Lloyds Livestock Committee in London. Many of these horses, singly or collectively, are insured for substantial seven figure sums. The Lloyds Livestock Committee have advised, through personal communication, that the normal terms and conditions of their all-risks mortality policy are null and

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[5] Christensen J.W., Keeling L.J., Nielsen B.L. Responses of horses to novel visual, olfactory and auditory stimuli. *Appl. Anim. Behav. Sci.* 2005;93:53–65

[6] Saslow C.A. Understanding the perceptual world of horses. *Appl. Anim. Behav. Sci.* 2002;78:209–224

[8] Algers B. A note on behavioural responses of farm animals to ultrasound. *Appl. Anim. Behav. Sci.* 1984

[9] Gronqvist G., Rogers C., Gee E. The management of horses during fireworks in New Zealand. *Animals.* 2016;6:20

[10] Dai F., Rausk J., Aspegren J., Huhtinen M., Cannas S., Minero M. Use of Detomidine Oromucosal Gel for Alleviation of Acute Anxiety and Fear in Horses: A Pilot Study. *Front. Vet. Sci.* 2020;7:573309

[11] Lesimple C., Fureix C., LeScolan N., Richard-Yris M.A., Hausberger M. Housing conditions and breed are associated with emotionality and cognitive abilities in riding school horses. *Appl. Anim. Behav. Sci.* 2011

[12] Holler A.C. Am Ind Hyg Assoc J 1984 Jan;45(1):34-8.

[13] Gimsing S. Hesterelaterede arbejdsskader 1992-1999 [Horse-related occupational injuries 1992-1999]. Ugeskr Laeger. 2001 Oct 22;163(43):5982-5.

void if horses are knowingly maintained or placed in situations of risk. They have advised that policies for horses on studfarms immediately adjacent to industrial scale solar plants may be subject to significant additional charges and exclusions or may be forfeit altogether.

It is therefore entirely reasonable to state as in the Letter of Instruction Ref 23408-24/JN/PW that major wind farm proposals and adjacent viable thoroughbred breeding enterprises are incompatible land uses. I am in full agreement with the need identified in same, for a carefully evaluated buffer between these entities.

In this context I would cite the following from Whisperview Trading and Carriganog Racing, Carriganog, Owing Hill, Piltown, County Kilkenny, in response to Kilkenny County Council's notice pursuant to Section 12(1)(b) of the Planning and Development Acts 2000 (as amended), inviting submissions to the Draft Kilkenny City and County Development Plan 2021-2027 (the Draft Plan):

> *"Given the importance of the bloodstock industry nationally, regionally, and locally, and the sensitivity of equine facilities to environmental change and impacts, a specific policy should be included in the Renewable Energy Strategy that requires any renewable energy proposal within the County to include a detailed assessment of potential impacts on equine facilities within a 5 km radius. Any proposed development that has the potential to adversely impact the industry or the perception of the industry, will not be permitted."* (my underlining).

This is an eminently reasonable reconciliation of the needs for preservation of one of Ireland's premier industries and national assets, and the needs for the creation of renewable energy.

Signed and dated Monday 9th September 2024



Dr D.P. Leadon
MA MVB MSc FRCVS DipECEIM, European College and RCVS registered Consultant in Equine medicine

Abridged Curriculum Vitae

Dr Desmond Leadon MA, MVB, MSc, FRCVS, DipECEIM, European College & RCVS registered Consultant / Specialist in Equine Medicine

Qualifications

- Fellow of the Royal College of Veterinary Surgeons with more than 40 years of clinical veterinary experience. Diplomate of the European College of Equine Internal Medicine.
- Registered Consultant in Equine Medicine from both the RCVS and the European College of Equine Internal Medicine.

Positions Held

- Head of Equine Clinical Pathology at the Irish Equine Centre for 30 years. Current position there is that of Clinical Consultant.
- President British Equine Veterinary Association (1993-1994)
- President World Equine Veterinary Association (2001-2006)
- Founding Diplomate and former Vice-President of the European College of Equine Internal Medicine (2002 to 2008).
- International Director of the American Association of Equine Practitioners (2009 to 2012)
- Past Presidents Advisory Committee of the World Equine Veterinary Association (2006 to date).
- Chairman – Veterinary Advisory Committee - European Federation of Thoroughbred Breeders Associations.
- Chairman – Veterinary Advisory Committee - International Thoroughbred Breeders Federation

Presentations and Publications

- More than 200 presentations to national and international meetings and 80 contributions to the scientific literature.

Expert Advice

- Member of the International Movement of Horses Committee of the International Federation of Horseracing Authorities.
- Pre-movement inspector for the International Racing Bureau, the Hong Kong Jockey Club and the Saudi Cup.
- Commissioned to travel with horses to the 2020 Tokyo Olympics.
- Expert Advisor to the FVO of the EU on the transport of Horses.
- Member of the EFTBA delegation to EU Commissioner Phil Hogan and his officials at the EU Commission on the movement of horses
- Pre-Auditor (with Professor W Bayly) for South Africa's bid for the resumption of direct horse exports to the EU (2019).
- Expert Veterinary Advisor to the Lloyds Livestock Committee.
- Member of International Horse Sport Council Task Force on the Transport of Horses post Brexit and on the 2021 EU Animal Health Laws (2020 to present).

Awards

- Presented with the « Outstanding Contribution to the Thoroughbred Industry Award » by the Irish Thoroughbred Breeders Association (2014)

IRTA
IRISH RACEHORSE TRAINERS ASSOCIATION

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Our Ref: AOG/RMC

29th August 2024

Dear Sir/Madam,

I write to you on behalf of Arthur O'Grady who is a member of the Irish Racehorse Trainers Association (IRTA). In recent weeks Mr O'Grady contacted me as the head of his representative body to outline his concerns about the development of a wind farm adjacent to his premises.

As Mr O'Grady has outlined to you a wind farm represents a hazard for his business as there will exist a significant health and safety hazard to both horse and rider. Mr O'Grady notes that the British Horse Society has found that horses are spooked by the noise, blade movement and shadow flicker created by wind turbines.

The potential health and safety hazards presented by this proposed development could have a very grave impact on Mr O'Grady's training business to the point where closure and the winding up of the business is a very real and live possibility.

Any development that could impact on one of the IRTA's members to this extent is one of grave concern to this organisation whose members play such a vital role in rural communities throughout the country. I would ask you to take on board these pressing concerns as the closure of such a business which plays its part in maintaining a vibrant rural community would be regrettable in the extreme.

Yours Sincerely

Ryan McElligott
CEO Irish Racehorse Trainers Association

4. EFFECT ON COMMUNITY

The community of Ballyclough, Lisgriffin and Hazelwood with the support of our neighbouring communities would like to express our strong objection to the installation of wind turbines and associated works in our small community. While there may be arguments in favour of renewable energy sources such as wind power, the negative effects that these turbines can have on our community cannot be ignored.

First and foremost, the visual impact of these towering structures on our landscape cannot be understated. These wind turbines standing at 175 metres would be some of the tallest in the country. Our community is known for its natural beauty and pristine surroundings, and the presence of industrial-sized wind turbines would greatly diminish the aesthetic appeal of our area. This could have a detrimental impact on the local community.

They have shown no consideration whatsoever to the people of our community. Some of these structures will be within 500 metres of homes with a lot of them only 750 metres from people's homes and livelihoods. Lisgriffin Primary School will be under 2 kilometres from these structures and to make it worse it will be to the North side; this gives a massive chance of light flicker effecting the students.

As is the case in most rural areas, Ballyclough, Lisgriffin & Hazelwood are close knit communities. In rural areas we are known to look out for one another. However, our good nature has been taken advantage of by this greedy Green Energy Company, coming into our villages and offering sponsorship to influential members of Community, to gain support for their project. This has caused great rifts among people who have grown up together, represented their community in sport and many more activities. It has caused great anxiety in planning functions and weeding's etc. We now feel we must take sides.

We feel that there has been a lack of meaningful consultation with the local community regarding this development. Contrary to what is stated on their website, that they have been in constant consultation with the Community since November 2022, in fact there was only **ONE** public meeting which was held in Springfort Hall on 8th February 2023. The concerns of residents, particularly about the scale and location of the turbines, have not been adequately addressed. Effective community engagement is essential for projects of this magnitude, and the current process has fallen short.

Many a great friendship has been lost because of this.

With the possibility of the wind turbines coming to our community we fear that they could diminish our community. It has been noted of other communities around Ireland where people have been selling their homes and in turn what we're thriving communities they are now desolate. The communities are left with empty houses for sale with nobody willing to purchase them. Where once was a growing population it turns out that families that have lived in the area for generations are now being forced to move away. Local schools and clubs struggle with numbers to keep going.

Our community has always been a stronghold for the local agricultural and equestrian industry, with Ballyclogh having a rich history of farming; Ballyclogh Creamery was founded in the early 1900s and grew to join forces with Mitchelstown Co-op to form Dairygold Co-Op, now one of the largest Co-Op's in the country.

In light of these concerns, we strongly urge the Planning Department to reject this application. While renewable energy is important, the negative impacts of this particular project on our community are too significant to overlook.

5. ENVIRONMENTAL IMPACT

a) CO2: It is a well-known ecological fact that the generation of concrete is not environmentally friendly.

"Carbon dioxide emissions and climate change; The CO_2 produced for the manufacture of structural concrete (using ~14% cement) is estimated at 410 kg/m^3 (~180 kg/tonne @ density of 2.3 g/cm^3)."

It is understood that a minimum of 30 lorry loads of concrete, each approx. 8 cubic meters, are needed to support 1 base to hold 1 turbine. That means at least 3,280 kg of CO2 is produced for each load. Multiplied by 9 is nearly 10,000kg of CO2. And that does not include the 10^{th} pylon base to support a 100 meter meteorological mast on a concrete base. How can this be 'good' for the environment?

b) Habitat Destruction: The proposed works and subsequent turbines will lead to a decline in biodiversity. It will impact on species, primarily birds and bats and harm species through disturbance, habitat loss and collision.

c) Water Pollution: Run off may contain harmful chemical sediment. There may be contamination of local surrounding water sources / wells.

d) Waste Generation: Due to the nature of concrete the generation of waste in the future will be significant as it is difficult to recycle or dispose of responsibly. "Steel has a lower embodied carbon impact than concrete and generates less waste"

e) General:

The application has shown several habitats in the location or near the proposed site. One North East of the wind farm in an area of scrub.This water habitat is of ecological value and supports a wide range of species. We may be affected by pollution during the construction and decommissioning phase of the project.

There is a wetland area within the proposed site which will may also be affected by construction

"The project proposes some permanent (89 m) and temporary (11m) of treeline loss" which will have a major impact on the habitat there.

"The project plans some permanent (221m) and temporary (220) removal of hedge-grow to facilitate the construction and transportation of wind turbines"

However, in chapter "Project need and Alternatives considered" the loss of hedge grows is considered much greater.

Scrub removal at certain points on the turbine delivery site is also proposed though some of these scrub areas have the presence of Japanese Knotweed, which is considered an invasive species. Other invasive species such as Giant Hogwood, Himalayan Balsam, Giant Rhubarb

were also identified during the Habitat Survey. Construction and removal around these areas may well lead to the further spread of the weeds.

The proposal is a temporary loss of approx. 8.36 ha during construction.

While mitigation factors have been included to replace hedgerow and trees it will take years to replace this amount of loss and the habitat that will be lost as a result of the proposed construction.

The area in Tullacondra and surrounding areas have many underground watercourses. These may be affected during construction especially in times of wetter weather when run off will occur. These underground waterways are the source of much of the human and animal water consumption in the larger area due to private wells. If this water becomes contaminated due to run off the implications for human and cattle will be adverse.

There is a stream within 80m of the proposed T1 on the site. The site also contains may drainage ditches and these may flow to the stream which is directly connected to the Blackwater River (Cork/Waterford)SAC.

Pollution of these water course will have significant impact on the ecology of the area as well as human health

6. HEALTH IMPLICATIONS OF WIND TURBINES

The Planning applicant has stated in their application that 'There is potential for adverse effects on human health during the wind farm construction Phase' citing emission to water of hydrocarbons and release of slit- laden runoff into water courses which could potentially pollute water supplies and the release of dust and exhaust emissions to the air which could increase air pollution causing increased risk of stroke, heart disease, lung cancer, and chronic acute respiratory conditions. The effect of this on those in our communities that already suffer from ill health and related issues will be adverse with both children and adults.

Noise and shadow flicker produced by wind turbines are two major elements associated with health problems. The World Health Organization conducted research that there is an increased risk of depression to those affected by shadow flicker of wind turbines. This is due to the intermittent shadow caused by rotation of blades.

Wind turbine noise and shadow flicker will have a substantial interference to our homes causing sleep disruption, anxiety levels will increase and overall psychological distress.

As we know from other local communities that noise, vibration and shadow flicker has had a huge effect on children with Autism, ADHD and Epilepsy. Further health related problems such as headaches, tinnitus, nausea and vertigo have also been associated with wind farms. Families with children of special needs throughout the country had no choice but to leave their family homes.

These proposed wind turbines of 175m (three times the height of Cork County Hall) x 150m span will be a wall of 1.5 Kilometers which will impact our scenic landscape for the next 35 years. There is no doubt that this will lead to displacement of community families where people will feel isolated which will then have a devasting effect on metal health.

7. IMPACT TO BOVINE SECTOR

The local community of Lisgriffin and Ballyclough and surrounding areas consist of high density dairying and livestock farming. We object to the above planning on the grounds laid out below. There are also Blood stock farms adjacent to the proposed site and the effect on them is laid out in another area of the submission

The area here in North Cork is very well suited to producing milk and quality cattle and is not a suitable location for wind turbines. Most if not all dairy farmers in the area supply their milk to the local Cooperative Dairygold where it is processed and becomes part of the essential food chain in this country. Farming in the area also provides much direct and indirect employment. Passing a viable farm on from one generation to the next keeps the younger generations in the rural area and ensures the ongoing viability of the farm. With out viable farms the younger generations will move away to bigger towns and cities leaving our beautiful country side and farms will lay derelict and empty.

If the application is approved and construction goes ahead the following will happen There will be huge disturbance of the ground in the proposed site. This can have an immediate and adverse effect on the local wildlife esp on Badgers. Having been displaced from their natural habitat due to its destruction these badgers will have no choice but to move further afield to create new habitats In doing so some will bring the disease Bovine Tuberculosis with them. Badgers will need to access cattle troughs for water and in doing so will start the spread of the disease to the bovine population in the vicinity. Once in a herd this disease will spread among the other close animals. During a routine herd test these animals will test positive for the disease and will have to be culled from the herd to try and minimize the spread of the disease. 1 Culling animals have several consequences.

1. milking animals taken from the herd result in less milk production

2. This leads to less income for the farmers.

3. It leads to much stress and worry for the farmers who have animals with TB.

4. If the disease becomes too prevalent in the herd the whole herd is culled.

5. The farmer and his family are now left without their source of income, their livelihood is decimated and the level of anxiety and stress caused will lead to major varied health problems.

6. Many farmers may make the decision to quit farming be it dairy or beef.

A study took place in Galway between 2011 and 2019 of the M17/M18 involving the upgrade and construction of motorway through the open countryside mainly composed of grassland. This study presents the following

1. Evidence of an association between road construction including large ground disruption and an increased risk of Bovine TB breakdown among cattle herds. An increased risk of the

Bovine TB outbreak was observed in herds within 1km of major roadworks during the construction and post construction (both single and multi reactor Bovine TB breakdowns)

2. Until further data become available the study recommends "that badgers are vaccinated, as a precautionary measure in advance of the commencement of major roadworks"

3.The report further states that "in recent years concerns have been raised in Ireland, and particularly in the farming and veterinary community, about the potential adverse consequences for the bTB control following vegetation clearance, excavation, fencing and earth moving (Gaughran et al.,2020:lesmerises et al 2013) Preventative Veterinary Medicine Volume 198, January 2022

"Is there an association between road building and bovine tuberculosis herd risk? A three time-point study in Ireland 2011-2019"

If the proposed Windfarm is built in this area the noise and flicker will contribute to other animal issues. Animals, especially dogs , horses and cows are animals that become very nervous when a routine or location or environment in the immediate area is changed. This will make them more nervous and excited and in turn make them more dangerous to handle. All the above animals are very sensitive to noise much more so 2 than humans. The flicker on affected farms will also cause stress on the bovine population during the Summer while out grazing but especially in the winter while animals are housed. There is also risk of early abortion in breeding animals due to the stress brought on from the above

How Does Wind Power Affect Livestock Husbandry?

" For farm animals that are sensitive to sudden changes in their environment, the sight, sound, and vibrations coming from the turbines can cause anxiety and stress. The wind turbines' emission of low-frequency sound waves, inaudible to humans, can also be unsettling to animals, affecting their behavior and productivity. From cows to sheep, studies indicate that some livestock species can perceive the turbines as a source of danger as they produce a low humming noise that can be heard over long distances. In response to this threat, animals may show signs of unease, stop grazing, and, in extreme cases, run away from the pasture."

Moreover, the presence of wind turbines can cause changes in the local microclimate, which can have additional effects on livestock. Glare from the turbines can cause animals to overheat in summer, while ice build-up can occur in winter, making feeding difficult. Since wind power plants often require access roads, the use of heavy machinery can also damage land and lead to soil erosion, impacting livestock farming negatively.

" What Are The Economic Impacts of Wind Power on Livestock Farming?

The negative behavior of animals due to wind turbines can have significant economic impacts on livestock farming. Farmers may experience a decrease in livestock productivity, with animals that are not feeding adequately resulting in less yield. For example, milk yields in dairy cows are known to decline under the effect of wind turbines.

https://energysavingslab.com/renewable-energy/wind-power/how-does-wind-power-impact-the-livestock-industry/

8. ECONOMIC IMPACT – Negative Equity

This area does not rely on Qualitative analysis, only on Quantitative analysis. This covers research carried out by Gillespie & McHale layered upon 18 key papers published both in Europe and in the United Stated & Canada.

Auctioneer valuations are, in our opinions, not required as the studies were undertaken by qualified Applied Economists.

In the 18 key papers mentioned above, **all European based studies consistently find significant negative impacts on residents near turbines.**

All references are contemporaneous unlike the 2006 guidelines that are currently being observed by the Planning office for Cork County. The 2006 guidelines are oblivious to the increases in scale that have taken place in the past 18 years.

The proposed Tullancondra development comprised 9 turbines in relatively close proximity, each of a height of 175mt. Dröes and Koster (2021) evaluate the effect of turbine height, finding significantly greater effects from turbines taller than 150m compared to turbines shorter than 50m, up to 2.5km away. Dröes and Koster also assert that distance to nearby turbines is a good proxy of all negative impacts experienced by residents.

While this group accepts the need for the increased investment in renewable energy, as development increases there is an obvious commercial desire, on the part of developers, to utilise the most convenient and accessible sites first. Economics, absolutely, has to be a factor for the developer in identifying a site.

If the development is approved, Economics will also have a part to play for the residents in the area. As is shown in the studies cited, there is to be a significant negative economic impact for the residents within the 5km range of the turbines. As is the case for the majority, our house is the single most valuable asset. It is the main store of value we possess. The Gillespie & McHale working paper clearly illustrates the acute decline in property value over the 10 years, post-construction of the turbines.

A clear re-distribution of wealth occurs, from the local residents to the developer/land-owners. Gillespie & McHale's sample is significant, comprising **64,163 observations** of properties within a 15km range of turbines in the **POST-CONNECTION** period.

Their finding are summarised as follows:
Baseline Effects (compared to Property 5-15km to nearest turbine) show a strong negative price effect of **14.7%** with each additional turbine within 1KM leading to an additional negative **2%** effect.

(These figures are based on <150mt turbine height)

Height Effects Table 4 Gillespie & McHale outlines that turbine height is influential in values. Turbines greater than 125mt incur a discount of **22.9%** at 1km but the negative effects persist up to 5km.

Urban Influence Effects underscores the negative impact of the turbines on rural areas, with the most significant negative effect in rural areas with moderate urban influence at 20.1%.

The proposed Tullancondra development lies in one of these rural areas.

The siting of Turbine Farms is not random (Dröes and Koster (2016))., The location of wind turbine development is not random (Dröes and Koster, 2016), but in fact highly limited to areas outlined in local government policy (González et al., 2016). Areas acceptable for wind development are limited by wind speed, population density, proximity to existing transmission infrastructure, proximity to areas of natural beauty or historic significance, etc. (gov.ie, 2019).

Gillespie & McHale assert that while there is no impact on valuations of properties in the "zoned" areas, there is a significant negative impact on values post-connection.

Tullacondra Values impact on Residents
Less than 1km
According to the current proposal, there are 51 houses closer than 1km to a turbine.
Given the current property market we are giving each house a value of €275,000
The following shows the negative impact on values using data from the Gillespie & McHale Working paper:

1. **14.7%** discount on houses <1km (<125mt Turbine) €40,425*51 properties = **€2,061,675** cumulative discount
2. **22.9%** discount on houses <1km(>125mt Turbine) €62,975*51 properties = **€3,211,725** cumulative discount

These cumulative discounts consider only the 51 properties within 1km of a turbine. We do not include those between 1km and 5km, where the negative impact is less but the number of properties affected is substantially more.

The devaluations shown above demonstrate again the redistribution of wealth from ordinary householders to corporate entities.

The idea that one should "take one for the greater good" is also tending to zero, as we are currently seeing a large-scale purchase of Turbine Farms across Europe being purchased by Chinese entities. Carbon credits going to the country of the owner of the development.

We contend that on equitable economic grounds there is no argument in favour of the proposed development in Tullacondra and the granting of permission would in essence, be

the taking of hard-earned house values and passing it to Tullacondra Green Energy, with nothing in lieu except all of the negative aspects outline elsewhere in this submission.

References:

CERIS Centre for Economic Research on Inclusivity and Sustainability

Working Paper Series 2023/1

Gillespie T, McHale P (2023) "Wind Turbines and House Prices Along the West of Ireland: A Hedonic Pricing Approach" Centre for Economic Research on Inclusivity and Sustainability (CERIS) Working Paper Series, 2023/01 Available at: Encl

Droes, M.I. and Koster, H.R.A., 2016. "Renewable energy and negative externalities: The effect of wind turbines on house prices," *Journal of Urban Economics*, 96, pp. 121–141. Available at: https://doi.org/10.1016/j.jue.2016.09.001.

Gillespie T, McHale P (2023) "Wind Turbines and House Prices Along the West of Ireland: A Hedonic Pricing Approach" Centre for Economic Research on Inclusivity and Sustainability (CERIS) Working Paper Series, 2023/01 Available at: Encl

Gonzalez, A., Daly, G. and Gleeson, J., 2016. Congested spaces, contested scales–A review of spatial planning for wind energy in Ireland. *Landscape and Urban Planning*, *145*, pp.12-20.gov.ie (2019) *Draft revised wind energy development guidelines December 2019*

9. SAFETY ISSUES FOR THE WHOLE COMMUNITY

During construction-

The huge volume of traffic during construction (over 11000 vehicles) both ways including over 7000 HGVs and LGVs over an 18 month period will have a significant negative impact on our roads and will lead to major issues for all users of the local roads in the area. During the peak construction phase the planning application has the average trips per day generated by the development over the L5523 and the L5302 as 4. Our local roads are small and narrow and not made to take HGVs etc of this volume.

The local roads around the area are used by walkers, cyclists, runners and families. The proposed volume of traffic for the construction phase will decimate the ability of the community to enjoy the country side as they will be unable to use the roads for recreational purposes.

There are 3 national schools in the vicinity of the proposed site. Ballyclough National School, Lisgriffin National School (less than 2K), and Baltydaniel National School..

There are 2 schools in Buttevant which is about 4km from the proposed site, A national and a secondary school Ability of parents and children to reach these schools in the mornings for drop off and the afternoons for collection will be rendered almost impossible.

Along with the schools there are several Childcare facilities in the local area. Three in Buttevant-Eden Childcare Early Years LTD, Donna's Montessori School, Countryside Montessori and Pre-School One in Ballyclough village- Balyclough Playschool One in Newtwopot House- Step by Step Childcare (on the main N20 where the proposed CDR is passing by) One in Lisgriffin- CherryBlossoms Childcare LTD Lisgriffin School NS.

The safety issues around the delivery and collection of children to the above facilities will be adversely hindered both during the construction period and the proposed Cable laying.

The cable route from the proposed site to the Sub station at St. Josephs road in Mallow will take another 55 months of construction and will lead to another 249 HGV (two way) trips over that period. Most of this cable will be laid on rural roads blocking access and exit routes for all families in the area.

There are many vulnerable and elderly people living on these rural roads. They rely on visits from family, friends and neighbours. Many also rely on the daily visit by a carer or a community nurse and other essential care workers. The use of these local roads by the developer to deliver huge loads to the site will hinder the frequency and continuity of care for them and may lead to unnecessary stress, illness and other complications.

There is also the possibility of accidents on local roads, farms, houses which may not be accessible by gardai, doctors or ambulances during peak delivery hours.

After construction,

The most common cause of accidents after construction is Blade failure and breakage. Blades and blade particles will travel a significant distance if they fail. While the proposed buffer zone for this development is 700metres there are records of blade parts especially travelling much further, thus increasing the risk of either human or animal injury.

10. SAFETY – SULPHUR HEXAFLUORIDE (SF6) GAS

Sulphur hexafluoride SF6 Gas will be used in the proposed Tullacondra Wind Farm(TWF) and Substation.

As TWF are aware leaks of the gas are detrimental to Environment but also the health of those who work with the gas and the communities that surround the Windfarm.

Knowingly using a gas that has the highest global warming potential of any known substance; 23,000 times more warming effect than carbon dioxide and has an atmospheric lifetime of 1000 years, this seems to be irresponsible of TWF.

SF6 is banned in nearly all other manufacturing sectors except the electrical sector.

The industry knows how dangerous this substance is and still decides to use it even though there are safer alternatives.

If this company is to planning to make use of hazardous substances within our community, I don't think it unreasonable for them to show us their records for reporting on use, how much they use, training records for those who work with SF6 and how they recycle the substance.

SF6 is very hazardous to Operatives who work around this gas and inhale SF6, they may suffer from carbon dioxide narcosis and respiratory arrest.

When workers are exposed to electrical discharges through everyday usage within SF6-filled equipment, highly toxic by-products are produced that pose a serious threat to those in close proximity to the switchgear.

The presence of such by-products is of real concern due to the documented fact of leakage, as well as uncontrolled releases or discharges that occur during routine development, testing, commissioning, maintenance and repair, and decommissioning of SF6 -filled equipment.

The regulation requires that equipment containing fluorinated gases, such as SF6, be regularly checked for leaks. How have TWF implemented leak detection and repair programs to minimize emissions in past projects, has this been recorded and is this something they can prove?

For companies like Tullacondra Wind Farm using SF6 we have legitimate concerns over the health and welfare of their Operatives, Sub-Contractors as well as the community that live around these Substations.

How does the client protect it's Operatives, Subcontractors, Communities and Environment from such a hazardous substance?

It is all good saying something, but implementing and proving it are two very different things. Can Tullacondra Wind Farm prove from past records they are responsible with their use of this substance, and if there are other alternatives, why have they not gone with the obviously safer option for both their workers, Communities and Environment?

11. ECOLOGY IMPACT

1. GENERAL

The proposed wind farm has the potential to impact on the following potentially notable habitats and species:

- Treelines (WL2), hedgerow (WL1), scrub (WL2), mixed woodland (WD1), wet grassland (GS4) and eutrophic lakes (FL5)
- Invertebrates (Red-listed bee species),
- Mammals - Badger, bats (Common and Soprano Pipistrelle), Hedgehog and Pigmy Shrew
- Aquatic ecology

2. HABITATS / FLORA

2.1 General

Mixed woodland and a eutrophic lake occur adjacent to the windfarm and will not be directly impacted upon. One **Annex I priority habitat** was identified within 5km of the windfarm, namely residual alluvial woodland occurring c. 4.8km to the south-west. This could only be impacted upon via a hydrological pathway.

2.2 Hedgerow

221m of hedgerow is proposed to be temporarily removed with 220m proposed to be permanently removed. This has the potential for a localised impact on flora and fauna. However, most of this seems to comprise either dying Ash trees and/or poor-quality hedgerow.

2.3 Hydrology

Watercourses (e.g. drains) on site are not of any significant ecological value. Most are relatively dry. Historic maps indicate that a stream rises approximately 90m southwest of turbine T4. All surface waters drain from the site eventually combines with the Blackwater (Munster) River. Therefore, the development of a windfarm has the potential to negatively impact on any nearby streams and watercourses e.g. the Dreenagh East stream (within 800m of turbine T1).

Karst features identified within the vicinity of the wind farm site include a swallow hole and enclosed depression in relative proximity to T1 and T5 turbines respectively. This is a potential pathway for sediment and polluting material run-off into nearby aquatic habitats.

2.4 Invasive species

The non-native **Japanese Knotweed** was recorded within the site in two different locations. There is a potential to spread this plant species if work occurs in proximity to these areas.

3. SPECIES

3.1 Invertebrates

The loss of hedgerow and disturbed ground would have a negative impact on the **Red-tailed Bumble Bee** and **Buff Mining Bee** respectively - both Red Listed Species. However, this impact would only be significant if extensive, good quality hedgerow was removed.

3.2 Bat species

There are no roost locations for bat species on site, although there is a Brown Long-eared Bat roost building within 200m of the windfarm (with a Common Pipistrelle roost within 600m). Neither will be impacted upon. However, the loss of hedgerow will impact negatively on bat commuting and foraging corridors. This has the potential for a significant adverse effect. Impacts from habitat loss on bats species will continue to persist throughout the operational phase of the windfarm site.

3.3 Badger

There is mention of Badger setts on site. The development of the windfarm would have the potential for a significant adverse effect here, especially if work occurs during the Badger breeding season. Also, the loss of hedgerow would be negative impact on any resident Badger population. This would similarly negatively impact upon Hedgehog and Pigmy Shrew. The extent of negative impact depends on the quantity and quality of the hedgerow removed.

3.4 Birds

Notable bird species recorded included five species listed under Annex I of the EU Birds Directive, four BoCCI Red Listed species and seven BoCCI Amber Listed Species. However, most were present in low numbers or occasionally. Also most were recorded outside the breeding season. Also, two Hen Harrier breeding sites have been confirmed within 10 – 20km of the wind farm, while at least five possible breeding locations occur for Peregrine Falcon within 5km of the wind farm. Other potentially notable species were only recorded infrequently and /or in low numbers. The wind farm site is only considered to be of local value to bird species, including Hen Harrier, Peregrine Falcon, Buzzard, Kestrel and Barn Owl. Grey Heron was recorded using the wind farm site and adjacent land during field surveys.

There is always the potential for wind turbines to impact on bird populations due to bird strike with the turbine blades. This is most applicable to raptors and larger birds such as Hen Harrier, Peregrine Falcon, Buzzard, Kestrel, Barn Owl and Whooper Swan. However, other bird species such as Snipe can also suffer bird strike.

4. NATURA 2000 SITES

4.1 Blackwater River SAC

The nearby Dreenagh East stream directly connects with the Blackwater River Special Area of Conservation (SAC), 5.6km distant. The construction phase of the windfarm has the potential to negatively impact on this SAC via sediment and polluting material run-off. There is also a potential hydrological connection with Abwe Valley pNHA, which could be similarly negatively impacted upon.

4.2 Kilcolman Bog SPA

This Special Protection Area (SPA) is <10km distant and has been designated for internationally important numbers of Shoveler, Teal and Whooper Swan. The only qualifying species recorded on the wind farm site was one Whooper Swan flying over in November 2021 and four in January, 2023. Considering this and the distance to the SPA, the wind farm site is considered of little value to this SPA and its designated bird species. However, there is always the potential for bird strike from the rotor blades.

12. IMPACT ON WILDLIFE IN COMMUNITY

Environmental impact of Turbines, Cable route and Substation within our communities Mallow, Ballyclough and Lisgriffin.

Our communities in Mallow, Ballyclough and Lisgriffin have great concern for the Environmental impacts these Turbines, Cable Route and Substation are going to have on our Wildlife.

Wildlife protection in Ireland is governed by several key pieces of legislation aimed at conserving biodiversity, protecting habitats, and ensuring the survival of various species of which we believe our local Council and Wind turbine company should adhere to.

The primary laws include:

1. Wildlife Act 1976 (as amended)

- Core Legislation: The Wildlife Act 1976, as amended by the Wildlife (Amendment) Acts of 2000 and 2010, is the principal piece of legislation concerning the protection of wildlife in Ireland. This Act protects wild animals, birds, and plants, and their habitats.
- Protection of Species: It establishes provisions for the protection of specific species and their habitats, including the designation of protected areas.
- Hunting Regulations: The Act regulates hunting activities, including specifying hunting seasons and the licensing requirements for hunting certain species.
- Protected Areas: It also allows for the creation of Nature Reserves and National Parks.

2. European Communities (Birds and Natural Habitats) Regulations 2011

- EU Directives: This regulation transposes the EU Birds Directive (Directive 2009/147/EC) and the Habitats Directive (Directive 92/43/EEC) into Irish law.
- Special Protection Areas (SPAs) and Special Areas of Conservation (SACs): It facilitates the designation and management of SPAs for the protection of birds, and SACs for the protection of various habitats and species across Ireland.
- Conservation Measures: The regulation includes measures to maintain or restore the favorable conservation status of habitats and species.

3. Flora (Protection) Order 2015

- Plant Protection: This order, made under the Wildlife Act 1976, lists plant species that are protected from being picked, uprooted, damaged, or sold. The order is updated periodically to reflect changes in the status of various species.

4. National Parks and Wildlife Service (NPWS)

- Enforcement and Management: The NPWS, part of the Department of Housing, Local Government and Heritage, is responsible for implementing wildlife protection laws, managing national parks, and ensuring the protection of Ireland's natural heritage.

5. The Planning and Development Act 2000 (as amended)

- Environmental Impact Assessments (EIA): This Act requires that an EIA is conducted for certain developments that might impact the environment, including wildlife and their habitats.
- Appropriate Assessment (AA): It also requires an Appropriate Assessment for plans or projects likely to affect Natura 2000 sites, which include SPAs and SACs.

6. Fisheries (Consolidation) Act 1959 (as amended)

- Marine Wildlife: While primarily focused on fishing regulations, this Act includes provisions related to the protection of certain marine species and the regulation of activities that could impact marine wildlife.

7. Animal Health and Welfare Act 2013

- General Protection: This Act provides general protection for animals, including wildlife, against cruelty and mistreatment. It also regulates the use of animals in research and other activities.

8. Forestry Act 2014

- Forest Biodiversity: This Act includes provisions related to the conservation of forest biodiversity, which is important for wildlife habitats.

These legislative frameworks are critical in protecting Ireland's rich biodiversity and ensuring that wildlife and their habitats are preserved for future generations.

Impact on our local Red/Orange-Listed Species and other wildlife within our community

The proposed development site is located within areas where there are red/amber listed species. This will destroy our local wildlife but also those of the surrounding area.

In our area alone we have confirmed sightings, recordings, pictures and local knowledge of the below species which our local communities have been gathering since we heard of the Wind turbines potentially entering our community.

Time given to gather information is very limited considering the Turbine company were given three years, if not more to gather this information.

We are unable to properly complete a survey of the actual area for the Turbines, as we would be trespassing onto the farmer's land. This seems unfair as we don't believe the Environmental company RSK completed a rigorous enough report on this area but below is what has been gathered as a community.

Our wildlife and yours














STOP
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TURB

























Species			
Common Name	Category	Critically Endangered	Local
Badger	Mammals	Least concern	Confirmed
Barn Owl	Bird	Red-list species (high conservation concern)	Confirmed
Black bird	Birds	Least concern	Confirmed
Blue Tit	Birds	Least concern	Confirmed
Buff mining bee	Insects	Endangered	Confirmed
Carrion Crow	Birds	Scarce visitor	Confirmed
Chaffinch	Birds	Least concern	Confirmed
Common Buzzard	Birds	Least concern	Confirmed
Common Chiffchaff	Birds	Summer Migrant	Confirmed
Common extinguisher moss	Flora	Near Threatened	Confirmed
Common Frog	Amphibians	Least concern	Confirmed
Common Lizard	Reptiles	Not currently red-listed	Confirmed
Common White Throat	Birds	Least concern - Summer Migrant	Confirmed
Daubenton's Bat	Mammals	Least Concern (LC)	Confirmed
Dunnock	Birds	Least concern	Confirmed
Eurasian Jay	Birds	Least concern	Confirmed
European Hedgehog	Mammals	Vulnerable (VU)	Confirmed
European Otter	Mammals	Near Threatened (NT)	Confirmed
Fieldfare	Birds	Least concern	Confirmed
Fresh Water Pearl Mussel	Shellfish	Critically Endangered	Confirmed
Gold Finch	Birds	Least concern	Confirmed
Goldcrest	Bird	Amber list species (medium conservation concern)	Confirmed
Golden Plover	Bird	Red-list species (high conservation concern)	Confirmed
Great Tit	Birds	Least concern	Confirmed
Greenfinch	Bird	Amber list species (medium conservation concern)	Confirmed
Grey Wagtail	Bird	Red-list species (high conservation concern)	Confirmed
Hen Harrier	Bird	Amber list species (medium conservation concern)	Confirmed
House Martin	Bird	Amber list species (medium conservation concern)	Confirmed
House Sparrow	Bird	Amber list species (medium conservation concern)	Confirmed
Irish Hare	Mammals	Near Threatened (NT)	Confirmed
Irish Stoat	Mammals	Least Concern	Confirmed
Jackdaw	Birds	Least concern	Confirmed
Kestrel	Bird	Red-list species (high conservation concern)	Confirmed

Kingfisher	Bird	Amber list species (medium conservation concern)	Confirmed
Lapwing	Bird	Red-list species (high conservation concern)	Confirmed
Linnet	Bird	Amber list species (medium conservation concern)	Confirmed
Magpie	Birds	Least concern	Confirmed
Mallard	Bird	Amber list species (medium conservation concern)	Confirmed
Meadow Pipit	Bird	Red-list species (high conservation concern)	Confirmed
Merlin	Bird	Amber list species (medium conservation concern)	Confirmed
Natterer's Bat	Mammals	Least Concern (LC)	Confirmed
Natterjack Toad	Amphibians	Red-listed	Confirmed
Peregrine Falcon	Bird	Protected	Confirmed
Pheasant	Birds	Least concern	Confirmed
Pied Wagtail	Birds	Least concern	Confirmed
Pygmy Shrew	Mammals	Least Concern (LC)	Confirmed
Red Fox	Mammals	Least concern	Confirmed
Red Squirrel	Mammals	Near Threatened (NT)	Confirmed
Redwing	Bird	Red-list species (high conservation concern)	Confirmed
Robin	Birds	Least concern	Confirmed
Rook	Birds	Least concern	Confirmed
Sedge Warbler	Birds	Least concern Summer Migrant	Confirmed
Short-eared Owl	Bird	Amber list species (medium conservation concern)	Confirmed
Skylark	Bird	Amber list species (medium conservation concern)	Confirmed
Smooth Newt	Amphibians	Red-listed	Confirmed
Snipe	Bird	Red-list species (high conservation concern)	Confirmed
Snowy Owl	Bird	Red-list species (high conservation concern)	Confirmed
Sparrowhawk	Birds	Least concern	Confirmed
Starling	Bird	Amber list species (medium conservation concern)	Confirmed
Stonechat	Birds	Least concern	Confirmed
Swallow	Bird	Amber list species (medium conservation concern)	Confirmed
Swift	Bird	Red-list species (high conservation concern)	Confirmed
Tree Creeper	Birds	Least concern	Confirmed
Twite	Bird	Red-list species (high conservation concern)	Confirmed
Willow Warbler	Bird	Amber list species (medium conservation concern)	Confirmed
Wood Pigeon	Birds	Least concern	Confirmed

Wren	Birds	Least concern	Confirmed
Yellowhammer	Bird	Red-list species (high conservation concern)	Confirmed
Atlantic Salmon	Fish	Vulnerable	Confirmed
Black headed Gull	Bird	Amber list species (medium conservation concern)	Confirmed
Brambling	Bird	Amber list species (medium conservation concern)	Confirmed
Brown long eared bat	Mammals	Least concern	Confirmed
Buzzard	Bird	Protected	Confirmed
Common Gull Lesser Black Backed Gull	Bird	Amber list species (medium conservation concern)	Confirmed
Common Pipistrelle	Mammals	Least Concern	Confirmed
Coot	Bird	Least concern	Confirmed
Cuckoo	Birds	Least concern - Summer Migrant	Confirmed
Eel/European Eel	Fish	Critically endangered	Confirmed
Gadwall	Bird	Amber list species (medium conservation concern)	Confirmed
Garganey	Bird	Amber list species (medium conservation concern)	Confirmed
Goshawk	Bird	Amber list species (medium conservation concern)	Confirmed
Grebe (Little)	Bird	Amber list species (medium conservation concern)	Confirmed
Grey Herron	Bird	Least concern	Confirmed
Herin Gull	Bird	Amber list species (medium conservation concern)	Confirmed
Lamprey	Fish	Near threatened	Confirmed
Leisler bat	Mammals	Least concern	Confirmed
Lesser Horseshoe Bat	Mammals	Vulnerable	Confirmed
Lesser Black backed hull	Bird	Amber list species (medium conservation concern)	Confirmed
Long Tailed Tit	Birds	Least concern	Confirmed
Minnow	Fish	Least concern - nonnative	Confirmed
Mistle Thrush	Bird	Amber list species (medium conservation concern)	Confirmed
Mute Swan	Bird	Amber list species (medium conservation concern)	Confirmed
Myotis bat species	Mammals	Least concern	Confirmed
Native Crayfish	Fish	Least concern	Confirmed
Northern Wheatear	Bird	Amber list species (medium conservation concern)	Confirmed
Pomarine Skua	Bird	Least concern	Confirmed
Red tailed bumblebee	Insects	Endangered	Confirmed
Salmon	Fish	Vulnerable	Confirmed
Sand Martin	Bird	Amber list species (medium conservation concern)	Confirmed
Slow Worm	Reptiles	Near Threatened	Confirmed
Soprano Pipistrelle	Mammals	Least concern	Confirmed

Spotted Flycatcher	Bird	Amber list species (medium conservation concern)	Confirmed
Stock Dove	Bird	Red-list species (high conservation concern)	Confirmed
Three-spined stickleback	Fish	Least concern	Confirmed
Thrift	Flora	Least Concern	Confirmed
Trout	Fish	Least concern	Confirmed
twaite shad	Fish	Protected under FPO	Confirmed
West European hedgehog	Mammal	Least concern	Confirmed
Wheatear	Bird	Amber list species (medium conservation concern)	Confirmed
Whiskered bat	Mammals	Least concern	Confirmed
Whooper Swan	Bird	Amber list species (medium conservation concern)	Confirmed
Wigeon	Bird	Amber list species (medium conservation concern)	Confirmed

As you can see from above table we have an amount of threatened and vulnerable species ie Barn Owl, Hen Harrier, Kestrel, Peregrine Falcon, Buzzard, Kestrel, Redwing, Yellowhammer, Red Squirrel, Irish Hare, Lesser Houseshoe Bat, Buff Mining bee, Red Tailed bumblebee, Freshwater Pearl Mussels etc in the locality and it's all going to be threatened by the introduction of the Wind turbines, Cable route and Substation.

Wind turbines especially pose a significant collision risk to birds. Studies have shown that birds often fail to detect the rotating blades, leading to fatal collisions.

Mallow, Ballyclough and Lisgriffin are well-maintained rural communities, all above are resident, breeding or winter visitors to the area because the countryside has unspoiled habitats, which suit them.

Due to older style houses and many older outbuildings, we have an array of Bats in the locality ie Lesser Horseshoe Bat which is at vulnerable status. The destruction or alteration of roosting sites, maternity roosting sites, feeding grounds, such as tearing km of land, trees, hedges, buildings is a significant threat to these birds, bats, fish etc. Changes in land use and development can reduce suitable habitats.

The construction and operation of wind turbines will lead to habitat displacement. Birds and other wildlife will avoid areas near turbines due to noise, vibration, and the visual disturbance of the rotating blades. Many birds use sound to hunt it's prey. This displacement can result in the loss of critical foraging and breeding grounds.

Disturbances during critical breeding periods can lead to reduced reproductive success and population declines.

These Wind turbines will interfere with the established migratory routes of birds. Many species rely on specific pathways for their seasonal migrations, and the introduction of turbines along these routes can lead to increased mortality and stress for migratory birds.

Changes in the landscape i.e. permanent removal of 221m and 220m temporary removal of this habitat to facilitate the construction and transportation of wind turbines, also potential removal of scrub on route for transport of cable, will alter the populations of many species, which above amber/red species rely on, thereby affecting their food supply.

Unfortunately, there will be removal of Japanese knotweed. Japanese knotweed is an invasive plant species that has become a significant problem in Ireland. It has spread extensively, causing ecological and structural -p

As you can see there is significant confirmed breeding in the area from Fig 1 & Fig 2. Population in 1972

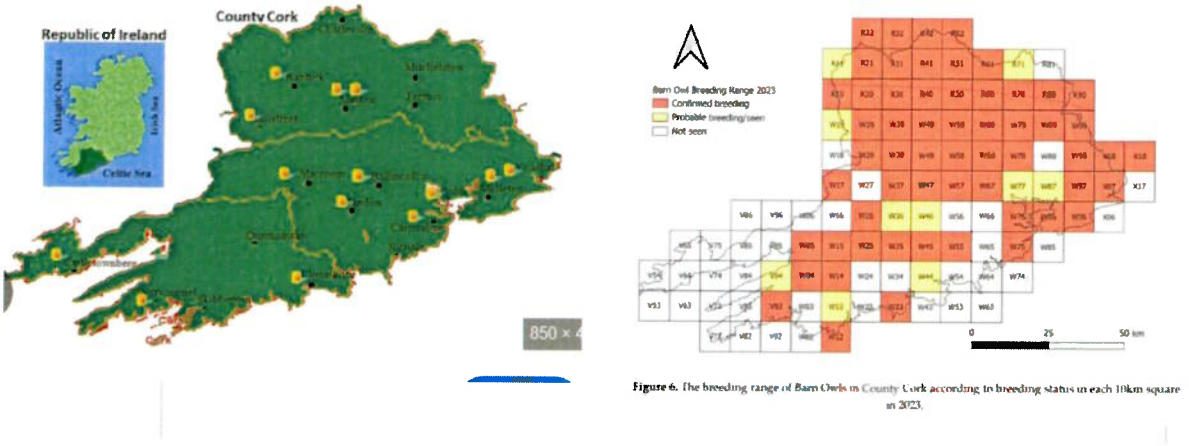


Figure 6. The breeding range of Barn Owls in County Cork according to breeding status in each 10km square in 2023.

Fig 1 – Confirmed Breeding areas within Cork

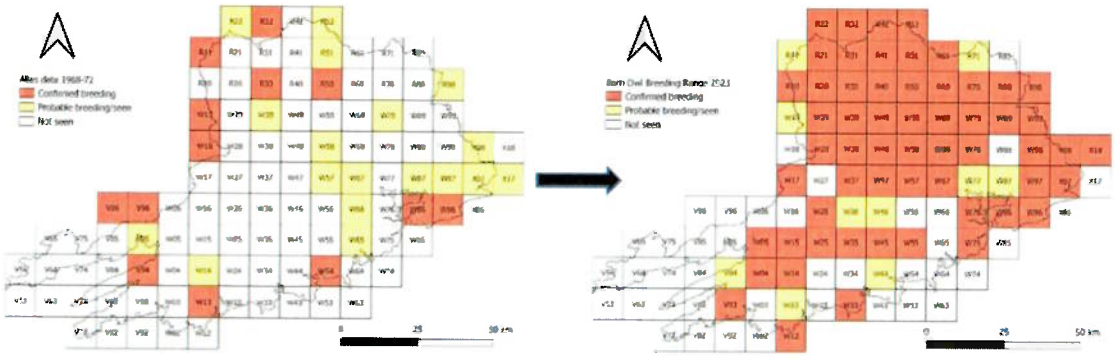


Figure 7. The breeding range of Barn Owls in County Cork recorded by the first Atlas of Breeding Birds in Britain and Ireland (1968-1972) (left) compared to the current distribution recorded by this survey (right)

Fig 2 Increase in the space of 50 years

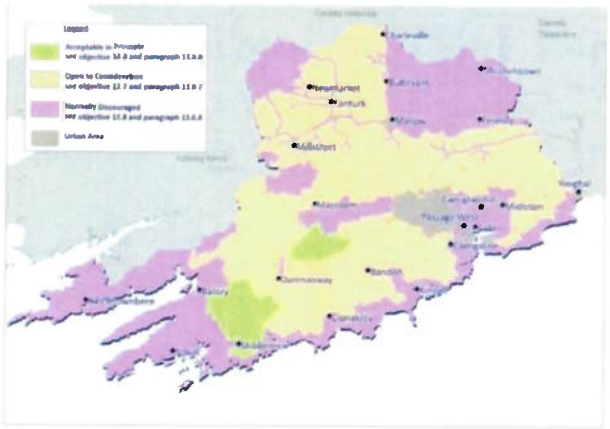


Figure 13.3 – Wind Energy Strategy Map

Fig 3 Wind Energy Strategy Map

If we look at the Wind Energy Strategy Map for Cork alone, which is Fig 3, Cork has been opened for consideration. The green and yellow areas are considered "Acceptable/Open for consideration". We are literally going to wipe out the Owl population in Cork if all these areas are going to be littered with Wind Farms.

The given time to complete an overview of the species in the area

The number of hours which is considered best practice recommends a survey effort of 72 hours per VP per year (i.e. 36 hours during the breeding season and 36 hours during the non-breeding season). VPs were surveyed for 36 hours per breeding season, and for 35-36 hours per non-breeding season. For the size and scale of this project, we do not believe enough hours were spent getting a true representation of the area. The time given for a community to survey and get a true representation to combat a corporation who had about three years to make their case is just down right disrespect to a community which you are potentially about to ruin. A community should at least be given a timeframe of more than end of summer to complete a survey of the area. A lot of birds migrate in the Winter or are passage birds ie Whooper Swan, Curlew, Snipe etc

More time is required to give respect to the Wildlife but also to the community.

Impact on waterways

The proposed development site is located within the Muster River Blackwater catchment area, Awbeg (Kanturk), the Finnow (Ballyclough) and the Awbeg (Buttevant). There are also many streams and ponds within the 2km catchment area i.e. 2 pond near T2, streams and drains within the site.

Pollution to ground waterways and underground water networks is inevitable due to mass moving of earth, use of chemicals, diesel and pouring of huge amounts of cement. These water networks travel towards the above-mentioned rivers, streams and ponds which lead into the River Blackwater which is known to host populations of the freshwater pearl mussel, trout, Salmon to name a few.

Some species are highly sensitive to changes in water quality, sedimentation, and hydrological regimes, all of which could be adversely affected by the construction of windturbine, substation and cable route.

One example is the red listed freshwater pearl mussel which the proposed wind farm is again in area targeted for Agri-Climate Rural Environment Scheme (ACRES) conservation of the freshwater pearl mussel catchments. FWP require extremely clean, well-oxygenated water and stable riverbeds to survive and reproduce. Any increase in sediment runoff or changes to water flow patterns resulting from the construction activities, such as road building, excavation, and land clearing, will lead to detrimental impacts on the mussel population, potentially leading to local extinction. The freshwater pearl mussel is protected. We should be maintaining and improving water quality to support biodiversity not destroying it.

All our water features connect, have high water quality, and support FPM, crayfish, and other fish species like salmonids, it is the responsibility of the planning authority to ensure that any development does not contravene these legal protections. A failure to adequately assess and mitigate the potential impacts to all species could lead to breaches of national and European law, potentially resulting in legal action and financial penalties for the local authority.

The Environmental Impact Assessment submitted with the planning application appears to inadequately address the risks to red/Amber species. Furthermore, the mitigation measures proposed are insufficient to ensure the protection of the species and its habitat.

Given the high conservation value of the above-mentioned species and the critical state of its population in Ireland, further assessment of potential effects is required.

Consultation

Consultation was not had with some very important groups i.e. Irish Wildlife trust, Birdwatch Ireland, Irish Raptor study group, Bat conservation Ireland and An Taisce, Department for Energy Communication and Climate Change. As these areas are of vital biodiversity importance, is begs the question, in the space of sending all these correspondence letter/emails etc in September to October 2022, no correspondence was had with all of the above when submittal of this report was completed early 2024. One would have to question the validity of this report.

Birdwatch Ireland and Cork branch were contacted by those affected within the area and I can confirm generic message is sent back immediately like below message for both branches this is true, but Cork responded within three days, and this was not a generic message. The Ireland branch was contacted by phone, and we were informed that Birdwatch Ireland are monitoring Snowy Owls and Barn Owls in Ballyclough.

We submit that TWF did not do their due diligence when it comes to providing the correct facts and that they have not tried their best to convey the situation. Considering this area has red and amber listed wildlife a greater effort should have been given for the protection of our these. We believe the mitigation they would have in place would only be words on a page and not implemented to its fullest to protect this already venerable wildlife that we have in the area.

		the project seeks planning permission."	
Irish Wildlife Trust	No response	n/a	n/a
BirdWatch Ireland	28th September 2022	*"Thank you for your email. Please note that we receive a high volume of emails. We endeavour to respond as quickly as possible, but during busy periods please note that there may be a delay."*	n/a

RSK

Consultee	Date of Response / Communication	Response Received / Key Issues Raised	Where the responses / key issues are addressed in the EIAR
Irish Raptor Study Group	No response	n/a	n/a
Bat Conservation Ireland	3rd October 2022	*"Unfortunately, as we are a very small organisation with limited resources, we do not have the capacity to get involved in planning issues."*	n/a
Southern Regional Assembly	No response	n/a	n/a
An Talsce	28th September 2022	*"Please note that our resources are very limited and we receive a large volume of queries. As such, we are unfortunately unable to respond to every query and ask that you review these frequently asked questions. If your message is a statutory referral to us per our role as a prescribed body, it will be processed as normal."*	n/a
Department for Energy Communications and Climate Change	28th September 2022. See response from GSI 24th October 2022	*"Our Customer Service team will review your query and forward it to the relevant Division who can provide you with a comprehensive answer. You should receive this response within 20 working days as stated in our Customer Service Charter. If you do not receive a response within this time, or if you have any further queries, please do not hesitate to contact us."*	n/a

Fig 4 – Consultation with groups

While we recognize the importance of renewable energy development, it must not come at the cost of our most vulnerable species and habitats. Allowing this development to proceed without adequate safeguards could set a dangerous precedent, undermining the integrity of environmental protections in Ireland and compromising our commitments to biodiversity conservation.

Conclusion

For the reasons outlined above, we strongly urge Cork County Council to refuse planning permission for the proposed wind turbine development, allowing this development to proceed would set a dangerous precedent. Protecting our wildlife must be a priority, and alternative sites or mitigation strategies should be explored to ensure that renewable energy goals do not conflict with environmental conservation.

13. ARCHAEOLOGY IMPACT

The Archaeology of Ballyclough and especially of Kilmaclenine and the areas around the proposed wind turbine farm contain very rich history. History maps of the proposed and surrounding area clearly outline a large number of sites of Archaeological and historical interest, Holy Wells (4), Burial grounds (3), Standing Stones (10), Fullcht Fias (14), Mass Rock, Megalithic Tomb, Mounds and Moated sites(5) as well as churches and a Castle and several Ringforts of importance all within approximately 2km radius.

The planning application states that there are "no National Monuments in the proposed site "however there are several archaeological monuments. The planning application also states that the design of the wind-farm was informed by the constraints listed, one being "maintaining a setback buffer from all wind-farm infrastructure of at least 20 meters from the known archaeological monuments and cultural heritage features.

ON examination of the proposed site map

There is a Fulacht Fia under T2, A Fulacht Fia beside T6, A moated site near T3. A lime kiln at the top corner of the field near T7, a ring fort at the opposite corner. There are also a number of fulacht fias not recorded in the area or shown on the map. These are only visible when the fields are ploughed.

This is all on the site of the proposed development. While they are not national monuments, they are an integral part of our local history and have stood the test of time. Any interference with them as a result of site excavation or turbine erection would be adverse and would probably lead to their disappearance altogether.

On the Turbine delivery route option 1 there are 4 NIAH structures and 14 monuments recorded.

While some of the monuments recorded are considered redundant records

The rest include a town defence, three fullacht fiadh's a moated site, a recorded excavation, and a ringed ditch. On the L5523 there is a heritage Bridge (known as Grange Bridge NIAH structure), and a ringfort located on the L5523. (NMS 2023). This ringfort hugs the road ditch on a right-hand bend.

Just up from this ringfort and in a private avenue is a megalithic tomb from 2000BC still standing and visible. This wedge tomb is known locally as "the Cuitoge". When excavated a skeleton and remains were found along with a sword and some beads. By the side of the tomb part of a very ancient road was visible until the late1800's. This road led to the neighbour's field which is known to this day as the city field which lies beside the road on TDR 1.and like Caherduggan was a settlement of great importance at the time. A well is shown in the field in OS XXIV-8 but this well no longer exists.

It was here in the last century between the cuitoge and the city field that the great fair of kilmaclenine was held on 21st June every year. The fair is mentioned in a report prepared for the Royal Dublin Horse Show in 1775.

On option 2

There are four monuments recorded within the study area of 100m taken by the developers. Two of these are associated with a Soutterrain, a ringfort and a kerb circle monument.
There is also a single arch railway bridge at the turn off from the N20 to the L200. Any off road works required on the L200 to the site have the potential to affect a 2 ringforts, a souterrain, the bridge a house and a farmyard complex.

The planning application states that "without mitigation the magnitude of this effect could range from no change to high and the significance of this effect on these heritage assets could range from neutral to profound adverse" for both routes.

Record of Protected Structures within the Turbine Delivery Route Option One Study Area:

145 912 Abbey – Medieval Site – Franciscan Friary Moig South –

NIAH Structures within the Turbine Delivery Route Option One Study Area:

35 20902411 553339 605187	Grange Bridge	Ballybeg
150 21901123 540336 652179	Hollypark House Wall	Currahchase North
151 21901216 548135 652330	M. O'Kelly house	Cloghatacka
152 21901219 548305 652324	Public House	Cloghatacka

NIAH Structures within the Turbine Delivery Route Option Two Study Area:

166 20903320 554619 600412	Railway Bridge	Ashgrove, Lodge
167 20513166 567471 572220	Limestone Plaques	Cork City
170 20902410 552432 603235	Copsetown Abbey House	Copsetown
171 20902414 552445 603242	Copsetown Abbey	Farmyard Complex

The Grid Connection route will also have the potential to affect several archaeological monuments if allowed to take either option 1 or option 2. Historical bridges, ringforts, souterrains.

For an area so plentiful in archaeology it is beyond comprehension that any development would consider an application for planning that will more than lightly have an adverse effect or complete destruction of many of these monuments

NIAH Structures within 100m of Grid Connection Route Option One:

125 20902510 155948 104670	Two-Pot House Chapel	Oldtwopoth
126 20902518 156107 103428	Castle Kevin	Castlekevin
127 20902525 156178 102406	Wood View	Curraghphade
149 20902512 155734 104459	Hazelwood House	Two-Pot-House

NIAH Structures within 100m of Grid Connection Route Option Two:

35 20902411 153379 105132	Grange Bridge	Ballybeg
125 20902510 155948 104670	Two-Pot House Chapel	Oldtwopoth
126 20902518 156107 103428	Castle Kevin	Castlekevin
127 20902525 156178 102406	Wood View	Curraghphade

There are many other historical sites within the 2km zone of the proposed site. Kilmaclenine Castle, Kilmaclenine Moat, Kilmaclenine Manor, Augustinian church and graveyard. All are now in ruins but are still very visible from the L200 Liscarroll Mallow road and are of huge significance to the history of the area. The surrounding area of Knockauvadreen and Kilmaclenine formed one of the estates of the Sea of Cloyne, (1000 acres in total) from the 13th century down to the middle of the 17th century.

The Barrys who resided in the manor were responsible for building Ballyclough castle as well as others in the area. Ancient records called the Pipe Roll of Cloyne were thought lost and later found contained a large amount of information on the history of kilmaclenine from the 13th to the 17th century during the ownership of the lands here by the Catholic Church.

All of these sites have the potential to be damaged or destroyed during the development of the turbine wind farm, due to traffic, drilling, digging and all other works associated with the proposed development.

Archaeology

Desk Top Study

The Irish countryside is unique in Europe in the number of ancient monuments that survive from past ages. This campaign aims to increase understanding and appreciation of these monuments so we can all play our part in protecting them for the next generation.

Minister of State for Heritage and Electoral Reform, Malcolm Noonan TD, at the Department of Housing, Local Government and Heritage commented:

"Ireland has over 145,000 recorded archaeological sites and monuments spread across every town, parish and townland, meaning we are never far from a special place that provides us with a tangible link to our ancestors and our past. The rate of survival of Ireland's archaeological and architectural heritage is unique and something to be proud of. We all have a role to play in ensuring its survival for present and future generations. I encourage everyone visiting a heritage site or monument this summer to be mindful of how their actions might impact these sites or monuments."
Minister of State with responsibility for Office of Public Works, Patrick O'Donovan, T.D., said:

"Our heritage defines our sense of identity; it tells us about who we are and where we came from and is a critical resource for education and learning. It includes evidence of the environment in which those societies lived – from the everyday to the very special. Heritage also plays a vital role in contributing to our tourism sector, especially in rural areas, so we need to come together to ensure we protect it."
Our archaeological monuments are a source of pride and provide a sense of place, belonging and collective identity to communities across the country. These sites can inspire us with a profound sense of joy and wonder and make a contribution to enhancing well-being. Collectively we can work together to ensure that they are preserved for future generations to enjoy - just as we do today. Please take a moment to think about your actions when you next visit one of our precious archaeological sites.

The Archaeology of the proposed site for the Tullacondra Wind Farm by company Green Energy Ltd is unique in that the amount of **Fulacht Fiadh's, Ringforts, Standing Stones** concentrated in a small area could only mean that there is ground penetrating aquifer water sources throughout the site and it is a major settlement of archaeological significance.

Definition of *Fulacht Fiadh* - The Irish word "fulacht" denotes a pit used for cooking. "Fiadh" meaning "of the deer" or "of the wild",

Definition of *Ringfort* - A ringfort is a circular enclosure, surrounded by a raised earthen embankment and a ditch or moat. The majority were occupied between 600–900AD.

Additionally, the rings formed a primary defence to secondary water filling of the ditches by water springs and streams source flowing at the site. The third defence was timber tree stakes struck into the outer perimeter of the settlement footprint.

Definition of *Standing Stones* - also known as menhirs, are a common feature in the archaeology of Ireland. They are large, vertically oriented stones that were erected in the prehistoric period, often as part of complex sacred landscapes.

National monuments are protected by the National Monuments Act Ireland 1930. The Law simply states that the owners are responsible for not letting the items of National Monuments status to fall into any further disrepair.

Not only will it be a travesty to lose this precious site and it historic connection to the past but, it also will form the major Ecological fallout from the site with fault lines and a network of underground streams means that the ground is a powder cake – unstable and porous and facilitating the hydro carbons, soil particles,

Link of Archaeology disruption and unearthing to polluting drinking water and tributaries of the Blackwater River poisoning the best Salmon cycle and Freshwater Pearl Mussel. It can be best outlined as below.

- Diffuse nitrogen losses
- Phosphorous run-off and sediment losses
- Impacts of farm chemicals such as pesticides and sheep dip

- Critical Source Areas (CSA)
- Drainage
- Buffers
- Sheep dip and footbaths

Diffuse Nitrogen Losses:

Nitrogen (N) loss typically occurs on soils that have high permeability. These are 'light' free draining soils and water can quickly permeate through these soils.

Where excess Nitrogen fertiliser is applied above crop requirement, this N is not utilised by the grass or tillage crop and is left in the soil. N does not bind tightly to soil like P and therefore when there is heavy rainfall, the water leaches N away to groundwater, streams and rivers. The natural biological processes in the soil increase the N available particularly in autumn. This requires careful management to minimise N losses at that time of the year.

Diffuse Phosphorus and Sediment losses

Phosphorus (P) loss typically occurs on soils that have low permeability. These are poorly draining soils and get quickly saturated with rainfall. When there is heavy rainfall on these saturated soils this leads to the water staying on the surface of the soil. This in turns leads to overland flow of water, particularly on fields with slopes.

The overland flow of water across fields carries phosphorous in soluble form. It also washes off soil particles that have P attached to them. P binds tightly to soil particles. The soluble P and soil particles can then be washed into the drainage network and streams located in the farm and end up impacting on the quality of water in the streams. Recent 90mm rainfall in one day equivalent to one month as a result of Global Warming. It is like the guy who starts a gorse bush fire saying it is a controlled burn. Imagine such a man to be able to control the element of wind and you have imagined god. There is no controlling the elements.

Phosphorus losses

The implementation of appropriate buffer strips and prevention of livestock access to streams/rivers will help to reduce losses occurring.

Improved management of wet areas with high connectivity to the streams or rivers is also important. These Critical Source Areas (CSA's) are more prone to nutrient and sediment loss during wet weather than the surrounding fields. Changes to land management in these areas can help reduce the impact on water quality.

Land drainage can increase sediment and phosphorus losses.

Surface and subsurface drains provide preferential flow paths for water. Poorly designed drainage systems and inappropriate use of fertilisers and pesticides can lead to an increase in losses of nutrients and chemicals to waters.

Drains can also add additional sediment to waters where poor land management – poaching or cattle access to drains and where drains are inappropriately managed and cleaned.

Sediment & Drinking Points

Sediment is the fine material associated with soils and can be both mineral and organic (e.g. peaty) in nature.

Sediment has a twofold effect on water quality. Excess sediment entering a watercourse can impact the river bed & loss of habitat. This will have an adverse effect on invertebrates and life cycles of a watercourse and result in a decrease in water quality.

Sediment carries other elements in association with it – phosphorous being the most significant. This phosphorous will become available in the water body and can cause algal blooms and plant proliferation.

Sediment can enter a water body as a result of a number of farm activities. These include drainage; drain maintenance, land reclamation, reseeding, out watering and poaching of land, watering points for cattle and inappropriate stream interactions.

There is a reservoir at Kilmaclenine that services as far as Lisgriffin, Copstown, Ballycough as all the land falls away from this point, the point from which the wind farm is located.

Critical Source Areas - CSA's

Critical Source Areas (CSA's) are areas that are at highest risk of impacting a water body. These are often low-lying parts of farms where runoff accumulates in high concentration. Runoff from CSA's carries sediment and nutrients to waterways.

Identification of these areas on a farm is necessary to reduce nutrient sediment and pesticide losses. It is important that appropriate farm management practices are applied on these areas.

The critical source areas (CSAs) often coincide with hydro -logically interconnected areas where overland and/or shallow subsurface water flows and transfers nutrients from the land to rivers and streams.

These CSAs vary across individual catchments and sometimes even within individual fields. As a result, effective measures to reduce nutrient losses will require differing levels of management that are appropriate for different areas of farmland within individual catchments.

What is not shown is the harm that will be done to not just the Archaeology Site inside the red line Planning Boundary but also out side the Red Line Planning boundary to the Blue Line extent of the land owned by the land owner.

EIAR Report Chapter 15 states there are no Protected Structures recorded within the wind farm site or within 1km of it. Has the National Monuments Service been contacted to confirm this and has the project checked if there are any applications in progress with the National Monuments Service for structures in the area to be considered as protected structures?

15.6.10 Archaeological and cultural background; 15.6.12 Early Medieval Period (AD500 – 100)
On page 15-32 the report states that 'fifty-four monuments are located within 1km of the wind site boundary.' On review of these SMR's it is apparent that this area had a rich early medieval landscape. This is further supported on page 15-46 where the report identifies 'a possible ringfort (60) 16m north of the wind farm site boundary near T2. There is no visible trace of this monument, but historic mapping analysis indicates that it was approximately 25m in diameter (NMS, 2023)'. On page 15-47 the report states 'a barely perceptible mound of burnt material (61) is recorded 15m south of the wind farm site boundary near the site tracks and within approximately 123m of the nearest turbine T2 (NMS, 2023). This may represent a fulacht fiadh and may be associated with the nearby possible ringfort.'

This information is significant as it is linking two SMR's, one to the north of proposed T2 and one to the south of the proposed T2. The report suggests that both SMR's are likely to be associated, indicating that the chosen site for T2 traverses a landscape that contains evidence of a settlement that is of archaeological significance.

On page 15-49 the report also states 'there are a number of undated enclosures and field systems that are likely to reflect land use and occupation of the wind farm site, and the land immediately around it, from the prehistoric period through to the present day.' Furthermore its states 'the cropmark of the arc of a fosse (83) is recorded approximately 27m west of the wind farm site boundary near T1.'

Direct effects of the project.
Direct effects of the project on Archaeological and cultural landscape of the area are also detailed in the report, from the construction phase through to the operations phase. In the construction phase a number of the proposed groundworks are detailed to have neutral to profound effects on these heritage assets. On page 15-62 the report clearly states 'any off-road groundworks required along the GCR Route Options and along the section of the TDR Options between the junction of the N20 and the wind farm site have the potential to directly effect current unknown buried archaeology, unregistered earthworks, unregistered built heritage structures of historic interest in the fields either side of the public road.'

The mitigation measure for direct effects is detailed as follows 'the decommissioning phase would see a reversal of any negative effects on setting', on page 15-69. **Where a site of archaeological of historical interest is profoundly effected by the commissioning of the wind farm, proposing this as mitigation measure is insufficient.**

Advanced archaeological test trenching is also proposed as a mitigation measure in advance of the construction phase to identify areas of archaeological significance, however the report states on page 15-70 'if significant archaeological material is encountered during the course of archaeological monitoring, then resolution of any such

significant material will be determined in consultation with the NMS (DHLGH) and Cork County Council.' What constitutes 'significant archaeological material' and what does not?

On page 15-71, the report also states 'where possible, every reasonable effort will be made to preserve in situ or reduce the impact on any identified archaeological material. Where preservation in situ cannot be achieved, either in whole or in part, then a programme of full archaeological excavation will be implemented to ensure the preservation by record of the portion of the site that will be directly impacted upon. This work will be carried out by a suitably qualified archaeologist under license and in accordance with the provisions of the National Monuments Acts 1930-2004.'

The report summarises on page 15-73 that 'with the implementation of the proposed archaeological mitigation for the Tullacondra wind farm Project, it is anticipated that all potential direct and indirect effects on buried archaeology, upstanding earthworks and upstanding structures of historic and architectural interest will be either mitigated or avoided.' As such the report surmises that the cumulative significance of effects of this activity on the landscape is of no significance. **This conjecture should be challenged. In situ preservation of negative and positive archaeological features is the best outcome, even after archaeological testing, and a proposal of full or partial excavation to preserve any features by record only will have a very significant impact on the landscape.**

I think it would be worth reviewing the EIA Scoping Consultation Document (EIAR Vol III Appendices) in detail to analyse exactly how the report was prepared because all consultation correspondence is detailed here. In particular the correspondence with Mary Sleeman, Cork County Archaeologist and Mona Hallihan, Conservation Officer with Cork Count Council. **It would appear that concerns have been raised by other agencies in relation to these works, and the EIAR report should address all of these concerns.**

14. ACCESS ROADS TO THE PROPOSED SITE

Turbine Access Routes(TDR'S)

Tullacondra Green Energy have identified 2 possible access routes to the site at Tullacondra.

Option 1 travels west and then south from Foynes in Co. Limerick using mainly the N20 as far as Boherash cross where it turns left onto the L5523 to Kilmaclenine Cross and then the L5302 to the proposed site

Option 2 travels North from Ringaskiddy Port to cork Mallow also using the N20. It then turns at the County Hospital Mallow under a railway bridge using the L1200 as far as Kilmaclenine Cross where it turns on to the L5302 to the proposed site.

The Planning application has quoted in excess of 7000 additional HGV trips (two-way) over the 18 months of construction and over 11500 vehicles in total during construction.

While the N20 Cork Limerick road may be suitable for these vehicles the local roads are not.

To pass a vehicle on these local roads require slow speed and driving very close to the ditch beside the road. If this development goes ahead access for many on these roads will be not only restricted but in some cases stopped for the families living on the route and those who use it to travel to and from work. The local co-op Dairygold have milk suppliers on these roads and rely on regular collection of milk from the dairy farms in the area. The local farms will also need deliveries of feed fertilizer, Diesel to mention just a few. Having road closures and restrictions over an 18 month period will cause stress and anxiety both for the farmers and the delivery or supply companies as well as the many families living in the area.

There are several archaeological structures/sites on or near both routes.

On option 1 there are 4 NIAH structures and 14 monuments recorded.

While some of the monuments recorded are considered redundant records (160 and 162-165)

The rest include a town defence, three fullacht fiadh's a moated site, a recorded excavation and a ringed ditch. On the L5523 there is a heritage Bridge(35) (known as Grange Bridge),and a ringfort (128) located on the L5523. (NMS 2023). This ringfort hugs the road ditch on a right hand bend.

A little further up the access route and not shown by the Tullacondra application is a well in what is known as the city field. Taking this into account it seems that turbine access on this

route would not be an option.. The planning application states that" TDR option 1 between the junction of the N20 and L5523 at Boherash Cross and the wind-farm site have the potential to directly affect the Knockaunavadreen ringfort 128) and the Bridge" The planning application states that "without mitigation the magnitude of this effect could range from no change to high and the significance of this effect on these heritage assets could range from neutral to profound adverse"

On option 2 There are four monuments recorded within the study area of 100m taken by the planners. Two of these are associated with a Soutterrain, a ringfort and a kerb circle monument. There is also a single arch railway bridge at the turn off from the N20 to the L200. Any off road works required on the L200 to the site have the potential to affect a 2 ringforts, a souterrain, the bridge a house and a farmyard complex. With the same possible effects without mitigation as option 1.

We are aware that some landowners **have not given permission nor signed any contract with the Developer** for this off road work should it be required for the HGVs to travel any of these local roads to the site.

On access route option 1 there is a large scrub area which the company have included in diagrams to take away and include hard surface to turn the turbines off the N20. The high risk invasive Japanese Knotweed is present on this scrub area and have signs showing its presence. There is also Japanese Knotweed near the bridge in Option 2. As no one is allowed to interfere or remove this knotweed clearing these areas for access should not be allowed.

Grid Connection Routes (GCR's)

There are 2 proposed Grid connection routes to place the underground 38kv cable from the proposed site at Tullacondra to the Sub Station at St Joseph's Road Mallow. Approx 13.5k of cable route. The Planning Application opts for option 2.

These routes are mainly on local and small roads with a crossing on the N20 and another on the N72. An additional 249 HGVs will travel our local roads to facilitate the construction of this cable route, on roads not capable of carrying this size or weight of vehicle. 5 months have been allocated for the work during which times travel on locals roads will be greatly disrupted during day time hours when families are going to and from work, school and other activities, deliveries are made and farms and other businesses accessed for drop off or collection.

Option 2 leaves the site and travel on the L5302, onto the L5523 to the N20. crossing the N20 at Boherash Cross and travelling the L5568 the L5566, it then crosses the L581 at Hazelwood and travels to the Sub Station on the same route as option 1.

Grange Bridge is situated on this route as well as the ringfort (128). Both would be impacted by the work from drilling. The mains Gas pipeline is also on this route.

The laying of these cables will consist of a huge amount of drilling. While drilling the drill is greased with drilling fluids to keep the drill lubricated and prevent it heating. These fluids used are composed of a mixture of bentonite clay which can be harmful to the environment. There are a large number of family homes on these local roads and most are in very close proximity of the proposed cable route. These families will be adversely affected by the grid connection work due to excess noise and dust and the environmental and health issues associated with it.

Issues with Lorry access to the many farmers in the area will also be greatly impacted during GCR on either of the routes and will have a far reaching impact to the farming community not only around the Proposed site but on the 13.5k to the sub station taking in all other minor roads on the route.

15. ADDITIONAL CONSIDERATIONS

Matters to be considered in relation to planning objection for proposed energy project.

- **Is there an issue regarding whether consideration of this proposal by the planning authority (Cork County Council) is ultra vires?**
  It would appear that Cork County Council, as the planning authority for the County of Cork (and indeed, the city of Cork) is empowered and obligated to consider and, where appropriate, grant applications in respect of proposed developments to be carried out within the area over which they have jurisdiction, namely the city/county of Cork. Presumably, the considerations that they must take account of, include the benefits accruing to the applicants and indeed, any other persons within their jurisdiction, as well as the effect, adverse or otherwise, on persons within their jurisdiction. Presumably, decisions progress on the basis that adverse effects on some citizens are deemed to be capable of being "trumped" or overridden, provided the greater interests of the applicants, or indeed, other persons are served. There are very few, if any, applications in respect of planning permission for developments that do not have some detrimental effect on neighbours and, presumably, the entire process is frequently a "balancing act". Often, the benefits served by developments are simply the furtherance of the interests of the applicants themselves, rather than anybody else. This would be the case, for example, in respect of most applications for residences or businesses where the outcome will be of benefit for the developers, who, either reside or conduct business in the area. The question that may deserve to be raised is whether Cork County Council has the power to consider the development, in this case, of the energy project, without the Council making the following enquiries of the applicants.

    What obligations will the applicants (or indeed subsequent developers or assignees) have to ensure that any power generated by the project will ever be actually used to supply electricity to either the locality, the County of Cork, or indeed any part of Ireland at all. Perhaps this is something that ought to be dealt with in the conditions of any grant of permission in this regard but if it is not the case that there is a legal, binding, commitment that's the overriding driving ethos of the project (purported generation and supply of sustainable/"green" power) is actually going to be fulfilled by the provision of this power for the benefit of the locality, or at least the county, or, at least the country of Ireland.

    If this matter is not investigated and defined, then the local authority is being requested to give consideration to a plan which will impose risks and effects on an area within its jurisdiction, without serving any of the "green" aims and objectives which, presumably, is a motivating force behind the propensity of planning authorities to grant such applications. In short, is it possible that this project could sell all of its produce to a grid and used internationally to serve in no way, the county of Cork, or indeed the Republic of Ireland. It would seem to me that it

would be ultra vires for the County Council to consider such a proposal without a clear visitation on the developer as to how the project will actually meet the stated benefits for the people of Cork, or indeed Ireland.

16. ENVIRONMENTAL SCHEMES

Over the past 25 years, the Department of Agriculture, Food and the Marine in Ireland has implemented several environmental schemes aimed at promoting sustainable farming practices and protecting biodiversity. The most recent scheme is ACRES (Agri Climate Rural Environmental Scheme)

Before ACRES, there were other notable schemes such as the **Green, Low-Carbon, Agri-Environment Scheme (GLAS)**, which aimed to enhance biodiversity, improve water quality, and combat climate change. GLAS was part of the Rural Development Programme 2014-2020 and supported farmers in implementing environmentally beneficial practices2.The rural environment protection scheme (REPS) was the Irish Government's response to its obligations under EU Regulation 2078/92. The measure was introduced in 1994 in order to encourage farmers to extensify and farm in an environmentally friendly manner. These schemes reflect a long-term commitment to integrating environmental sustainability into agricultural practices in Ireland.

Taken from the Department Agriculture website.

Landowners in the vicinity of the proposed wind farm have been partaking in these various Environmental Schemes for over 20 years. On an area of approximately 1.5 sq. miles, there has been an estimated €1,000,000 paid out over the years to protect this area and this has worked well to date. There has been a significant increase in the numbers of wildlife, birds, bees and habitats in the area as a result of the success of these schemes.
The landowners involved in the proposed wind farm also took part in these schemes and were often more involved than others.
Now, it seems to be the case that these landowners and others with the influence of money want to undo all of this protection previously provided by the Environmental Schemes.

Some individual submissions will also highlight this impact.

17. AVIATION IMPACT

1. Development is not in keeping with the Government of Ireland, Wind Energy Development Guidelines, Section 4.9.5 Aircraft Safety - considering its location (less than 20km) to Rathcoole Aerodrome (ICAO: EIRT) which states *'If located close to an airport (within 20 km), a wind turbine could interfere with the safe operation of an airport, simply by its presence and height'.*

   Object as no information or assessments has been given regarding distance to Rathcoole Aerodrome runway threshold and helipad for each proposed turbine and contact with both the Irish Aviation Authority (and the operators of Rathcoole Aerodrome if outside the control of IAA) regarding potential impact of the proposed development with existing flight paths, air navigation safety, including airports, RADAR, and aircraft guidance systems that may be present in the area and impacted by proposed development.

2. Development could create a hazard to air traffic as proposed development lies within 2.5km of a visually observed flight path in use by HSE Air Ambulance helicopters as they transit to the North-West of Ballyhoura mountains and follow a direct flightpath over townland of Currymount, settlement of Lisgriffin and onto the HSE Air Ambulance base at Rathcoole Aerodrome (ICAO: EIRT). Attached Fig 1. And see Map with Rathcoole Aerodrome circled in red.

   Object as no information or assessment has been given regarding contact with the HSE as provider of the Air Ambulance service, on how this proposed development impacts any existing flight path and waypoints in use and any potential impact to flight time and maximum range for Air Ambulance to respond to call outs from Rathcoole Aerodrome to locations North East of the proposed development and if a potential route change to avoid the development would result in extended time over elevated terrain with a potential reduced ability to fly due to low cloud over these higher terrains and/or a reduction in Air Ambulance range from potential obstacle avoidance.

3. Development could potentially impact Cork Airport IAA as some or all of the Development is observed to lie within the 25 Nautical Mile (46.3 kilometre) Localiser Coverage of Cork Airport Runway 16 or a ILS Flight Inspection report, see Ballinagree Wind Farm Impact on ILS Flight Inspection (Report), Fehily Timoney and Company, 02 November 2020, Pg 11. See attached Fig. 2. This would appear to require clarification as email submitted by Developer to the IAA, dated 11th April 2023 in stating 'The project is located in north Cork approximately ..., and 50km north of Cork Airport'. See attached Fig 2.1

   No adequate information or assessment has been given regarding communication to the Irish Aviation Authority stating location is within Cork Airport 25NM ILS zone and to establish via similar report completed for Ballinagree Wind Farm, any adverse effect the proposed wind farm may have on flight inspection procedures and profiles associated with

commissioning and calibrating the Cork Airport Runway 16 Instrument Landing System (ILS) as the Terrain Elevation Profile at 25 Nautical Mile limit by adding turbines can be estimated as Ground height + maximum turbine height = 120 m + 175 m = 295 m (968 ft) on what would appear to be on or near to the highest ground elevation on the 25 NM limit and potentially negatively impacting any Vertical separation minimum and 500 foot obstacle clearance requirements.

4. Proposed Development lies on an observed direct flightpath between Cork and Shannon Airport and close to a direct flightpath between Kerry and Waterford Airports. This route is in use by low-flying Irish Coast Guard Helicopters which are active on this route with evidence provided of being directly above the proposed development. See attached Fig 3. and visually observed by Air Corps PC-12 Aircraft.

   Object as no information is given regarding contact with Irish Coast Guard, Irish Air Corps, Shannon Airport, Kerry Airport, Cork Airport and Waterford Airport for confirmed flightpaths and/or waypoints in use for the area of proposed development as they would appear to impact horizontal separation minimums on routes from Cork-Shannon and Waterford to Kerry Airports. See attached Fig 3.1

5. Proposed Development may impact flight safety in an area of active low-level (less than 2500 Feet) single propeller aircraft used as part of pilot training and registered to Atlantic Flight Training Academy, see attached Fig. 4

6. Development could negatively impact the habitat, routes and paths of the visually sighted protected species of Barn Owls, Bats, Red Squirrels, Sparrow Hawk and Buzzards sighted within 4.5km of proposed development.

7. Proposed development will impact a number of NBI Fibre Broadband lines on the proposed turbine transport route and negatively impact people, including myself, who currently or as part of NBI rollout avail of their right to work from home under Work Life Balance and Miscellaneous Provisions Act 2023. An unspecified and undefined times or continuous occasions, 'temporary disconnection' with no time-bound limits to NBI Fibre Broadband services and with limited 4G Vodafone mobile broadband backup that is called out as at risk of disruption from the proposed development is contra my ability to work from home, with local NBI hubs or shared spaces unsuitable due to device security and confidential data. I also do not consent to a disconnection to any utilities that allow me to exercise this right.

   Where necessary, overhead utilities and obstructions will need to be removed at several locations to provide adequate overhead clearance. The modification or removal of overhead utilities may involve temporary disconnections. Such works will be carried out by the utility providers in advance of turbine delivery to site.

On the basis of the above, we trust these concerns will be taken into consideration in advance to a decision being reached on this planning application.

Fig 1: visually observed HSE Air Ambulance flightpath at low altitude, departing its Base at Rathcoole Aerodrome and transiting to the Northeast, over areas of Lisgriffin, Templemary and Currymount (yellow line)



THE VERTICAL LIMITS OF THE SHANNON FIR ARE SFC / FL245

SHANNON CTR SFC/5000FT

SHANNON CTA 5000FT - FL245

SHANNON CTA 2500FT/FL245

SHANNON CTA 2500FT-3500FT

SHANNON CTA 3500FT(FL245

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CORK CTR SFC/5000FT

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DINGLE BAY

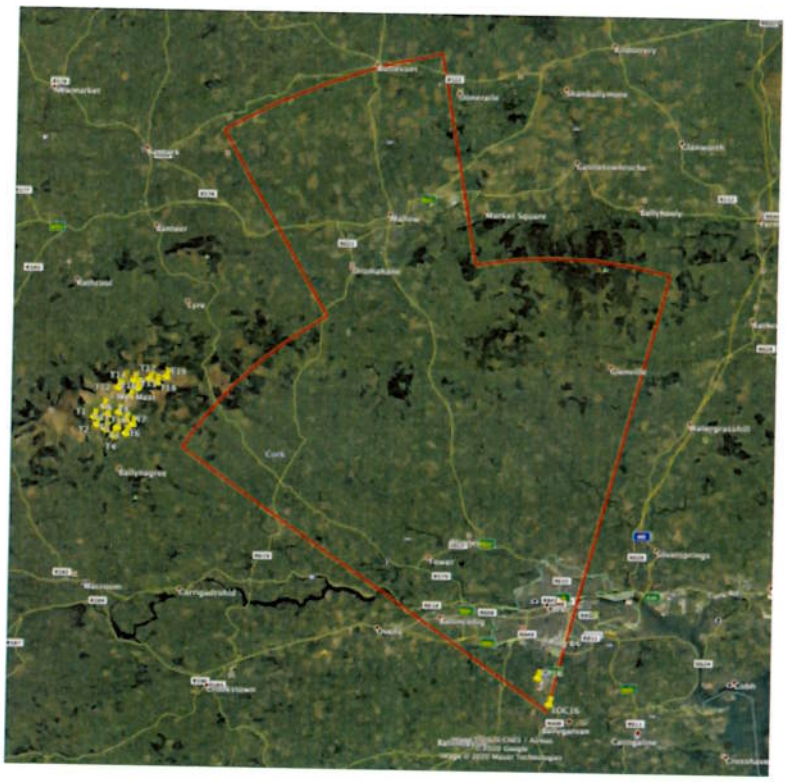
CASTLEMAINE HARBOUR GLIDING AREA SFC TO 2500FT

MOUTH OF THE RIVER SHANNON

CELTIC SEA

Fig 2: Runway 16 ILS Localiser Lateral Coverage Sector, see Ballinagree Wind Farm Impact on ILS Flight Inspection (Report), Fehily Timoney and Company, 02 November 2020, Pg 11. Some or All of the Proposed development is observed to be within the 25NM limit.

https://ballinagreeplanning.ie/wp-content/uploads/2022/01/updates/Appendix%2016-2%20Ballinagree%20Wind%20Farm%20Impact%20on%20ILS%20Flight%20Inspection%20(Report).pdf



FCSL FIP 23 states that flight inspection pilots will not fly within 1000 ft of the ground in IMC (unless on centreline and edge approaches) and commissioning flights should be carried out in sight of the surface at all times. FIP 23 also states that pilots will determine suitable minima to ensure that they will always be further than 500 ft from any object (except the last 2 miles of an approach with runway in sight).

Fig 3: Proposed development on a direct flightpath between Cork and Shannon airport, Evidence of <2 Km to 0 Km horizontal separation, source: Flightradar24.com

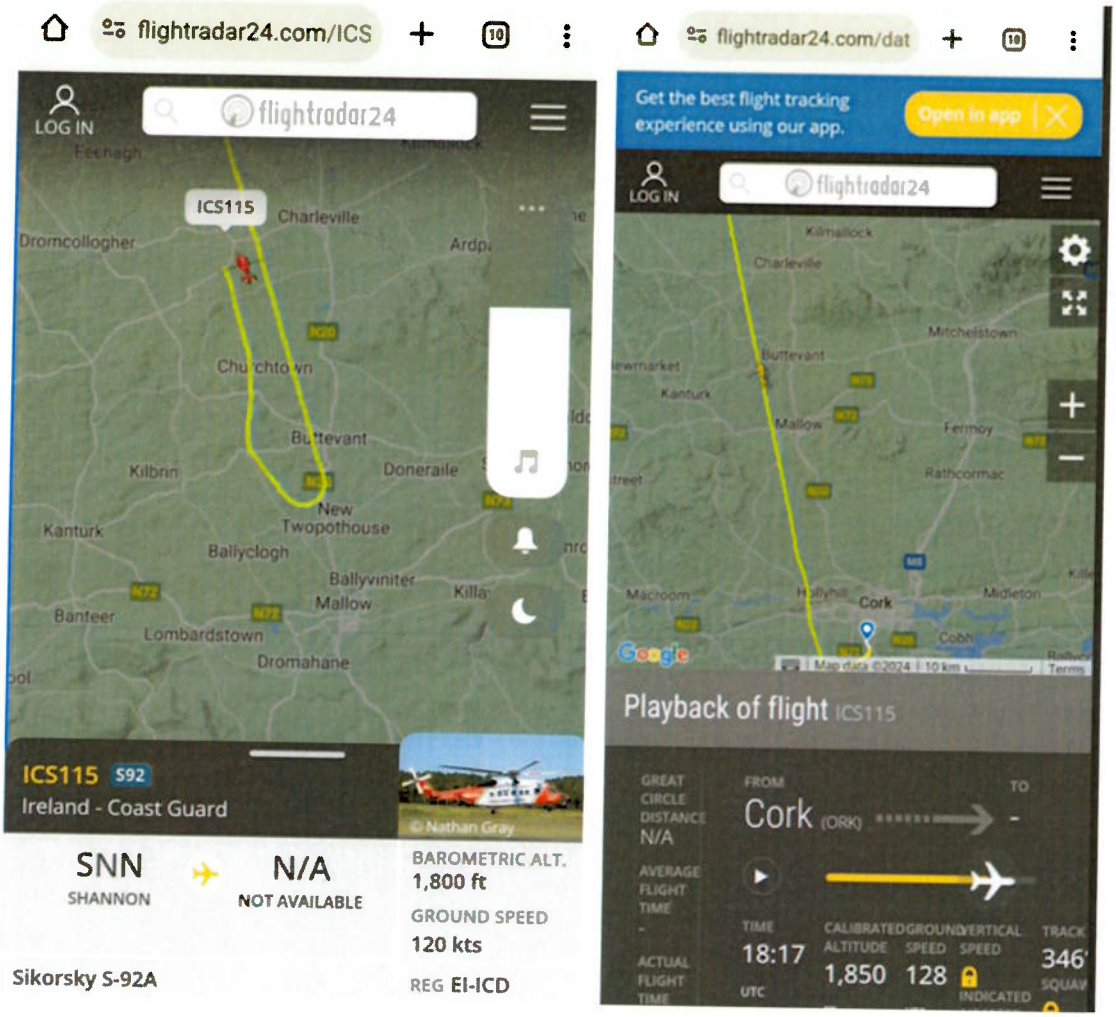


Fig 3.1. Potential impact to horizontal separation limits on flightpaths from Shannon-Cork and Kerry-Waterford

https://www.iaa.ie/general-aviation/drones/uas-geographic-zones

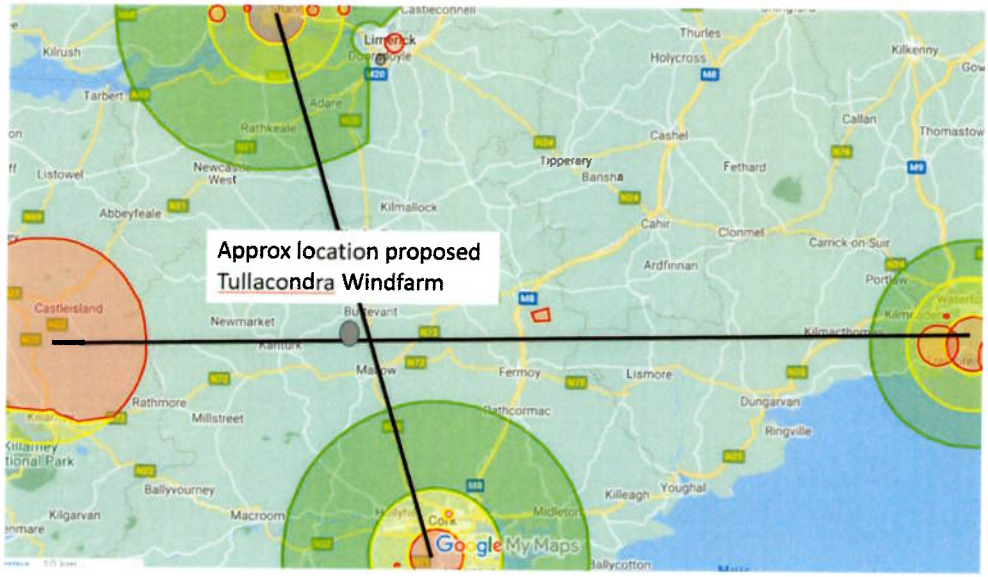


Fig 4: example of low-level single propeller aircraft near or on proposed Development

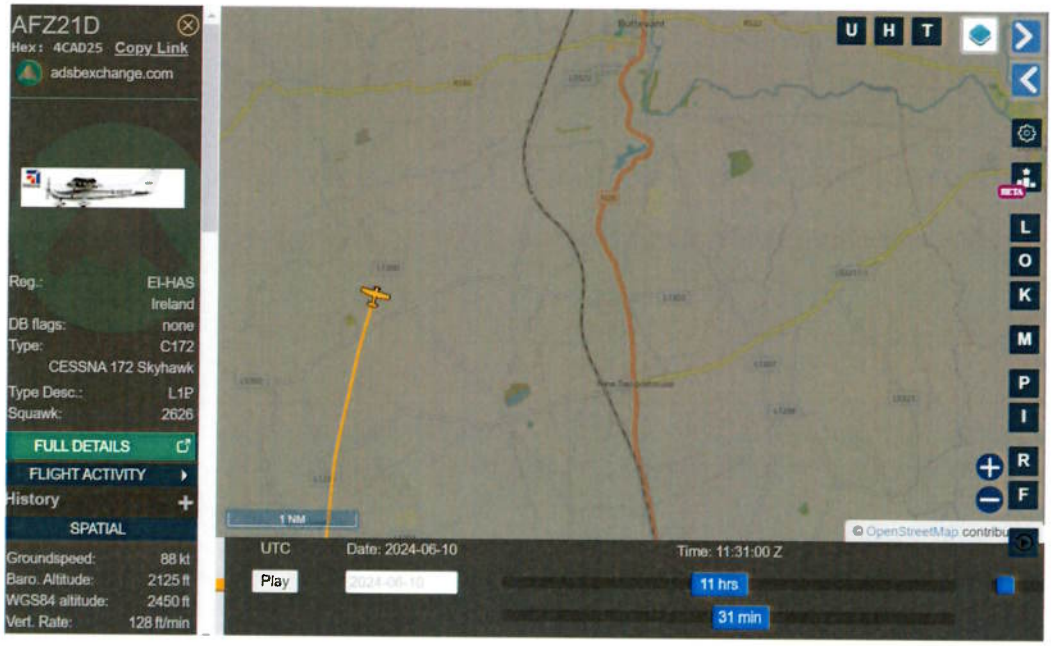
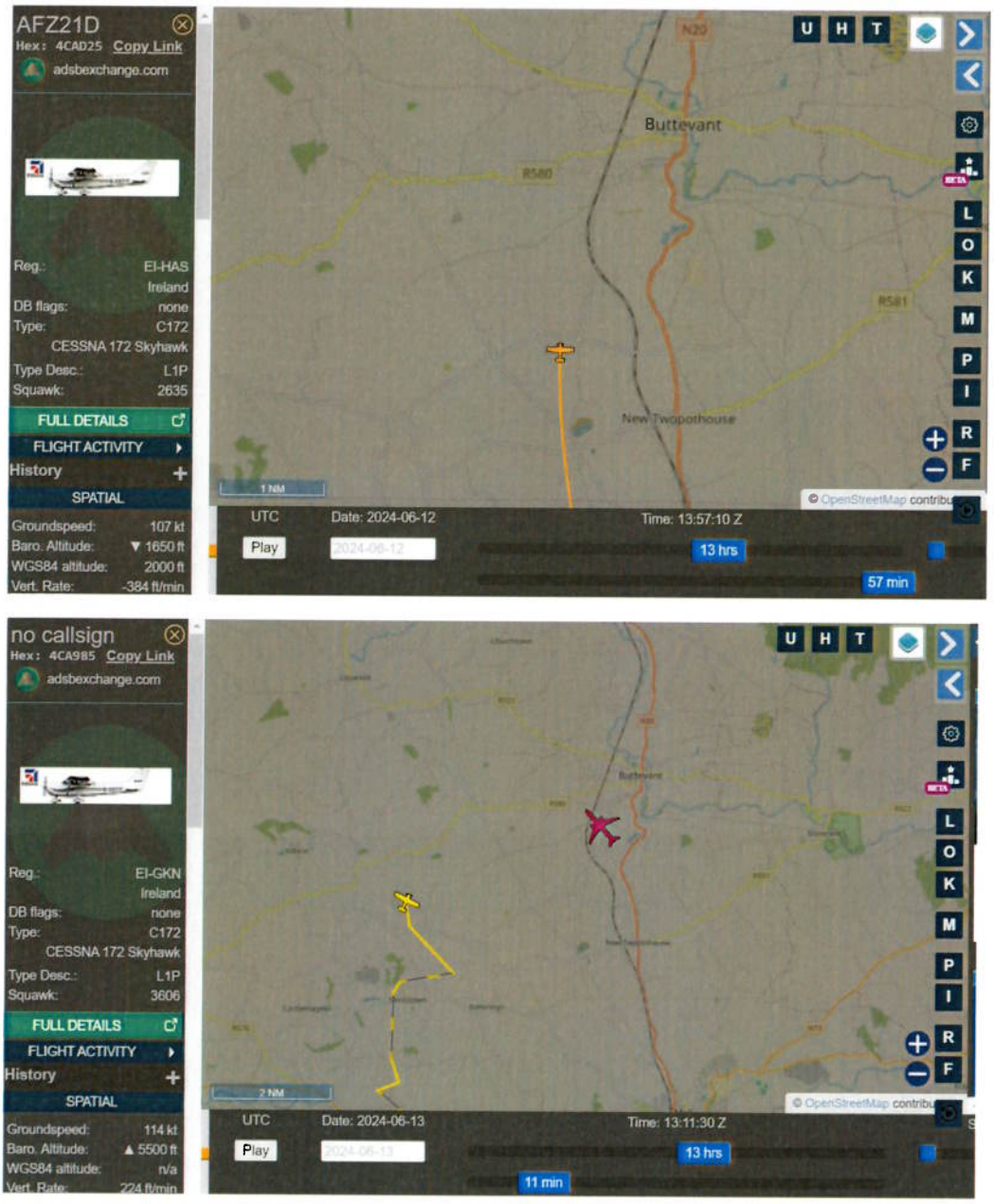


Fig 4 (continued): example of low-level single propeller aircraft near or on proposed Development



16. WIND FARM & TURBINE DESIGN IMPACT

Observation

This observation is made as the overall design of this project cannot be assessed.

Further information is requested on Tullacondra Windfarm to enable relevant public bodies, the public, and other interested parties to better understand the proposal.

1. **Label clearly on a map the distance between each turbine and its adjacent turbine. Also show on the same map the number of rotor diameters from turbine to turbine. (so as the wake effect and other issues can be analysed correctly).**

While the exact model and manufacturer of the turbine may not be decided, please supply the following data of the turbine type used in the submission. (In order that the application can be properly analysed for similar turbines with 150m rotor dia.)

(a) General design technical specification datasheet
(b) Power performance datasheet
(c) Noise emissions datasheets
(d) Any other datasheets relevant to the proper siting of Turbines relative to each other

These data sheets are necessary to ensure the siting of the turbines for noise, efficiency and various other calculations and can be analysed and assessed.

Reference distances between turbines in drawing below:

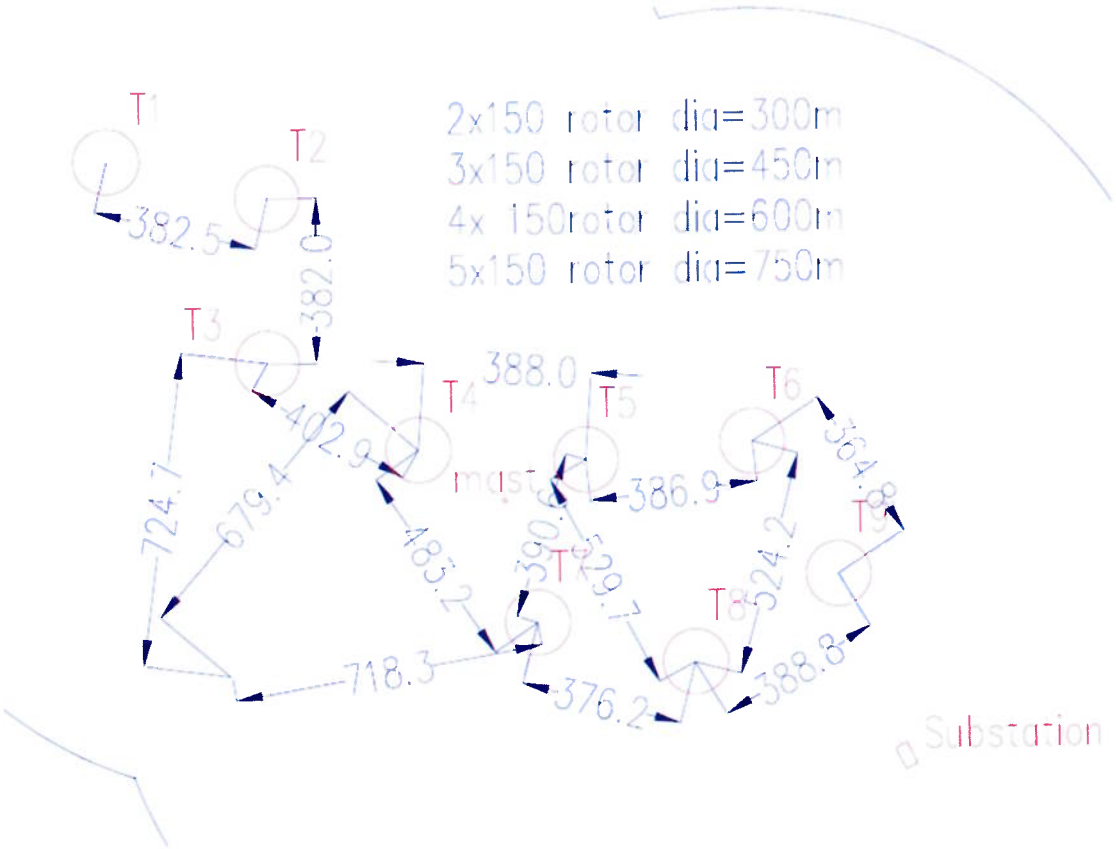


Diagram showing distances between neighbouring wind turbines

The wind turbine guidelines recommend spacing between neighbouring turbines to be a minimum of 5 times the diameter, 5 X 150M = 750m, in the case of this projects. This is needed to reduce the effects of turbulence and induced resonance between neighbouring turbines. Having turbines too close to each other could increase the risk of physical damage which could results in devastating consequences for near-by residents given that the differential speed between blade tips could be up to 650km/hour.

The drawing above shows the distances between neighbouring turbines. None of the neighbouring turbines are spaced 5 times the blade diameter (750m) away from each other and indeed none are spaced 4 diameters (600m) away. Ten of the distances between neighbouring turbines are not meeting the 3-diameter distance (450m). Given the enormous size of these turbines, there may be a significant risk here is the design of these turbines.

Another important factor with the wind turbine design is the lighting on the turbines themselves. The County Council have stated development should occur with regard to Dark Skies principles (Vol 1, section BE 15-13, point d). However, this development may conflict with the County Council plan due to excessive light pollution based on the requirements of the Irish Air Corps. The Irish Air Corps require turbines to be illuminated by Type C medium intensity fixed red obstacle lighting with minimum output of 2,000 candela to be visible 360 degrees in all directions and in operation 24/7 days a week. These types of lights are certified for offshore oil rig use. Possible light pollution mitigation measures such as low power lights

on bright days or only lighting the highest turbine or lights that only turn on only when a plane is nearby are not options given the requirements of the Irish Air Corps and demonstrated the unsuitability of the site for the proposed wind farm.

Background:

Buttevant (Population 970, Target population 1,292 in 2022-2028 County development plan)

Saorview is the national digital terrestrial television service in Ireland, owned by RTÉ and operated by 2RN. https://saorview.ie/en/check-coverage/

Summary:

Due to topography, homes as far East as Doneraile are advised by SaorView coverage checker to point aerials towards the mast at Mullaghanish on the Cork/Kerry border to receive SaorView TV channels. Fig 1

Tullacondra is located to the South West of Buttevant, into the prevailing wind direction and is bisected when drawing a straight line from Mullaghanish mast to Buttevant. Fig 2

Due to the height of the site at Tullacondra, by adding the proposed 176m tip height turbine, this is shown to infringe with the signal line of sight to the Saorview mast from Buttevant town. Fig 5

No Environmental Assessment or mitigation proposal has been carried out by Developers on what impact to Saorview signal to the town of Buttevant, pop. 970 will be from the proposed turbines.

Argument is that any proposed technical changes by adding deflectors or relays do not guarantee maintaining Saorview signal, especially as the size and overlapping nature of the proposed Tullacondra development and the large population that could be impacted.

Mitigation efforts such as using a satellite version of SaorView, namely SaorSat, should be viewed as unfeasible due to cost of a providing new equipment to the town of Buttevant, and also SaorSat has a reduced tv channel offering, not providing the Virgin Media television channels (Virgin Media One, Virgin Media Two, Virgin Media Three).

Technical confirmation regarding blockage of a digital television direct signal listed as significant impact to homes receiving it.

sserenewables-desk-based-television-interference-assessment

performance of digital television, but in the forward scattering region, if there is significant blockage of the direct signal, significant interference to the reception of the digital television signal is possible.

Fig 1: SaorView path from Buttevant to Mullaghanish. https://saorview.ie/en/check-coverage/

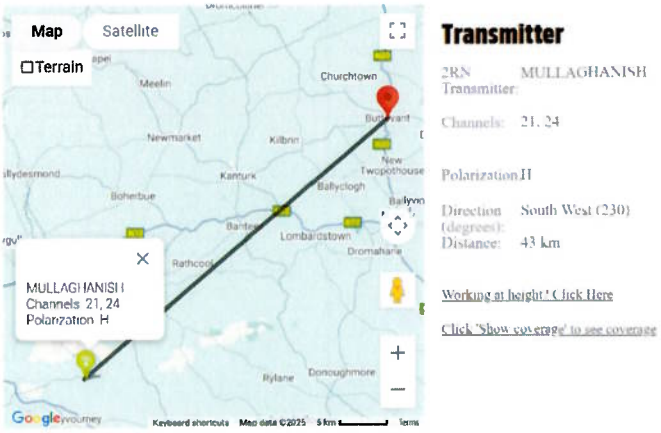


Fig 2: SaorView path bisecting Tullacondra site. https://saorview.ie/en/check-coverage/

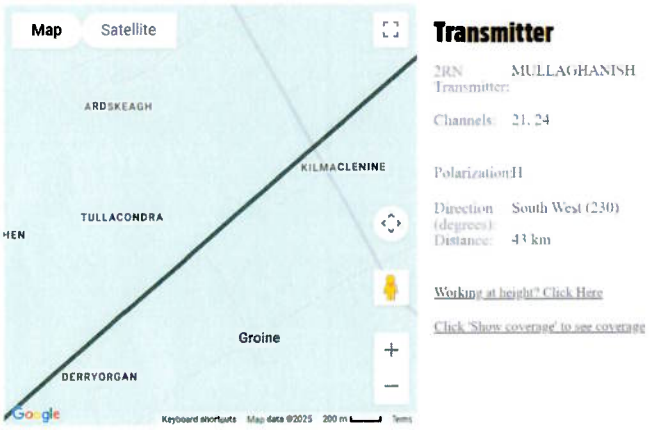


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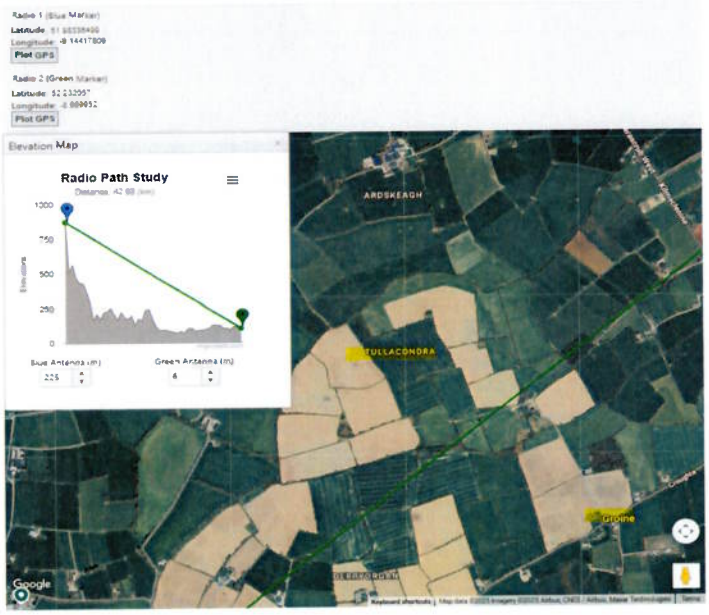


Fig 4: Location of Tullacondra site along Saorview path

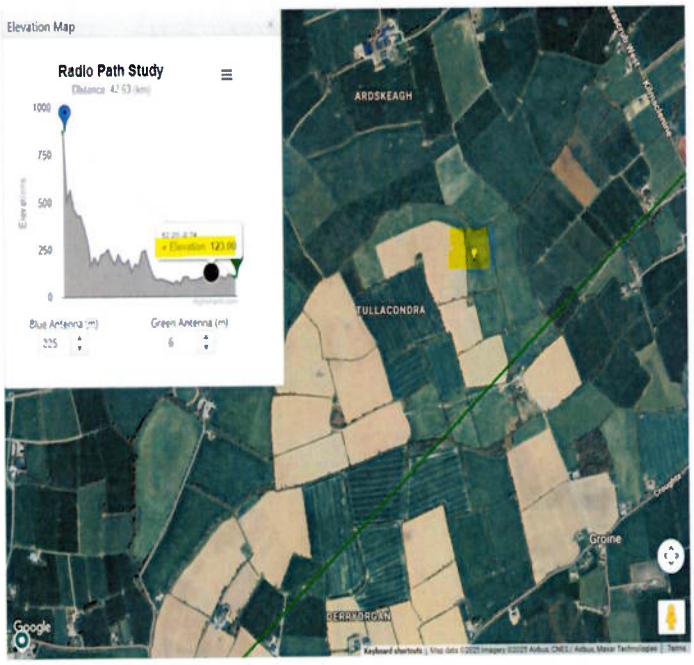
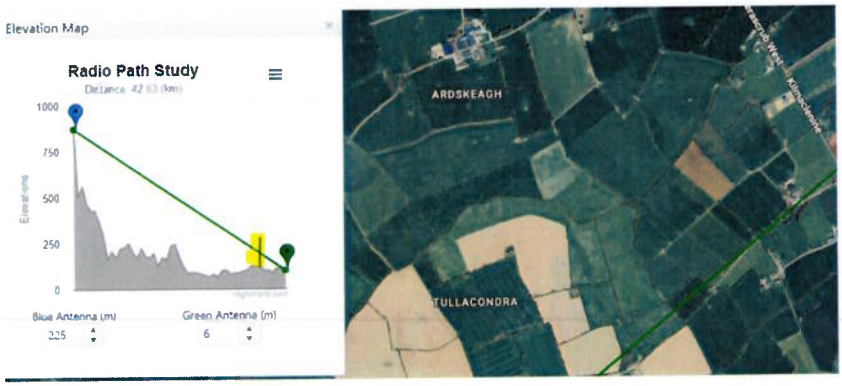
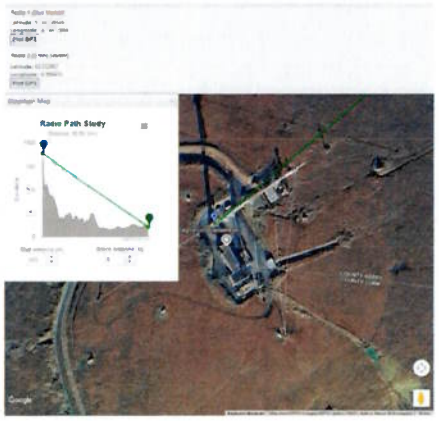


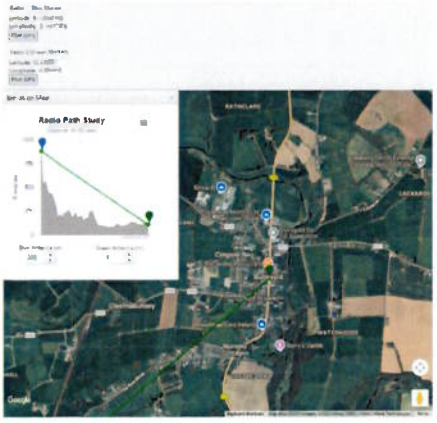
Fig 5: 123m height of the proposed development site at Tullacondra with the addition of a 176m turbine tip height , combined total heights 299m, is shown to interfere with the Saorview radio path (green line) that currently has a clear line of sight below the 250m elevation horizontal line



Appendix:

Blue marker point at Saorview tower at Mullaghanish
Green marker at Buttevant Town





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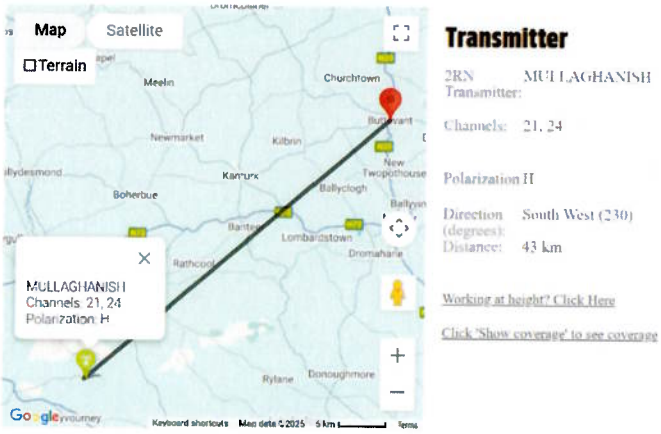


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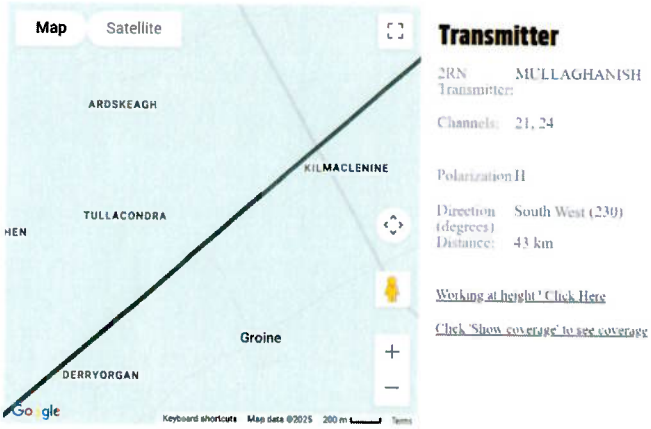


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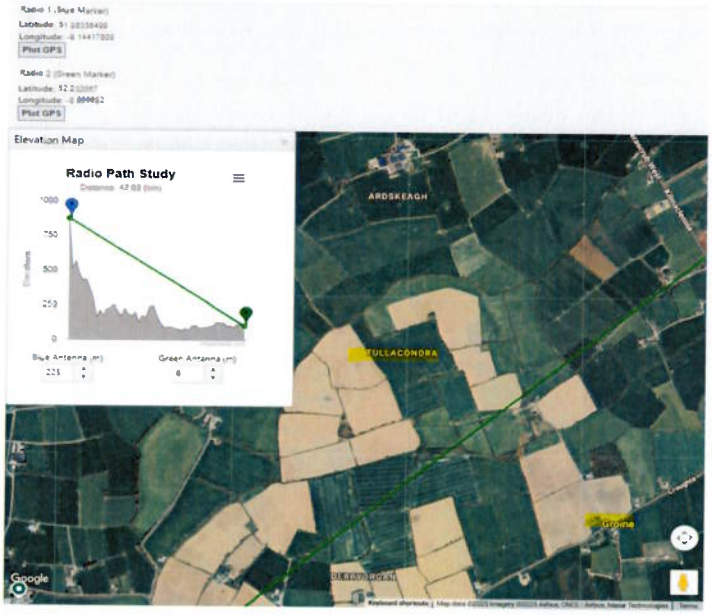


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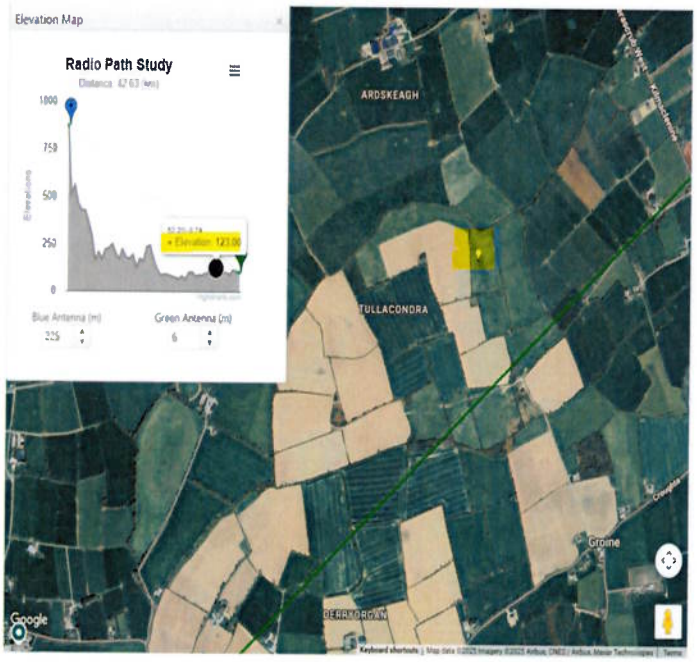
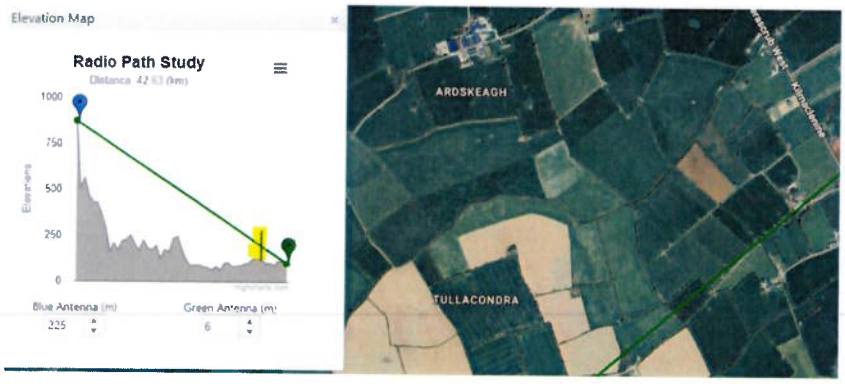


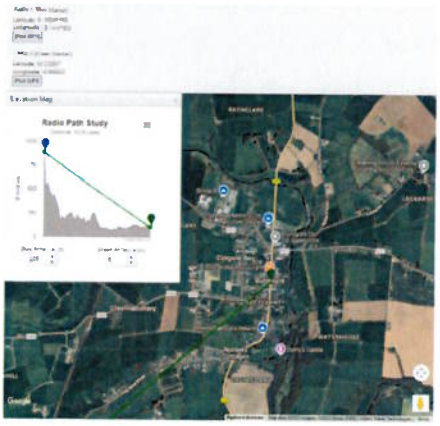
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Appendix:

Blue marker point at Saorview tower at Mullaghanish
Green marker at Buttevant Town





Community Action Group Against Tullacondra Green Energy

Name Sig.	Name PRINT
R.M.O'Grady	ARTHUR O'GRADY
E O'Grady	EOGHAN O'GRADY
Pat O'Grady	PAT O'GRADY
[redacted]	[redacted]
Tracy Walshe	TRACEY WALSHE
John Aherne	John Aherne
Nuala Geaney	Nuala Geaney
MARGARET BUTLER	Margaret Butler
Eavan Long	Bairbre Ní Dhuibhir
TERRA CROWLEY	Tara Crowley.
Daniel Crowley	DANIEL CROWLEY
Daniel Crowley	DANIEL O'[illegible]
Francis Lombard	EILEEN O'[illegible]
Antoinette Byrd.	ANTOINEITE BYRD
Martin Byrd.	CHARLIE BYRD.
Josephine Fahey	JOSEPHINE FIRMO
Frederick Ryan.	FREDERICK O'REGAN.
Agnes Buckley	Agnes Buckley
John Buckley	John Buckley
JOHN BUCKLEY	JOHN BUCKLEY
Aoife' Buckley	AOIFE BUCKLEY
Veronica O'Sullivan	Veronica O'Sullivan
martin murphy	MARTIN MURPHY
Jerry Shine	JERRY SHINE
Theresa Shine	THERESA SHINE
Nuala O Leary	NUALA O LEARY
Liam O Driscoll	[illegible]

Community Action Group Against Tullacondra Green Energy

Name	Name
PAUDIE DALY	Elaine Broderick
David Sheahan	Emily Curtis
Anne Marie Sheahan	Amy Relihan
CONOR CLARK	David Relihan
Cladagh Sheahan	Deirdre Daly
AIDAN O CONNOR	[illegible]
Helena Daly	[illegible]
Michelle Sheahan	[illegible]
Eoin Sheahan	Paudi McCarthy
[illegible]	Ciaran McCarthy
Evelyn Muller	Frank O Reilly
Richard Bolane	Mark O Reilly
Nicolette O'Mahony	[illegible]
Brian Grieve	Padraic Aherne
Gaining Cronin	Maria Hegarty
Tini Cram	[illegible]
Dolores Cronin	Andrew J Keeffe
[redacted]	TRINA Fitzgerald Ballybeg Baltric
ARTHUR Reidy	Mick O Connell Buttevant
John Buckley	Katie McCarthy Grange Buttevant
Conor Browne	[illegible]
Teresa Mc Auliffe	Thomas J Crowley
Neil Mc Auliffe	Mossie Cronin
Lorraine O'Connor	Thomas [illegible]
Colman Buckley	John Maher
Conor Buckley Browne	Victoria O'Connor
Michael Broderick	John Aherne

Community Action Group Against Tullacondra Green Energy

Name	Name
Denis Buckley	
John Finnegan	
Nicole Finnegan	
Helen Linnell	
Owen Linnell	
Sheila Gayer	
Donal Gayer	
Catherine Buckley	
[illegible]	
Fergal Sheahan	
William Fitzgerald	
Elizabeth Gayer.	

I am offering my signature in support of the group submission for planning reference number No. 24/5503 lodged by Tullacondra Green Energy, the group submission is being submitted by Tullacondra Turbine Awareness Community

Joanne Healy
Patricia O'Grady
Clonagh O'Connell
Georgina Wheeler
Marcella Healy
John Keane
Tracy Walsh
Jack [illegible]
Philip Cotter
Frank + Rose Lombard
Denis O'Keeffe
Denis O'Connor
Arthur O'Grady
Con Conan Crowley
Neil Mc Auliffe
Evelyn Mullen
Richard Boland
Tom [illegible]

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B Walsh.

M Whelan.

Mick Whelan

E Walsh.

J Fitzgerald

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Victoria O'Connor

Paul O'Connor

John Aherne

Donal Oleet

Ava Darcy

John Dunleavy

[redacted]

Paul Timmcarthy

Ciaran McCarthy

Daniel O Keeffe.

Kathleen Collins

Mark Collins

Denis Buckley

Catherine Buckley.

Michael McCarthy

Gill McCarthy

Group. Appeal Signatures
15/06/2025.

J. Fitzgerald.

William Fitzgerald

Conor Browne

Catherine Bricker.

Group. Appeal Signatures
15/06/2025.

J. Fitzgerald.

William Fitzgerald

Conor Browne

Catherine Brickley.

Submission by William McSweeney, B. Eng (Elec), M. Eng (Comp Sys), MVB
Ard na Greine, Ballyclough, Mallow, Co. Cork P51 V308

Cork County Council Planning Application: 245503

Applicant: Tullacondra Green Energy Limited

Description: Permission for the construction, operation and decommissioning of a wind energy development including 9 wind turbines each with a blade tip height of 175 metres, rotor diameter of 150 metres, hub height of 100 metres and a rated output of 4.5 megawatts

I wish to object to the above proposed planning application.

In doing so I believe my engineering background and life experience give me a unique perspective on what is being proposed. In 2011, my family together with six other households, were forced to take a high court challenge[1] against Carraigcannon Wind Farm because of intrusive noise, the defendants eventually admitting full liability to noise nuisance at distances of over 1km. From a noise perspective in particular, I know the severe consequences that can arise should a poorly designed and badly sited wind farm be given planning.

Allied to this, I also possess a range of relevant engineering skills including amongst others, electrical/electronic expertise, project management, data analytics, quality & risk management and electrical/electronic regulatory compliance.

Bringing this life experience and engineering expertise to bear, I object to this planning application on the following grounds:

1. EIAR Terminology
2. Inappropriate location
3. Visual Impact
4. Landscape Character
5. Wind Farm Layout
6. Noise
7. Inadequate community engagement

1. <u>EIAR Terminology</u>

In the EIAR report[2], the applicant classifies a Moderate effect on the environment as **Not Significant** and further classifies Significant, Very Significant and Profound effects all under the term **Significant**.

[1] High Court cases 2011 9852 P, 2011 9893 P, 2011 9854 P, 2011 9954 P, 2011 9955 P, 2011 9956 P, 2011 10137 P
[2] 6.3.4 Assessment of effects EIAR Volume II Main Report

Justification for doing so is based on a dubious interpretation of EPA EIAR Guidelines 2002 and EU Directive 2014/52/EU. This reclassification which runs right through the entire EIAR documentation results in any Moderate effects being dismissed and Very Significant and Profound findings being considered as Significant only.

I do not believe this is good practice and in particular, results in Very Significant and Profound impacts being downplayed. It risks what should be red flag issues being overlooked. It also risks misleading the planning authority and the public regarding the true impact of the proposed development.

In short, the EIAR terminology used is misleading and in my opinion, compromises the integrity of the EIAR documents themselves.

2. Inappropriate Location

The proposed location for this wind farm is inappropriate because, even though the area is rural, it is well populated and vibrant. This can be seen visually if one examines population maps from the 2022 census. Figures 1 & 2 below clearly illustrate that the proposed location is not some sparsely populated remote area with a few isolated houses but rather a well populated locality. In figure 2, when one zooms in so to speak, it becomes particularly clear visually that in the immediate vicinity of the wind farm, the population density is significant. This is reflected in the applicant's own EIAR document where it identifies 48 occupied/planned dwellings within a 1Km radius and a total of 154 occupied/planned dwellings plus a primary school within a mere 2Km of the proposed wind farm.

Put simply, the applicant is trying to shoehorn a very large, industrial wind farm into a well populated vibrant if rural community; imposing a very extensive industrial activity into a quiet residential area when sound planning dictates that every effort should be made to keep these competing objectives separate. 154 households and a school will be very significantly affected, some profoundly during the construction phase and for decades to come during the operational phase. 154 households and a school are big numbers. That is an awful lot of residential amenity and an awful lot of family and community life that will be adversely compromised over a very long time period. In my view, the proposal is asking too much of the community and too much of 154 households that will be profoundly affected if this development goes ahead.

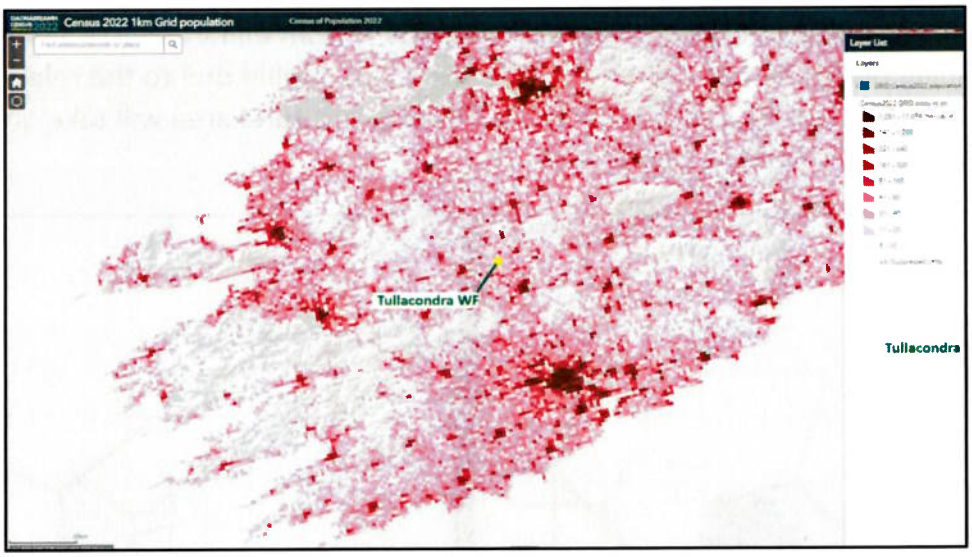


Figure. 1 - Census 2022 1Km Grid population

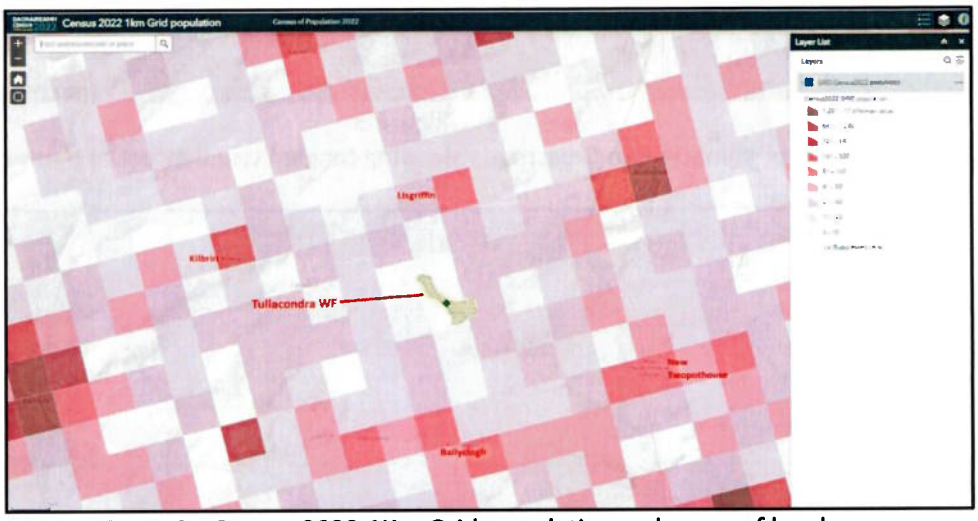


Figure 2 - Census 2022 1Km Grid population – closeup of local area

3. Visual Impact

The nine industrial wind turbines being proposed are gargantuan by any measure. With a tip height of 175 metres, they will stand ~2.5 times the height of the 18-story Elysian in Cork city, currently the tallest building in Ireland. The individual blade length of 75 metres will be nearly double the side profile of the Elysian tower (approx. 40 metres), the blade diameters being nearly four times this figure. The swept area of each turbine at ~17670 square metres is roughly 2.5 times greater than the playing surface of the Aviva stadium.

Unlike the single one-off Elysian tower, nine of these behemoths will stand on a relatively flat plateau in an open plain or as described by the Cork Area Planner, a *"fertile plain with moorland ridge*[3]." The development will be visible for miles and because of

[3] Planner's Primary Report for Planning Application 2304900

the proposed tight layout in double/triple rows, from many aspects a tangled view of spinning blades will be presented, with little visual relief due to the relative flatness of the terrain (figure 3 through figure 7). Visually, this rural area will take on a heavy industrial incongruous appearance.



Figure 3
Viewpoint 3 East of Kilmaclenine Crossroads showing tangled visual effect of tightly packed turbines



Figure 4 - Viewpoint 6 Kilgilky area



Figure 5 - Viewpoint 11 Kilbrin graveyard showing vista of entangled turbine blades with little visual relief



Figure 6 - Viewpoint 13 Knockcloona area



Figure 7 - Viewpoint 8 R580 Ease of Curraglass

The planning location proposed, per the Cork County Development Plan 2022 (CCDP), while in an area deemed Open to Consideration to wind energy projects, is classified as an important landscape (see figure 8 below). ET 13-7 of the CCDP states that

> *"Commercial wind energy development is open to consideration in these areas where proposals can avoid adverse impacts on... [v]isual quality of the landscape and the degree to which impacts are highly visible over wider areas."*

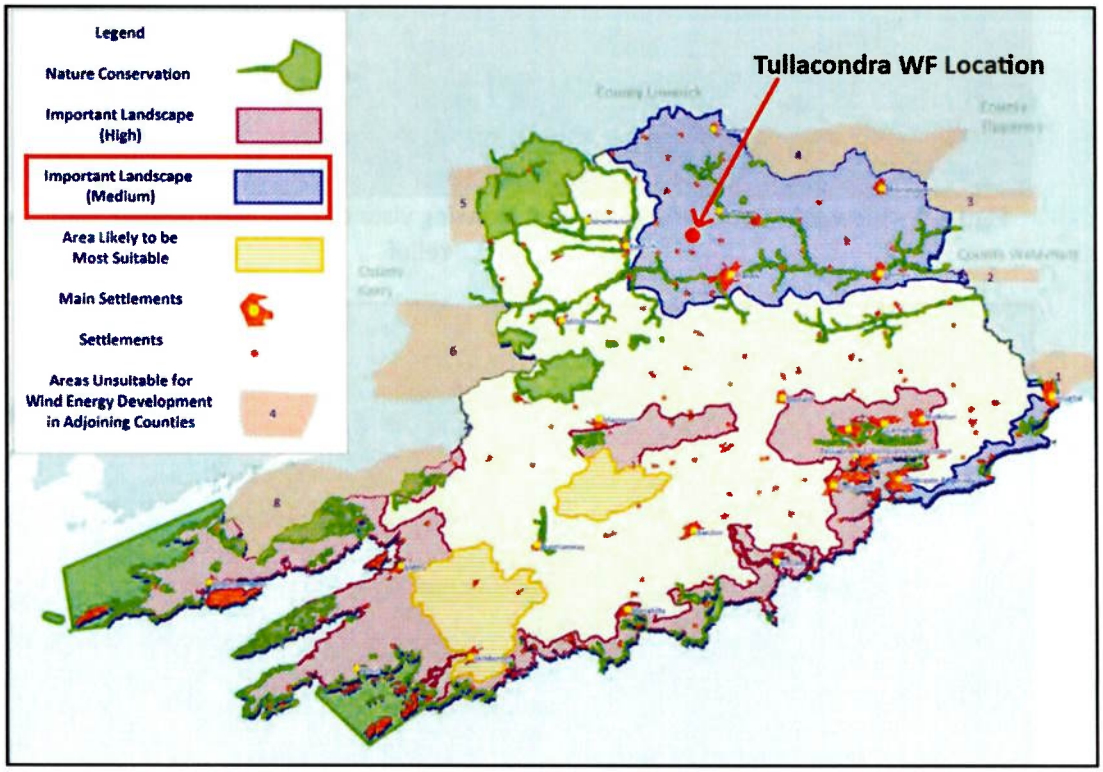


Figure 8 - from Cork County Development Plan 2022
with approximate location of Tullacondra WF added

Clearly this application should it go ahead, will significantly and negatively impact the visual quality of what is classified in the CCDP as an important landscape and will, for reasons already stated, be highly visible over wide areas.

Planning application 2304900 sheds further light on the nature and character of the site of this proposed wind farm development. This application in an adjoining townland for a one-off house to Tullacondra (NOTE: a mere 380 metres from the nearest proposed turbine location) drew the following comment from the Area & Senior Executive Planners[4] that this proposed one-off dwelling

- *"would militate against the preservation of the rural environment and amenities and it would detract from the character and visual amenities of the rural area,"*

[4] Planner's Primary Report for Planning Application 2304900

- *"on lands forming part of a High Value Landscape as defined in the Cork County Development Plan 2022...would be likely to seriously injure the amenities of the receiving environment."*

Clearly, if a standard dwelling house at virtually the same location is deemed unsuitable from a visual impact perspective, then a wind farm multiple orders of magnitude greater must also be deemed unsuitable and runs contrary to both objective 13-7 of the CCDP 2022 and the classification of the area as a "High Value Landscape." Clearly if one one-off house would *"on lands forming part of a High Value Landscape...be likely to seriously injure the amenities of the receiving environment,"* it must be patently obvious that nine colossal structures twenty times higher will have a profound negative impact and will cause very great damage indeed to the visual quality of the surrounding landscape as shown in figures 3 through 7.

4. Landscape Character

A brief study of the landscape around the proposed site, reveals a unique countryside having undergone minimal change in the past two hundred years. In particular, the field boundaries are unusual and taken together with the presence of Fulacht Fia and circular enclosures, it is clear the area has been inhabited through the millennia. What is especially noteworthy, is how little change there has been over the last two centuries with field boundaries in particular largely remaining intact. This is unusual given the bias until recently toward ever bigger fields especially from the 1970s onwards. If we compare a recent satellite image (figure 9) with its 1830's equivalent map (figure 10), the unique field pattern and how relatively intact it has remained is striking.

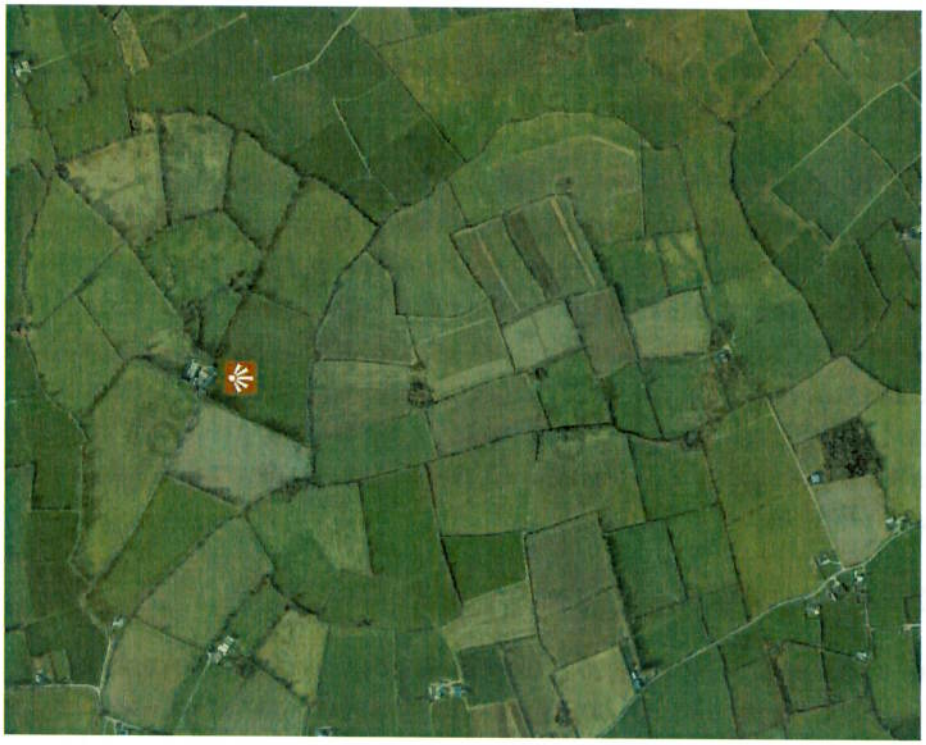


Figure 9
2013-2018 MapGenie Image- with viewpoint referred to in figure 11 added

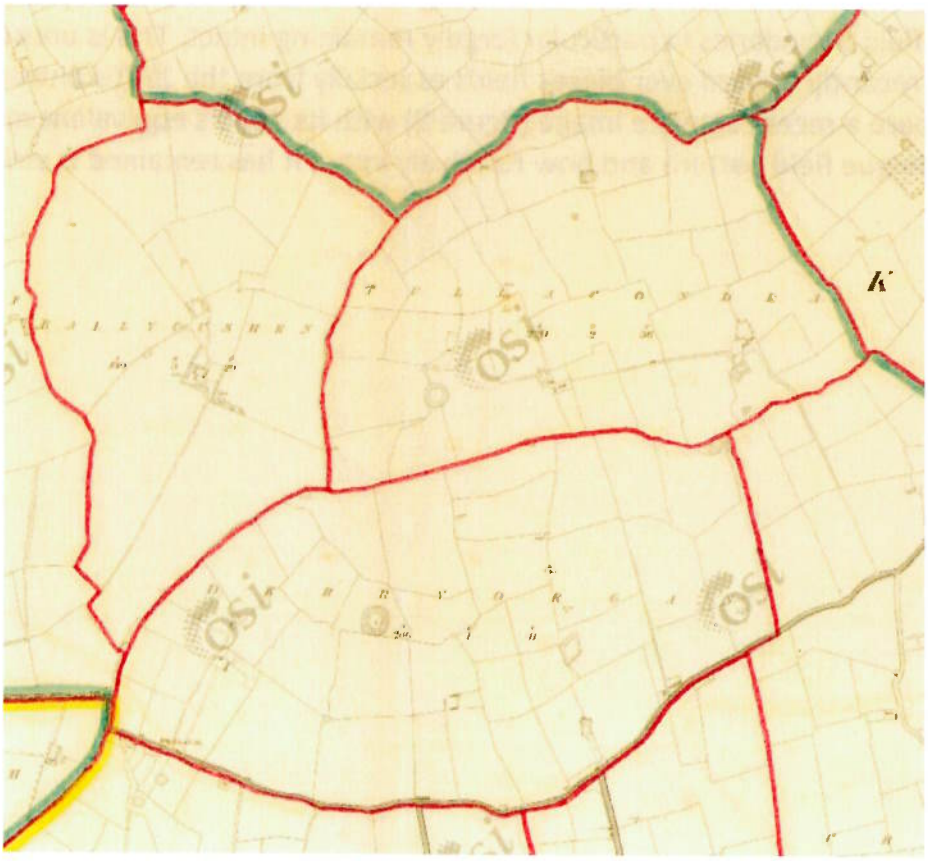


Figure 10
1829- 1841 Tailte Eireann 6 Inch Map

Standing at the viewing point indicated in figure 9, the rich undulating lowland vista is striking, clearly helped by the aforementioned field pattern, dense hedgerows and well-aged native tree species (figure 11). It is immediately evident why this rural landscape has been designated as high value.



Figure 11
View from Ballycushen looking east toward proposed turbine locations T7, T8 & T9

Given the unrelenting encroachment of modern infrastructure and industry, there are fewer and fewer settings that retain their traditional appearance and character, especially a lowland setting that is relatively well populated. This is one such locality and quite frankly, despoiling it with gigantic turbines towering over a landscape that cannot possibly absorb them makes little sense. If we let this rural area fall to major industrialisation as is being proposed, we will lose something unique, begging the question...why are we willing to sacrifice our high value landscapes? If they are deemed high value, as this location clearly is, then we need to protect them. If we follow a policy of suddenly landing enormous industrial developments into these areas, we will have no high value landscapes left because once heavily industrialised, the distinctive appearance and character that make them high value is lost for good.

5. Proposed Wind Farm Layout

It is clear from even a cursory examination of the wind farm layout that the site is much too tight for the number and size of turbines being proposed. It is also clear from the EIAR that maximising power output from the proposed site was the sole focus during the wind farm design phase.

> *The working footprint of the wind farm was finalised with involved landowners and the footprint was optimised to maximise the power output while increasing the setback distances from houses to 700m.*[5]

[5] EIAR Table 4.5: Evolution of project design EIAR: Chapter 4 – Project Need and Alternatives Considered

Taking a closer look at the evolution of the design, iteration no. 1 consisted of ten turbines with a 650 metres setback buffer to houses and a maximum wind farm capacity of 45MW.[5]

Iteration no. 2 followed which per the EIAR, *"aimed to provide fewer turbines with a greater tip height and rotor diameter,"* while at the same time optimising power output and *"increasing the setback distances from houses to 700m".*[5] The EIAR is clear that this re-design reduced the maximum capacity of the site from 45MW to 40.5MW due to the loss of one turbine, but through the use of turbines with a greater tip-height and rotor diameter, power output was optimised and the setback buffer to houses increased from 650 metres to 700 metres (presumably because of the turbine height increase).

What the EIAR fails to point out is that iteration no. 2 resulted in the spacing between the remaining turbines being significantly reduced. The net result, in terms of inter-turbine spacing from iteration no. 1, the initial design, with smaller turbines to the final design with bigger turbines is a significant reduction in turbine spacing, a spacing that was already tight to begin with. Table 1 clearly shows that in the prevailing wind direction, the spacing between turbines in the initial design was on average 425 metres but this average spacing shrunk to 387 metres in the final design. In rotor diameter terms the reduction is about 0.26 but this is likely an underestimate.[6]

Key (downwind) Seperation Distances between Turbines	**Design Iteration No. 1 Seperation in Metres** (approx as exact loaction not stated in EIA)	**Design Iteration No. 1 Seperation in Rotor Diameters** (150M assumed but EIA suggests smaller rotor diameter)	**Final Design Iteration Seperation in Metres** (exact loactions used from EIA)	**Final Design Iteration Speration in Rotor Diameters** (150M rotor diamter used per EIA)	**Reduction in Seperation in Metres (Interation no. 1 to Final Design)**	**Reduction in Seperation in Rotor Diameters (Interation no. 1 to Final Design)**
T1-T2	435	2.90	381	2.54	-54	-0.36
T3-T4	432	2.88	402	2.68	-30	-0.20
T4-T5	429	2.86	387	2.58	-42	-0.28
T5-T6	399	2.66	386	2.57	-13	-0.09
T7-T8	456	3.04	375	2.50	-81	-0.54
T8-T9	399	2.66	388	2.59	-11	-0.07
Average	425	2.83	387	2.58	-38.5	-0.26

Table 1 – Turbine separation distances in prevailing wind direction

Renewables First, a UK consultancy firm, specialising in designing and building, amongst other things, wind power advises that turbines *"need to be around '5 rotor diameters' apart so that they don't affect each other with turbulence."*[7] Lichao et al[8] state that,

> *"High turbulence intensity induced by the wake effect in wind farms is of great significance to the fatigue life of wind turbines"* and that *"spacing between wind turbines in a wind farm is about 6–10 turbine diameters in the prevailing wind*

[6] Calculation for Iteration no. 1 uses a rotor diameter of 150 metres as the smaller rotor diameter alluded to in the EIAR for Iteration no. 1 of the layout is not given in the EIAR

[7] https://renewablesfirst.co.uk/renewable-energy-technologies/windpower/community-windpower/location-size-no-of-wind-turbines/

[8] Applied Energy Volume 323 (Oct 2022) Wind farm layout optimization to minimize the wake induced turbulence effect on wind turbines

direction, which is not sufficient for the full recovery of the turbine wake, leading to a strong wake effect."

The draft Wind Energy Development Guidelines 2019[9] state that

"to ensure optimal performance and to account for turbulence and wake effects, the minimum distances between wind turbines will generally be three times the rotor diameter (=3d) in the crosswind direction and seven times the rotor diameter (=7d) in the prevailing downwind direction."

It is clear therefore, that in wind farm terms, the proposed footprint is very tight and the proposed turbine spacing, particularly in the prevailing wind direction is less than what is typically recommended and crucially, is far less than what is required to account for air flow turbulence and wake effects from upwind turbines. This latter point will be discussed further in the noise section of this submission.

Furthermore, when I compare the proposed wind farm layout with Carraigcannon wind farm (~17km to the southwest), the layouts are surprisingly similar (see figure 12 below). Both wind farms have extremely tight footprints with turbines partially arranged in double rows in the prevailing wind direction. The Carraigcannon turbines are smaller however being (100metres to the tip with a rotor diameter of 70 metres). In rotor diameter terms Carraigcannon turbine spacing in the prevailing wind direction on average is ~4.5 rotor diameters (compared to ~2.6 for Tullacondra)

I draw comparison with Carraigcannon wind farm because its tight footprint and double row layout is quite similar to what is proposed for Tullacondra. And the council should be aware that Carraigcannon Wind Farm led to seven homes being abandoned due to noise with an admission of full liability to noise nuisance at ~1km in the Irish High Court[10].

Clearly, the Tullacondra wind farm has a very similar extremely tight footprint with turbines which are too many, too large and spaced too tightly together. This has very significant negative effects in terms of both visual impact (an entangled clustering effect) and in terms of noise impact, (which I will address in more detail later).

[9] Section 4.9.6 Windtake Draft Revised Wind Energy Development Guidelines December 2019

[10] High Court cases 2011 9852 P, 2011 9893 P, 2011 9854 P, 2011 9954 P, 2011 9955 P, 2011 9956 P, 2011 10137 P



Figure 12
(Prosposed Tullacondra WF layout above
versus Carraigcannon WF layout below at the same scale)

In addition to the extremely tight layout, the proposed siting of the permanent met mast is particularly poor. The applicant's own wind monitoring survey[11] shows the predominant prevailing wind direction is ~north westerly, roughly ~280° to ~325°, (figure 13). But directly upwind from the proposed met mast siting in that very direction,

[11] EIAR Figure 13.7: Distribution of wind speed and direction during survey 28 Jun – 27 July 2022 EIAR Chapter 13 – Noise & Vibration

T4 is positioned a mere ~230 metres away with T3, also in that exact direction, only ~400 metres behind T4. This means the met mast will experience a double wake effect from both T4 and T3 in the predominant prevailing wind direction with T4 only ~ 1.5 rotor diameters away. I strongly contend that due to significant turbulence and inherent loss of energy in the oncoming wind in the immediate wake of two turbines, met mast measurements from this crucial wind direction will not be reliable.

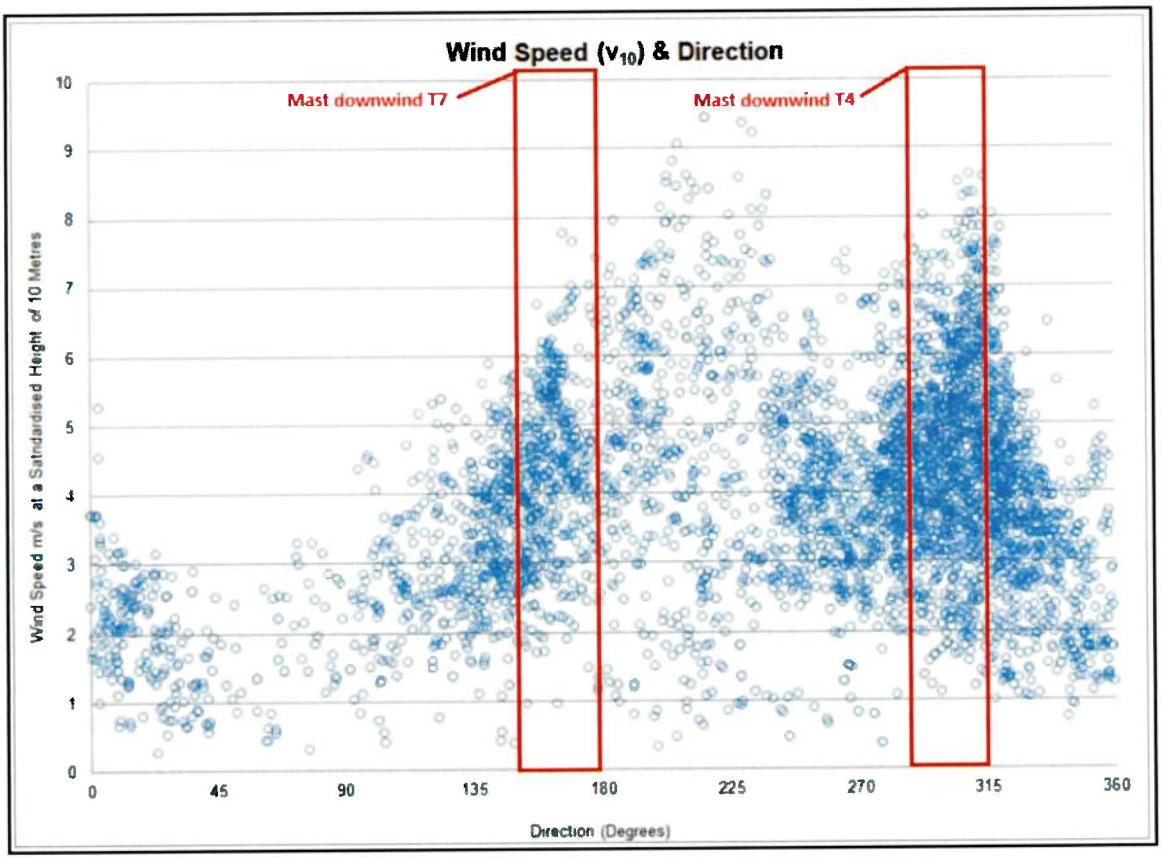


Figure 13

EIAR wind speed and direction graph showing Mast directly downwind of T4 in predominant NW wind direction and Mast directly downwind T7 in significant S-SE wind direction

Another significant wind direction highlighted by the applicant's own wind monitoring data is from a south to south-easterly direction (roughly ~130° to 180°). Here again, when the wind comes from this direction, the met mast will find itself downwind of T7, being only ~290 metres (or just ~2 rotor diameters) away. Again, a significant wake effect on the mast will occur.

So, for whatever reason, one of the worst possible places to site the mast is the location chosen by the applicants. I will deal with the knock-on implications of this poor siting later when I discuss the applicant's proposed noise mitigation plan.

To summarise, it is obvious for the proposed footprint, that the intended turbines are much too large, are too many in number and are packed in far too tightly together. In addition, the siting of the met mast could not be any worse.

6. Noise

I firmly believe, given my own personal experiences, that this development will have a profound negative impact in terms of the surrounding soundscape both in terms of proposed noise levels and noise character. I will discuss the noise aspects of the proposed project under the following sub headings

6.1 Noise – Monitoring Setup and Background Noise Results
6.2 Noise – Predicted Turbine Noise v Background Noise
6.3 Noise – Proposed Noise Limits
6.4 Noise – Proposed Noise Level Mitigation
6.5 Noise – Amplitude Modulation
6.6 Noise – Amplitude Modulation and absence of any proposed mitigation

6.1 Noise – Monitoring Setup and Background Noise Results

The EIAR lacks clarity and is missing key details about monitoring setups and how the results were obtained.

a. There is a photo of noise monitoring location BN1, but the picture provided gives very limited information regarding the placement of the monitor. From figure 13.2 of the EIAR, it seems the monitor was placed close to a dwelling but there is no dwelling visible in the picture provided. Hence, one cannot judge whether the monitor placement meets best practice in terms of representing an amenity area, whether it is sufficiently distant from reflective surfaces, from noise sources such as boilers, from bushes too close etc. This being the case it is not possible to be certain that the noise results obtained for BN1 are representative of the houses the EIAR associates with this monitoring location.

b. The EIAR provides no pictures for the BN3 monitoring setup and therefore, once again, no judgment can be made as to whether the siting and setup of that monitor was appropriate and meets best practice. Again, we cannot therefore say if the results obtained are valid, are representative and can be relied upon.

c. The EIAR details of the monitoring equipment used is incomplete. At every location a Brüel and Kjaer 2250 sound monitor was used but no details are provided in terms of the microphones or wind shields used. Neither are there any details of sound meter calibration. This is important because, the results across the four monitoring locations are not consistent. The noise floor[12] of the Brüel and Kjaer 2250 sound meter is around ~16dB and the nighttime results for BN2 & BN3 reach this value (as figure 14 shows for BN3). What is

[12] Definition of Noise Floor: The self-generated noise of a sound level meter, usually due to the microphone or pre-amplifier. This is therefore the level below which the meter cannot read https://pulsarinstruments.com/

inconsistent is the noise floor for nighttime noise at BN1 at around 20dB and in particular, BN4, higher again at ~22dB (figure 15 which shows the nighttime results for BN4) even though the sound monitors used were the same at all locations. When the two graphs are overlaid with each other the noise floor difference of ~6dB is striking (figure 16 showing nighttime results for BN4 with BN3 results overlaid).

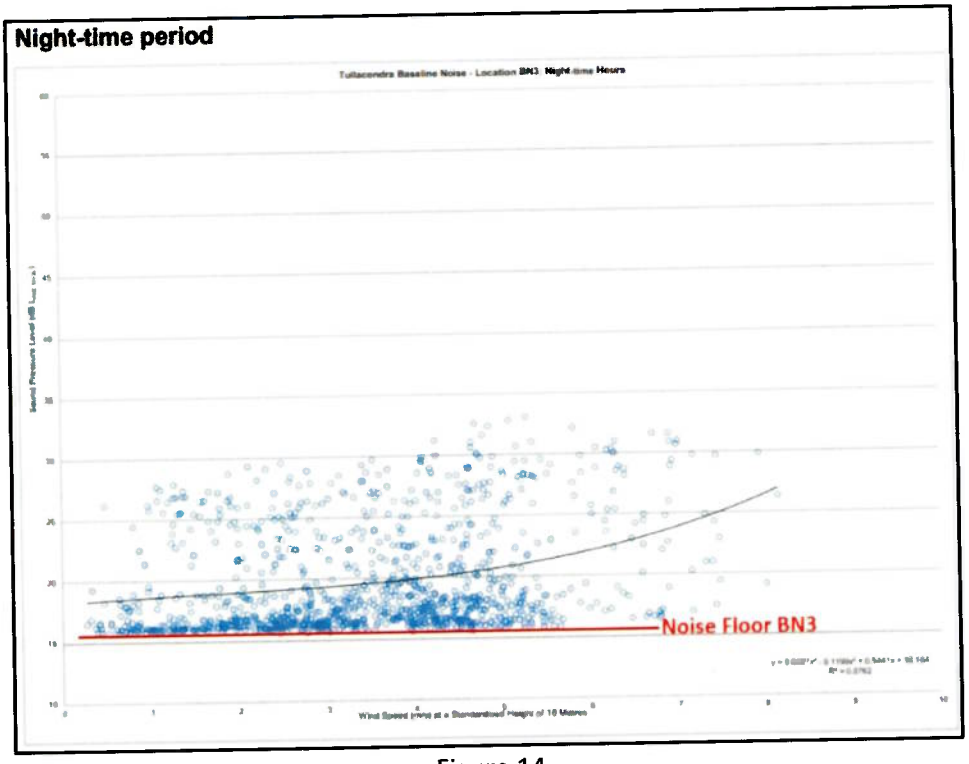


Figure 14
(EIAR figure 13. 13: BN3 Night-time periods
with Noise Floor at ~16dB added as red line)

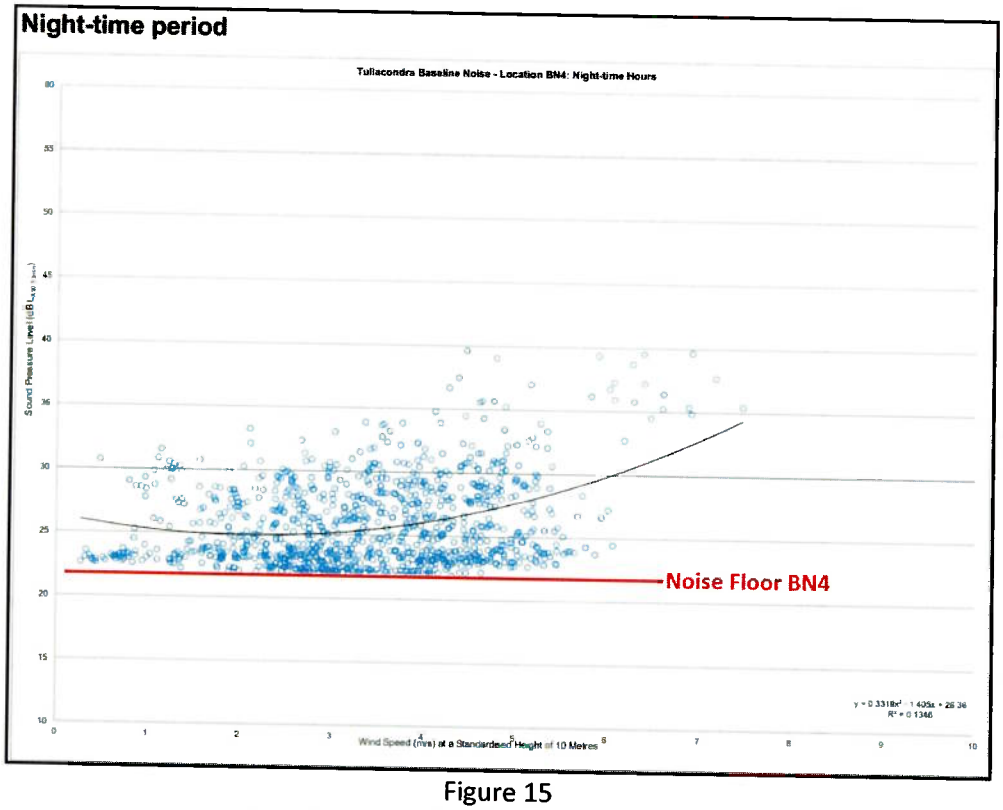


Figure 15
(EIAR figure 13. 15: BN4 Night-time periods
with Noise Floor at ~22dB added as red line)

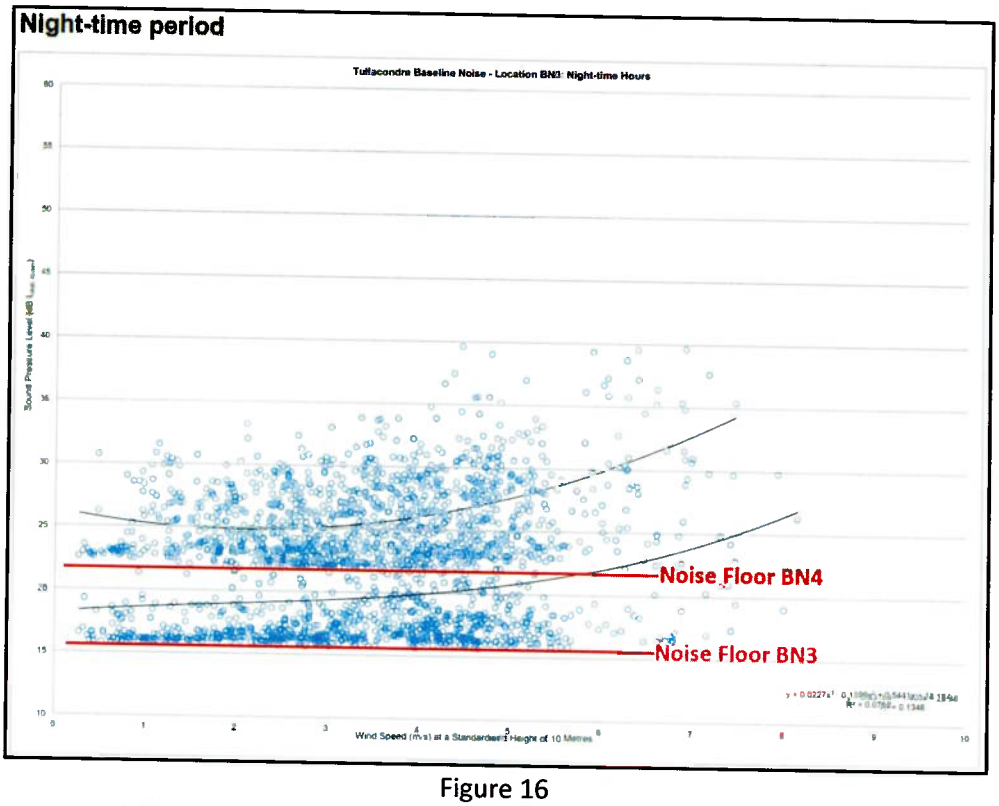


Figure 16
(EIAR figure 13. 13 & figure 13:15 overlaid with each other with
Noise Floor added for BN3 ~16dB and BN4 ~22dB as red lines)

Because of the EIAR's general lack of detail around such items as the wind shields and microphones used, their calibration details and the poor photographs provided, it is difficult to reconcile these monitoring inconsistencies. It could, of course be that BN4 is a noisier location than BN2 or BN3 but the latter are nearer busier roads and from my local knowledge I would expect the noise results for all four locations to be broadly similar. And this is not the case with BN4 especially looking like an outlier.

Graphing the monitoring results of derived background noise levels taken from Table 13.9 in the EIAR (titled Summary of baseline background sound levels, dB), it can be seen in figures 17 & 18 that there is reasonable correlation between BN2 & BN3 and to a lesser extent between them and BN1. However, BN4, which as explained earlier has the highest noise floor gives consistently higher derived results, always ~5dB to ~6dB greater than the other monitors. The analysis, strongly suggests that the BN4 derived results are out of line, are artificially high and may not be accurate.

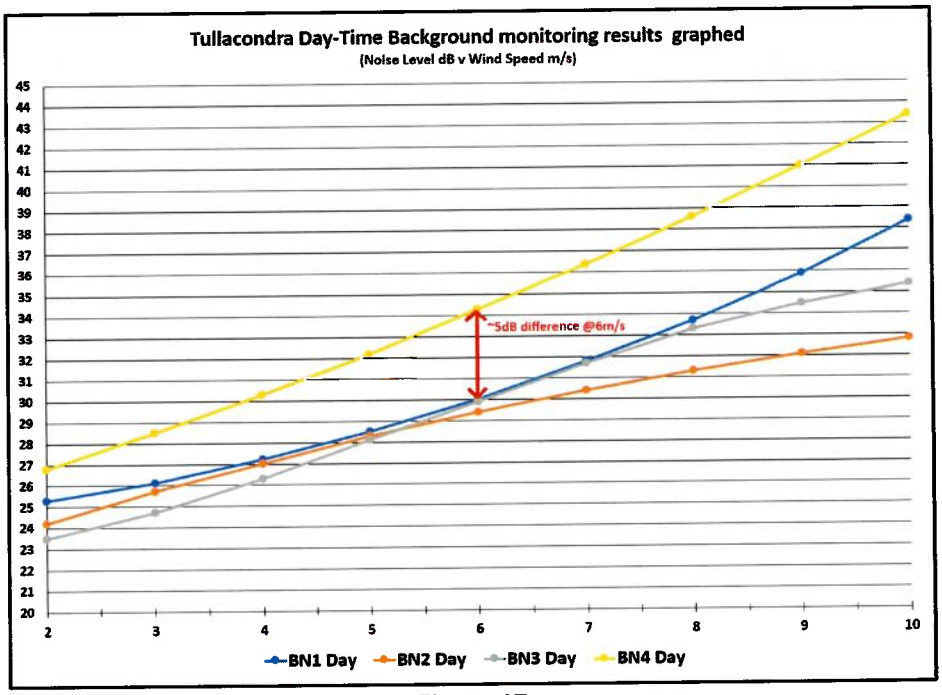


Figure 17
EIAR derived daytime background noise results graphed

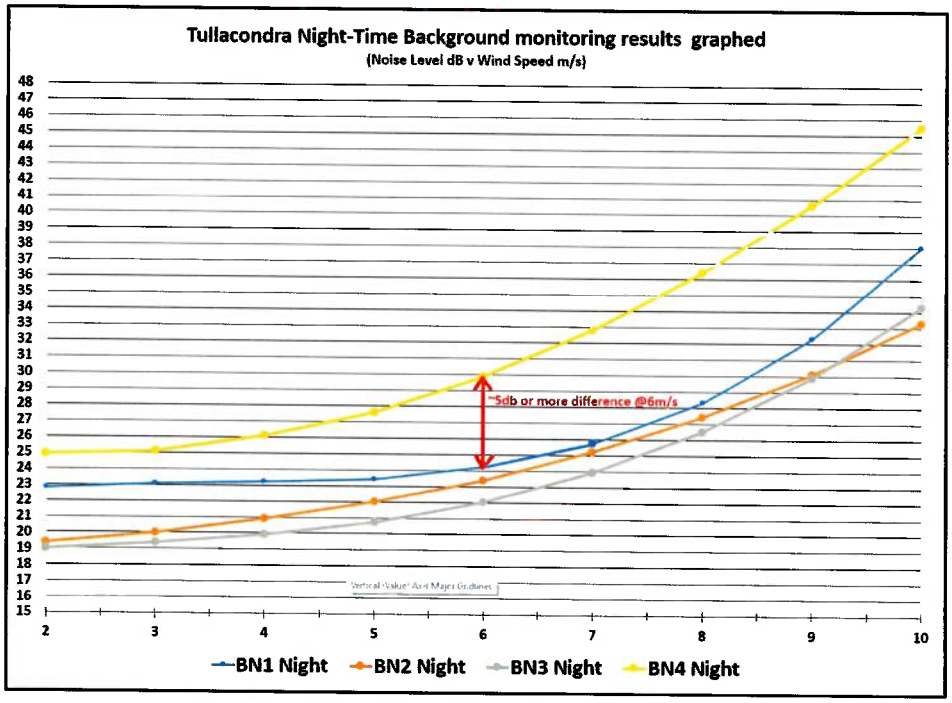


Figure 18
EIAR derived nighttime background noise results graphed

There could be several reasons for these inconsistencies in the noise floor of the monitoring setups

i. The microphone used at BN1 and in particular at BN4 may well have had a noise floor higher than that of the monitors and much higher than the background noise of the locality. For very quiet areas like this one, low noise microphones should be considered.
ii. There may have been an issue with the wind shields used at BN1 and BN4 preventing the meter measuring to its noise floor of ~16dB.
iii. There may have been some noise source in the vicinity of BN4 in particular or within the monitoring setup itself causing the measured results to be artificially elevated. But this noise source was ever present during the monitoring period because not one night-time sample at BN4 throughout the more than four-week monitoring period fell below 22dB at BN4, more suggestive of an issue with the monitoring setup itself.

The real possibility of the monitoring equipment itself influencing the noise results at BN4 and to a lesser degree at BN1 is briefly discussed in the 2013 SEAI commissioned Marshall Day Report[13] into the significance of noise in relation to onshore wind farms, where the report advises that

[13] Marshall Day Acoustics EXAMINATION OF THE SIGNIFICANCE OF NOISE IN RELATION TO ONSHORE WIND FARMS Commissioned by Sustainable Energy Authority of Ireland (SEAI) 2013

"[w]hile unattended measurement methods are well documented in a number of jurisdictions, the robustness and accuracy of results can be influenced by many factors such as equipment noise floor and wind screen performance."

I believe this is what may be at issue with the results obtained at BN4 in particular and unfortunately, the EIAR, severely lacking in detail, provides little insight as to what that issue might be. The results for the remaining monitoring stations may indeed accurately measure the background noise level but due to a serious lack of detail in terms of monitoring setups including a lack of proper photographic evidence, we cannot say this with certainty.

6.2 Noise – Predicted Turbine Noise v Background Noise

From the EIAR monitoring results, during nighttime hours, background noise levels are seen to drop to ~16dB and possibly even lower given that the monitors used can only measure down to around ~16dB. Even at a 10-metre standardised wind speed of 6m/s, the daytime background noise average is about ~30dB with nighttime levels averaging just ~23dB across three of the four noise monitors[14]. At 7m/s, these three monitors average just ~31dB by day and 25dB at night. To put these extremely low figures in context the United States Federal Aviation Administration[15] considers a quiet rural environment to be around 40dB (figure 19). Daytime averages for Tullacondra and its surrounds are much lower with nighttime values far lower again. It is clear therefore, that this is an exceptionally quiet area.

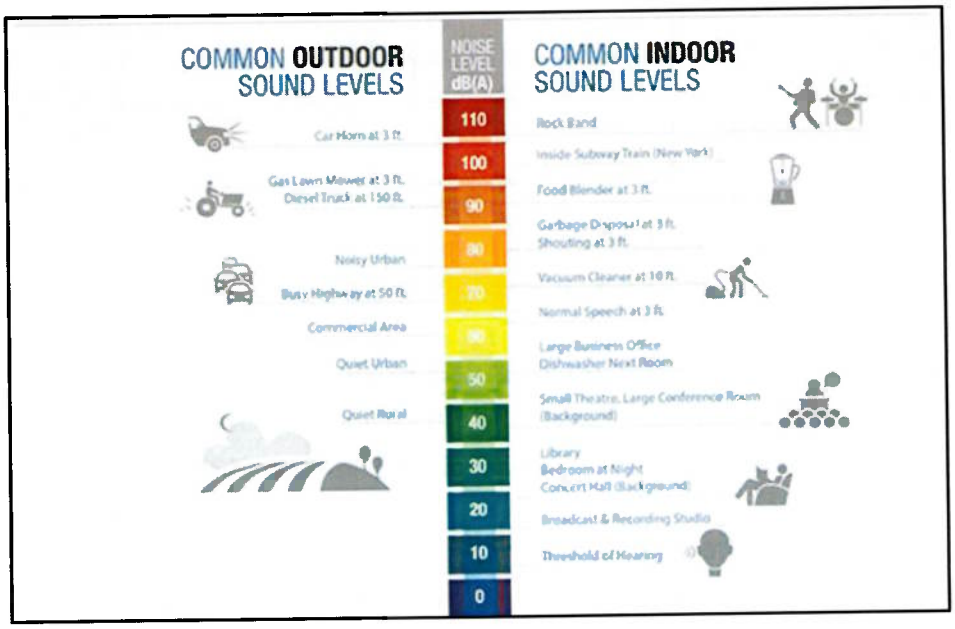


Figure 19
(US Federal Aviation Administration – Fundamentals of Noise)

[14] As explained in section 6.1, BN4 noise results may not be reliable
[15] https://www.faa.gov/regulations_policies/policy_guidance/noise Fundamentals of Noise

The surprisingly low background levels at 6 & 7 m/s 10-metre standardised wind speeds are especially important because at these wind speeds the proposed turbines will reach maximum power and sound output. For example, Table 2 below shows the higher predicted noise levels at 10-meter standardised windspeeds at 6m/s & 7 m/s for a sample of houses associated with monitoring location BN3.

Predicted Noise Levels at Receptors							
House Number	Monitor	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s
2	BN3	27.3	28.3	31.8	36.7	40.5	41.2
3	BN3	27.4	28.4	31.8	36.8	40.5	41.2
4	BN3	24.2	25.2	28.7	33.6	37.4	38.1
5	BN3	24	25	28.4	33.4	37.1	37.8
6	BN3	23.7	24.7	28.1	33.1	36.8	37.5
7	BN3	23	24	27.4	32.4	36.1	36.8
8	BN3	22.6	23.6	27	32	35.7	36.4
9	BN3	23.1	24.1	27.6	32.6	36.3	37
10	BN3	23.2	24.2	27.6	32.6	36.3	37
11	BN3	23.3	24.3	27.7	32.7	36.4	37.1
12	BN3	23.6	24.6	28	33	36.7	37.4
13	BN3	24	25	28.4	33.4	37.1	37.8
14	BN3	23.5	24.5	27.9	32.9	36.6	37.3
15	BN3	23.9	24.9	28.4	33.3	37.1	37.8
16	BN3	23.3	24.3	27.7	32.7	36.4	37.1
17	BN3	24.9	25.9	29.3	34.3	38	38.7

Table 2
Sample of houses associated with monitor location BN3.
Predicted noise levels above 35dB highlighted RED

The predicted noise levels shown in Table 2 in the context of the area being so quiet shows there will be very significant noise intrusion precisely because the background noise is so exceptionally low. For example, for the above sample of houses shown in Table 2, when we directly compare the predicted noise to the background noise level for daytime (Table 3) and nighttime (Table 4), it is immediately clear that turbine noise will dominate the soundscape, especially during nighttime hours as highlighted as shown in figure 22[16].

[16] For complete tables of Predicted Noise Levels for all houses versus Background see Appendix B

Predicted Noise levels above Daytime Background(BG)									
Day	23.5	24.7	26.3	28.1	29.9	31.7	33.3	34.5	35.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	3.8	3.6	5.5	8.6	10.6	9.5	7.9	6.7	5.8
3	3.9	3.7	5.5	8.7	10.6	9.5	7.9	6.7	5.8
4	0.7	0.5	2.4	5.5	7.5	6.4	4.8	3.6	2.7
5	0.5	0.3	2.1	5.3	7.2	6.1	4.5	3.3	2.4
6	0.2	0	1.8	5	6.9	5.8	4.2	3	2.1
7	-0.5	-0.7	1.1	4.3	6.2	5.1	3.5	2.3	1.4
8	-0.9	-1.1	0.7	3.9	5.8	4.7	3.1	1.9	1
9	-0.4	-0.6	1.3	4.5	6.4	5.3	3.7	2.5	1.6
10	-0.3	-0.5	1.3	4.5	6.4	5.3	3.7	2.5	1.6
11	-0.2	-0.4	1.4	4.6	6.5	5.4	3.8	2.6	1.7
12	0.1	-0.1	1.7	4.9	6.8	5.7	4.1	2.9	2
13	0.5	0.3	2.1	5.3	7.2	6.1	4.5	3.3	2.4
14	0	-0.2	1.6	4.8	6.7	5.6	4	2.8	1.9
15	0.4	0.2	2.1	5.2	7.2	6.1	4.5	3.3	2.4
16	-0.2	-0.4	1.4	4.6	6.5	5.4	3.8	2.6	1.7
17	1.4	1.2	3	6.2	8.1	7	5.4	4.2	3.3

Table 3 – Sample of houses associated with monitor location BN3
Predicted noise levels above Daytime Background level
Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB above BG

Predicted Noise levels above Nighttime Background(BG)									
Night	19	19.4	19.9	20.7	22	23.9	26.5	29.9	34.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	8.3	8.9	11.9	16	18.5	17.3	14.7	11.3	6.9
3	8.4	9	11.9	16.1	18.5	17.3	14.7	11.3	6.9
4	5.2	5.8	8.8	12.9	15.4	14.2	11.6	8.2	3.8
5	5	5.6	8.5	12.7	15.1	13.9	11.3	7.9	3.5
6	4.7	5.3	8.2	12.4	14.8	13.6	11	7.6	3.2
7	4	4.6	7.5	11.7	14.1	12.9	10.3	6.9	2.5
8	3.6	4.2	7.1	11.3	13.7	12.5	9.9	6.5	2.1
9	4.1	4.7	7.7	11.9	14.3	13.1	10.5	7.1	2.7
10	4.2	4.8	7.7	11.9	14.3	13.1	10.5	7.1	2.7
11	4.3	4.9	7.8	12	14.4	13.2	10.6	7.2	2.8
12	4.6	5.2	8.1	12.3	14.7	13.5	10.9	7.5	3.1
13	5	5.6	8.5	12.7	15.1	13.9	11.3	7.9	3.5
14	4.5	5.1	8	12.2	14.6	13.4	10.8	7.4	3
15	4.9	5.5	8.5	12.6	15.1	13.9	11.3	7.9	3.5
16	4.3	4.9	7.8	12	14.4	13.2	10.6	7.2	2.8
17	5.9	6.5	9.4	13.6	16	14.8	12.2	8.8	4.4

Table 4 – Sample of houses associated with monitor location BN3
Predicted noise levels above Nighttime Background level

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

The EIAR claims the noise level impact will not be significant[17] because the levels will be under noise limits they propose with reference to the out-of-date 2006 Wind Energy Guidelines. Relying on such out-of-date guidelines is unsafe and in doing so the EIAR is both misguided and misleading. In their 2023 report[18] commissioned by the UK's Department of Business, Energy & Industrial Strategy, consultants WSP note that ETSU-R-97 (and by extension the out-of-date Irish 2006 guidelines since they are largely based on ETSU) allows a nighttime minimum noise limit that is less stringent than the daytime and this is unique to the UK and Ireland compared to other jurisdictions.

In contrast to the EIAR's claims, I believe the predicted turbine noise will have a serious negative adverse noise impact. To try and quantify this impact, the British Noise Standard BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound is worth consulting. It is a noise standard that is continually being reviewed and updated (the latest version being BS 4142:2014+A1:2019) unlike the 2006 Wind Energy Guidelines which have never been updated following initial publication and are now widely viewed as not fit for purpose. This context-based guidance assesses the likely consequences when applied to the emergence of the noise above background and there is nothing precluding its use in Irish planning[19]. The standard concludes for noise relative to background that:

- *A difference of around +10dB or more is likely to be an indication of a **significant adverse impact**, depending on the context.*
- *A difference of around +5dB or more is likely to be an indication of an adverse impact, depending on the context.*

If we apply these criteria to the predicted noise levels at the sample of homes in Table 2 - Predicted noise levels above Daytime Background, BS 4142 indicates adverse impact at all homes in the sample with significant adverse impact at houses 2, 3 and 17.

The picture is much worse during nighttime hours. Here, looking at Table 4 - Predicted noise levels above Nighttime Background, BS 4142 indicates significant adverse impact at every house in the sample where dB noise level exceedance will be in the mid-teens.

In layman's terms, the EIAR predicted noise data, if compared directly against the EIAR's background noise results, clearly indicates that during daytime hours, turbine noise will

[17] Apart from Receptor 17 which the EIAR says can be dealt with by way of Noise Mitigation
[18] Department for Business, Energy & Industrial Strategy: A REVIEW OF NOISE GUIDANCE FOR ONSHORE WIND TURBINES September 2023
[19] In fact, BS 4142:2014 was used in the assessment of possible tonal noise at a number of wind farms including Knocknalour Wind Farm for Wexford County Council by leading acoustics consultants RPS Group in 2017

often dominate the soundscape, during nighttime hours it will frequently overwhelm it, with as many as 74 homes associated with BN1, BN2 & BN3 very significantly or profoundly affected[20]. This should not come as a surprise as the monitoring data shows this to be a very quiet area with BS 4142, a robust context-based standard, indicating unequivocally that noise complaints are virtually certain to occur. And this from a standard which is maintained and updated unlike the 2006 Wind Energy guidelines which are not.

6.3 Noise – Proposed Noise Limits

The EIAR implies the noise level impact will not be significant because noise will be under the noise limits it proposes with reference to the 2006 Wind Energy Guidelines. Cork County Council must realise that it is no longer credible for wind developers to give such assurances based on noise limits recommended by guidelines that are woefully out of date and have been proved repeatedly that they truly are not fit for purpose. While the guidelines advise that

> *"[a]n appropriate balance must be achieved between power generation and noise impact,"*

it is irrefutable given the widespread noise complaints and court cases that have ensued, that these guidelines fail dismally to achieve this balance. Chief reason for this is the fact that turbine size has almost tripled since the guidelines were drafted. One major consequence arising is the increasing influence of wind shear (or wind speed gradient) as turbine heights increase. With excessively tall turbines, sufficient wind at turbine hub height enables the turbines to operate and reach maximum output, while there is little or no wind and hence little masking at ground level. This issue is immediately apparent with this application, where for example at 6m/s standardised wind speed the predicted turbine noise can be ~38dB while average background is only around 22dB. That is a ~16dB increase over the soundscape or a threefold increase in perceived noise. It is only logical then, in such a quiet rural area, totally submerged by dominant industrial noise three times louder than background, that distress and complaints will follow. The proposed limits will allow this to happen and therefore, I say they will abjectly fail in striking that balance between power output and noise impact. In fact, all the proposed noise limits do, when one compares background levels with the noise the limits and by extension the 2006 guidelines will allow, is to highlight once again how out of date and misguided those guidelines truly are.

[20] I did not consider homes associated with BN4 as background noise results here may not be reliable.

6.4 Noise – Proposed Noise Level Mitigation

The EIAR identifies just one home/receptor (H17) as potentially affected by noise exceedance (at 38.0dB, the noise will be 0.5dB above proposed daytime limit) which the EIAR classifies as a

> *"Significant, adverse, long-term effect...calculated to occur at one receptor (H17), during daytime hours (07:00 to 23:00hrs), at 6m/s (v10) wind speed, and when the wind is blowing 220 to 340 degrees from north (i.e., broadly westerly winds)."*

The proposed mitigation, deploying noise reduced mode LO2 on T6, T8 & T9 will reduce the noise level at H17 from 38.0dB to 37.4dB at 6m/s and will the EIAR asserts render the Significant, adverse long-term effect on H17 to Not Significant which is clarified as

> *"an effect which causes noticeable changes in the character of the environment but without significant consequences."*

The EIAR categorises 38.0dB at 6m/s as a significant, adverse, long-term effect and then declares that a 0.6dB reduction will somehow fix the problem. But earlier, when advocating for a daytime noise limit of 37.5dB instead of a lower 35dB limit, the EIAR states that *"a difference of 2.5dB...is small and would be typically imperceptible."*

So, we have the EIAR claiming that a 0.6dB reduction will address a *"[s]ignificant, adverse, long-term effect"*, while at the same time saying that four times 0.6dB or 2.5dB difference is *"typically imperceptible"*. Clearly, the proposed noise level mitigation is a farce and a mere paper exercise which cannot be given any credence. The reality for H17, is the noise above background will be significant during the day and profound during nighttime hours where perceived noise will be a threefold increase above background. As stated previously, leaving aside the properties associated with noise monitoring location BN4, there are 74 homes which will be very significantly impacted by turbine noise and a mitigation strategy of 0.6dB, which is indeed imperceptible will not make one iota of difference. It is meaningless mitigation.

Besides, any mitigation measures will presumably use the onsite met mast to try to co-ordinate the operating mode switch of T6, T8, T9 to LO2 mode when the wind is supposedly at 6m/s. But as shown earlier the poor positioning of the met mast and the wind farm layout will result in significant wake effect turbulence at the met mast and through downwind turbines, rendering the proposed mitigation, worthless and all as it is, unimplementable because the met mast measurements themselves will not be reliable and the actual wind speed at the turbine hubs will be turbulent and everchanging.

6.5 Noise – Amplitude Modulation

The RenewableUK 2013 study concluded that the fundamental cause of Other Amplitude Modulation (OAM) was transient stall conditions occurring as the blades rotate, giving rise to the periodic thumping at the blade passing frequency.[21] Renewable UK commissioned further research into the mechanisms and causes of OAM and this research[22] found that

- significant wind shear and wind turbulence can cause changes in the angle at which a wind turbine blade comes into contact with the wind (the angle of attack of turbine blades) as they rotate through each 360-degree cycle;
- in more extreme cases, these changes can push the blades into partial stall over part of their rotation;
- in such conditions of partial blade stall, OAM can occur;

In their 2023 report[23] commissioned by the UK's Department of Business, Energy & Industrial Strategy, consultants WSP confirm that

> *"research evidence suggest that wind turbine wakes, especially in stable atmospheric conditions, can enhance wind turbine sound propagation and the potential for AM."*

As well as transient blade stall and turbine wake effects, the WSP report also identifies *"inflow turbulence variation"* as a potential cause of OAM[24]. So clearly, all the more recent research affirm to wind shear, wake effects and inflow turbulence as significant contributors to the likely occurrence of OAM (all three factors being present in this wind farm due to the turbine size and tight layout being proposed).

The EIAR argues that the occurrence of OAM is rare, cannot be foreseen at the planning stage and should complaints of OAM occur, can be dealt with through measurement and mitigation. The EIAR concedes however that when OAM does occur it can

> *"persist for several hours."*[25]

The EIAR describes Normal AM (NAM) as blade swish (which it is) while OAM includes other periodic variations of whoomph or thump type noise where

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[21] IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group Discussion Document Methods for Rating Amplitude Modulation in Wind Turbine Noise 2015

[22] RenewableUk Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect December 2013

[23] Department for Business, Energy & Industrial Strategy: A REVIEW OF NOISE GUIDANCE FOR ONSHORE WIND TURBINES September 2023

[24] The WSP report refers to OAM as non-TEDCAR-AM (non-trailing edge directivity and convective amplification-related AM)

[25] Amplitude Modulation (AM) EIAR Chapter 13: Noise & Vibration. Appendix 13.2

"the fundamental difference is that there is a low to mid frequency component (125 to 250Hz) to the AM in thump which does not occur in swish."[26]

Hence AM can be extremely intrusive, in fact devastating for those affected, both due to its attention-grabbing ability and its Low Frequency Noise (LFN) content especially when it penetrates indoors and for long periods.

The EIAR bases much of its claims on the results of the Salford report (2007) that concluded OAM is a relatively rare phenomenon and when it does occur, happens only between 7% to 15 % of the time.

The EIAR is wrong on a number of counts

- OAM in the far field occurs far more commonly than the EIAR contends and is more likely to occur at the proposed wind farm due to the turbine size and tight footprint as explained earlier.
- On wind farms where OAM does occur, it can occur frequently and is not easily mitigated.
- Proposing a wait and see approach with no proper mitigation proposal for such a serious issue is simply no longer good enough and should not be entertained by Cork County Council

6.5.1 OAM – Likelihood of Occurrence

MAS Environmental Ltd conducted much field research into the occurrence of AM at distance, compiling a list of over 30 wind farms across the UK generating OAM.[27] Many of these were not included in the 2007 Salford report, meaning the Salford report grossly underestimates the occurrence of OAM. Further research by MAS Environmental over several years at Cotton Wind Farm, Graveley, Cambridgeshire established that when a wind farm exhibits the problem of OAM it can occur frequently.[28] Specifically, MAS Environmental found at Cotton Wind Farm

"during a 10-month period 54% of nights were significantly affected by periods of AM with modulation depth (MD) of +5dBA. A focused study of 2 months of data found:

- *82% of nights MD+5dBA (46 nights)*
- *30% nights classed severe AM (17 nights)*
- *10% nights classed borderline MD+5dBA (6*
- *nights)*

[26] Why Turbine Noise Annoys – Bowdler (2011)
[27] https://www.masenv.co.uk/operational-wind-farms (2015)
[28] Cotton Farm Wind Farm – Long term community noise monitoring project – 2 years on. – Stigwood, Large Stigwood (2015)

- *18% nights little or no MD+5dBA (10 nights)*
- *4 continuous nights of severe MD+5dBA"*

There is further evidence that OAM occurs frequently when we again consider the noise nuisance case mentioned on the MAS Environmental website.[29] Noise graphs are presented for three different properties over a period spanning more than four years (Jan'12 to Aug'16) and OAM is a recurring feature in all graphs and across all seasons. Clearly at this wind farm where nuisance was admitted, OAM occurred frequently and like Cotton wind farm, any mitigation measures if tried must have failed.

Thus, AM/OAM is a common phenomenon associated with wind farm operation, a fact even the wind industry finally accepted (though it continues to claim it is rare in planning applications), given the admission of Dr. Jeremy Bass at the Bryn Llewelyn Wind Farm appeal in October 2013. Dr. Bass who was at the time in-house acoustician at the major UK wind developer, Renewable Energy Systems Ltd (RES), said

> *"foolishly ... we went along the industry line that amplitude modulation is rare.... I think that argument (dealing with AM by way of statutory nuisance law) is completely exploded by the weight of evidence.... we are in a difficult position now ... the landscape has changed and I suspect ....* ***in the future developers will no longer try the argument that AM is rare****".*

Furthermore, acoustician Mr. Dick Bowdler a long-time member of Institute of Acoustics (IOA) who was awarded the IOA Medal in recognition of outstanding contributions to research and developments in the field of engineering acoustics and whose speciality is wind farm noise, also agrees OAM is not rare. In February 2021[30,31] in a submission to An Bord Pleanala planning PL04 .308885 where the Salford report was also relied upon, Mr. Bowdler states that

> *"...the Salford study referred to is, as the footnote states, dated 2007. The suggestion that 4 out of 133 windfarms might have AM is far too old to be of any value. The turbines surveyed, for example, had an average height to blade tip of about 70m. It is now recognised that the possibility of AM is significant in any modern windfarm."*

My own personal experience also leads me to believe that OAM is NOT an infrequent occurrence. I have personally verified OAM at distance at the following wind farms

- Boggeragh Wind Farm, North Cork – numerous occasions, OAM clearly audible

[29] Case Study - Wind Farm Noise Nuisance - MAS Environmental Ltd
[30] Dick Bowdler Note on Amplitude Modulation (AM) submitted to An Bord Pleanala Case reference: PL04 .308885
[31] See Appendix A for Dick Bowdler Note on AM in full

- Boggeragh II Wind Farm, North Cork – numerous occasions, OAM clearly audible
- Scartaglin Wind Farm, North Kerry – Two visits and OAM clearly audible on both occasions
- Grouselodge Wind Farm, West Limerick - Two visits and OAM clearly audible on one occasion
- Rathnacally Wind Farm, North Cork – One visit and OAM clearly audible
- Taurbeg Wind Farm, North Cork – One visit and OAM clearly audible
- Esk Wind Farm, North Cork – Three visits and OAM clearly audible on two occasions

These seven wind farms are in the North Cork/North Kerry/West Limerick area and all seven exhibit OAM, so it is not a rare occurrence. It should also be noted that a number of these wind farms, Boggeragh II[32] and Scartaglin[33] resulted in legal cases, a key complaint in both being the suffering caused by frequent and incessant OAM. These cases were settled through mediation, not through noise mitigation.

Clearly, the EIAR is utterly wrong, when trying to argue that OAM is rare. Either it is out of touch with developments in the wind turbine noise debate or it is deliberately trying to mislead by relying on an outdated report dealing with turbines of only ~70 metres, a report one of the leading wind farm noise experts has said *"is far too old to be of any value."*

Finally, when we consider the tight layout of this proposed wind farm, the WSP report to the UK government mentioned earlier, concludes that the turbine wake effects and inflow turbulence do contribute to OAM occurrence, indicating once again, that, if built as proposed, there is a substantial risk of OAM occurring at this wind farm.

6.5.2 OAM – Likely Noise Impact should OAM occur

OAM is increasingly being taken much more seriously because the noise impact when it occurs is extremely intrusive. This is apparent if we look to the recent Wexford High Court where nuisance due to wind turbine noise and OAM in particular was established. In her judgment[34] Ms. Justice Emily Egan was satisfied that there were

> *"frequent and sustained periods during which the AM manifests typical AM values at a level widely acknowledged to be associated with high levels of annoyance"*

[32] 2017 4762 P KELLEHER & ANOR -V- GREEN ENERGY SUPPLY LIMITED & ANOR (case involved three separate homes)
[33] 2019 9091 P COOKE & ANOR -V- SCART ENERGY DAC
[34] MARGARET WEBSTER AND KEITH ROLLO AND MEENACLOGHSPAR (WIND) LIMITED ROSS SHORTEN AND JOAN CARTY AND MEENACLOGHSPAR (WIND) LIMITED JUDGMENT of Ms. Justice Emily Egan delivered on the 8th day of March 2024

which together with thump AM, rendered the wind turbine noise *"the dominant noise in the .... sound environment."* She unequivocally states that these features

> *"[i]n combination, I find that this is WTN[35] which reasonable people would find it impossible to habituate to."*

What the judge is manifestly saying is that when OAM occurs over frequent and sustained periods (thump AM being a feature of OAM), it will cause a high degree of annoyance and is impossible to habituate to.

I believe I have proved given the turbine size and tight layout of the wind farm, that there is a significant risk of OAM occurring and even the EIAR itself agrees that such occurrences *"can persist for several hours."* Therefore, should OAM occur, the impact will likely be very significant.

We now need to turn again to British Standard BS4142 to try and quantify what OAM impact will mean for Tullacondra should it arise. Analysis of the noise recordings gathered as part of the Wexford case found the AM displayed considerable impulsivity (sudden changes in sound level). Where impulsivity is present in the noise, BS4142 advises the addition of a penalty.

> *"of 3dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible."*

If we assume impulsive OAM is <u>just</u> perceptible and apply a +3dB penalty to the Tables 3 & 4, we get the following for day and nighttime predicted noise levels (Tables 5 & 6). Clearly, what BS4142 tells us in Tables 5 & 6, is that if just perceptible OAM occurs and assuming it lasts for several hours which the EIAR agrees can happen, the overall noise impact across a wide range of wind speeds will be such as to lead to widespread complaints as the resulting noise above background with the +3dB penalty added is frequently around +10dB by day and substantially above that level during nighttime hours.

[35] WTN = wind turbine noise

Predicted Noise levels above Background Daytime (BS4142 secton 9.2: +3dB penalty for just perceptable impulsivity)									
Day	23.5	24.7	26.3	28.1	29.9	31.7	33.3	34.5	35.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	6.8	6.6	8.5	11.6	13.6	12.5	10.9	9.7	8.8
3	6.9	6.7	8.5	11.7	13.6	12.5	10.9	9.7	8.8
4	3.7	3.5	5.4	8.5	10.5	9.4	7.8	6.6	5.7
5	3.5	3.3	5.1	8.3	10.2	9.1	7.5	6.3	5.4
6	3.2	3	4.8	8	9.9	8.8	7.2	6	5.1
7	2.5	2.3	4.1	7.3	9.2	8.1	6.5	5.3	4.4
8	2.1	1.9	3.7	6.9	8.8	7.7	6.1	4.9	4
9	2.6	2.4	4.3	7.5	9.4	8.3	6.7	5.5	4.6
10	2.7	2.5	4.3	7.5	9.4	8.3	6.7	5.5	4.6
11	2.8	2.6	4.4	7.6	9.5	8.4	6.8	5.6	4.7
12	3.1	2.9	4.7	7.9	9.8	8.7	7.1	5.9	5
13	3.5	3.3	5.1	8.3	10.2	9.1	7.5	6.3	5.4
14	3	2.8	4.6	7.8	9.7	8.6	7	5.8	4.9
15	3.4	3.2	5.1	8.2	10.2	9.1	7.5	6.3	5.4
16	2.8	2.6	4.4	7.6	9.5	8.4	6.8	5.6	4.7
17	4.4	4.2	6	9.2	11.1	10	8.4	7.2	6.3

Table 5

Sample of houses associated with monitor location BN3
Predicted noise levels above Daytime Background level with
+3dB penalty applied for presence of just perceptible impulsive OAM
Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB above BG
Highlighted Purple greater than 12dB above BG

Predicted Noise levels above Background Nighttime (+3dB penalty for just perceptable impulsivity)									
Night	19	19.4	19.9	20.7	22	23.9	26.5	29.9	34.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	11.3	11.9	14.9	19	21.5	20.3	17.7	14.3	9.9
3	11.4	12	14.9	19.1	21.5	20.3	17.7	14.3	9.9
4	8.2	8.8	11.8	15.9	18.4	17.2	14.6	11.2	6.8
5	8	8.6	11.5	15.7	18.1	16.9	14.3	10.9	6.5
6	7.7	8.3	11.2	15.4	17.8	16.6	14	10.6	6.2
7	7	7.6	10.5	14.7	17.1	15.9	13.3	9.9	5.5
8	6.6	7.2	10.1	14.3	16.7	15.5	12.9	9.5	5.1
9	7.1	7.7	10.7	14.9	17.3	16.1	13.5	10.1	5.7
10	7.2	7.8	10.7	14.9	17.3	16.1	13.5	10.1	5.7
11	7.3	7.9	10.8	15	17.4	16.2	13.6	10.2	5.8
12	7.6	8.2	11.1	15.3	17.7	16.5	13.9	10.5	6.1
13	8	8.6	11.5	15.7	18.1	16.9	14.3	10.9	6.5
14	7.5	8.1	11	15.2	17.6	16.4	13.8	10.4	6
15	7.9	8.5	11.5	15.6	18.1	16.9	14.3	10.9	6.5
16	7.3	7.9	10.8	15	17.4	16.2	13.6	10.2	5.8
17	8.9	9.5	12.4	16.6	19	17.8	15.2	11.8	7.4

Table 6

Sample of houses associated with monitor location BN3
Predicted noise levels above Nighttime Background level with

+3dB penalty applied for presence of just perceptible impulsive OAM
Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

If we now assume impulsive OAM is clearly perceptible and apply a +6dB penalty as BS4142 advises, to Tables 3 & 4, we get day and nighttime predicted noise levels shown in Tables 7 & 8. Here BS4142 shows that if clearly perceptible OAM occurs and assuming it lasts for several hours, the noise impact will be horrific, across nearly all wind speeds, leading to widespread complaints during day and night.

Predicted Noise levels above Background Daytime (+6dB penalty for clearly perceptable impulsivity)									
Day	23.5	24.7	26.3	28.1	29.9	31.7	33.3	34.5	35.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	9.8	9.6	11.5	14.6	16.6	15.5	13.9	12.7	11.8
3	9.9	9.7	11.5	14.7	16.6	15.5	13.9	12.7	11.8
4	6.7	6.5	8.4	11.5	13.5	12.4	10.8	9.6	8.7
5	6.5	6.3	8.1	11.3	13.2	12.1	10.5	9.3	8.4
6	6.2	6	7.8	11	12.9	11.8	10.2	9	8.1
7	5.5	5.3	7.1	10.3	12.2	11.1	9.5	8.3	7.4
8	5.1	4.9	6.7	9.9	11.8	10.7	9.1	7.9	7
9	5.6	5.4	7.3	10.5	12.4	11.3	9.7	8.5	7.6
10	5.7	5.5	7.3	10.5	12.4	11.3	9.7	8.5	7.6
11	5.8	5.6	7.4	10.6	12.5	11.4	9.8	8.6	7.7
12	6.1	5.9	7.7	10.9	12.8	11.7	10.1	8.9	8
13	6.5	6.3	8.1	11.3	13.2	12.1	10.5	9.3	8.4
14	6	5.8	7.6	10.8	12.7	11.6	10	8.8	7.9
15	6.4	6.2	8.1	11.2	13.2	12.1	10.5	9.3	8.4
16	5.8	5.6	7.4	10.6	12.5	11.4	9.8	8.6	7.7
17	7.4	7.2	9	12.2	14.1	13	11.4	10.2	9.3

Table 7

Sample of houses associated with monitor location BN3
Predicted noise levels above Daytime Background level with
+6dB penalty applied for presence of clearly perceptible impulsive OAM
Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB above BG
Highlighted Purple greater than 12dB above BG

Predicted Noise levels above Background Nighttime (+6dB penalty for clearly perceptable impulsivity)									
Night	19	19.4	19.9	20.7	22	23.9	26.5	29.9	34.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	14.3	14.9	17.9	22	24.5	23.3	20.7	17.3	12.9
3	14.4	15	17.9	22.1	24.5	23.3	20.7	17.3	12.9
4	11.2	11.8	14.8	18.9	21.4	20.2	17.6	14.2	9.8
5	11	11.6	14.5	18.7	21.1	19.9	17.3	13.9	9.5
6	10.7	11.3	14.2	18.4	20.8	19.6	17	13.6	9.2
7	10	10.6	13.5	17.7	20.1	18.9	16.3	12.9	8.5
8	9.6	10.2	13.1	17.3	19.7	18.5	15.9	12.5	8.1
9	10.1	10.7	13.7	17.9	20.3	19.1	16.5	13.1	8.7
10	10.2	10.8	13.7	17.9	20.3	19.1	16.5	13.1	8.7
11	10.3	10.9	13.8	18	20.4	19.2	16.6	13.2	8.8
12	10.6	11.2	14.1	18.3	20.7	19.5	16.9	13.5	9.1
13	11	11.6	14.5	18.7	21.1	19.9	17.3	13.9	9.5
14	10.5	11.1	14	18.2	20.6	19.4	16.8	13.4	9
15	10.9	11.5	14.5	18.6	21.1	19.9	17.3	13.9	9.5
16	10.3	10.9	13.8	18	20.4	19.2	16.6	13.2	8.8
17	11.9	12.5	15.4	19.6	22	20.8	18.2	14.8	10.4

Table 8

Sample of houses associated with monitor location BN3
Predicted noise levels above Nighttime Background level with
+6dB penalty applied for presence of clearly perceptible impulsive OAM
Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

It should, therefore, be abundantly clear from the above discussion, that if OAM occurs at Tullacondra and persists for sustained periods, the noise impact will be profoundly negative for the local community and will lead to widespread complaints.

6.6 Noise – Amplitude Modulation and absence of any proposed mitigation

To summarise succinctly the EIAR position on AM, it opines that

- OAM occurrence cannot be foreseen, it occurs infrequently/rarely
- Standard practice is to investigate only when there are complaints post construction and put mitigation measures in place at that stage if complaints are upheld

This totally reactive indifferent approach taken by the applicant to the risk of OAM occurring is diametrically opposite to the focused proactive best practice approach epitomised by a commonly used engineering and business methodology to analyse and manage risk & potential failure effectively and proactively called FMEA. It is a methodology I am personally familiar with and I introduce it here to highlight the

absurdity of the applicant's approach to AM/OAM. FMEA is an abbreviation for Failure Mode and Effects Analysis (FMEA), defined by the American Society for Quality (ASQ) as

> *"a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a product or service.*[36]*"*

The US federal Agency CMS describes FMEA as

> *"a structured way to identify and address potential problems, or failures and their resulting effects on the system or process before an adverse event occurs"*[37].

As stated by the ASQ, FMEA is a tool used commonly where

- *"Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the customer, and can be potential or actual.*
- *"Effects analysis" refers to studying the consequences of those failures.*

FMEA involves classifying or scoring the risk of a failure or negative event occurring, assigning a score from 1 to 10 based on the likelihood of occurrence, 1 being very unlikely and 10 being almost inevitable. The severity or seriousness of the event is also classified from 1 to 10, 1 being no discernible effect while 10 affects safe operation or involves government/regulatory non-conformance. A score of 7 or 8 does not affect safe operation or involves government/regulatory non-conformance but may cause disruption of change to subsequent processes. Finally, a detection score, that is the likelihood of detecting the event occurrence is also required, 1 meaning the event is almost certain to be detected with 10 meaning the event is almost impossible to detect. These three classification scores, (O)ccurence, (S)everity, (D)etection, are multiplied together to get an overall RPN or Risk Priority Number which is a numerical assessment of the risk assigned to a failure mode

$$O \times S \times D = RPN$$

Let us now apply the FMEA methodology to the risk of OAM occurring at Tullacondra Wind Farm to see what a proper, proactive and credible approach looks like.

Occurrence Score O – For Tullacondra I would suggest a score of 7 which equates to the event occurring roughly once per month. This would more than align with Mr. Dick Bowlder's views and would be an underestimate of MAS Environmental's findings at Cotton Farm. Personally, I believe the risk of OAM occurring at Tullacondra warrants a higher score in particular because the wind farm layout will make OAM occurrence more likely but let's be conservative and say 7.

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[36] https://asq.org/quality-resources/fmea Failure Mode and Effects Analysis (FMEA),

[37] https://www.cms.gov/medicare/provider-enrollment-and-certification/qapi/downloads/guidanceforfmea.pdf

Severity Score S – Here a score of 9 could easily be justified. This score is warranted as persistent OAM with high modulation depth will likely cause regulatory non-conformance as happened recently in the Wexford High Court case[38] where noise nuisance due to persistent OAM was established. Taking a more conservative approach, a score of 7 reflects a state of affairs where there is a high degree of dissatisfaction expressed which I believe reasonably equates to a high level of complaints received but where regulatory non-conformance is not occurring.

Detection Score D – Here I suggest a score of about 6. In some respects, a score of 10 could be argued given that the applicant admits there will be no detection method in place, the applicant instead relying on complaints arising. But again, taking a conservative approach a score of 6 equates to post event detection scheme where detection rate is deemed low.

If we multiply these scores together

$$7 \times 7 \times 6 = 294$$

we arrive at a RPN number of 294, which would be deemed high requiring immediate corrective action even though we scored it conservatively. In short, the score warrants a detailed strategy to bring the RPN number down below an acceptable limit either by reducing the risk of occurrence, the severity of the event or by improving the likelihood of detection with a view to immediate mitigation measures being implemented.

In contrast, the applicant's strategy, if it can be called that, is a Let's Do-Nothing approach. If it occurs, we'll then investigate and then decide on how it might be mitigated.

The Council should also be aware that there is no record of OAM mitigation being successfully deployed anywhere so how can the applicant be confident it can be mitigated successfully. Van den Berg (2023)[39] could identify only two studies into AM mitigation, one by Cand & Bullmore and the second by Mackowski & Carolus. The latter dealt with NAM or Normal AM which occurs nearer the turbine so that leaves just one study into OAM. Cand & Bullmore employed two methods, one involving a kit installed on the turbine blades with the second method involving a change to the blade pitch angle. While results were positive in terms of a reduction in prevalence using the kit and in modulation depth where blade pitch was used, I personally know their method of changing blade pitch achieved only mixed results.

[38] Webster et al v Meenacloghspar Wind Ltd 2018 8457 P

[39] The Relevance of AM Mitigation: Frits van den Berg – Forum Acusticum 2023

The applicant, therefore, is proposing OAM mitigation, where only one study was ever undertaken (which did not eliminate the issue) and where there is no subsequent record of successful deployment at any wind farm.

Persistent highly intrusive OAM occurred over a period of months and even years in some cases at Boggeragh II, Scartaglin, Grouselodge, Esk & Meenacloghspar wind farms and not at one of these was OAM mitigation successfully deployed. So why would anyone give credence to the applicant's assertion that should OAM occur, mitigation will be successfully deployed at Tullacondra? I assert that the EIAR is indulging once again in another instance of meaningless mitigation for the sake of appearance.

It is far more likely that should OAM occur, the applicant will do very little unless complainants are brave enough and have the financial resources, to plead their case in court where eventually, the applicant will likely opt for property buyout rather than OAM mitigation. Boggeragh II and Scartaglin fall into this category. Esk resulted in property buyout without the need for court proceedings. A case against Grouselodge is still proceeding through the courts, while noise nuisance was established against Meenacloghspar with the issue of damages still being dealt with. The key point being, that in all above cases where OAM was a key ingredient of the intrusive noise, mitigation was either tried and failed or was never tried at all.

Therefore, given there are reasonable grounds to expect that OAM will likely occur at this proposed wind farm (due to the turbine size, blade length and tight layout as explained earlier), I believe the application should be refused because the applicant has no credible means of addressing OAM when it will occur.

Ms. Justice Egan in her Wexford case judgment, highlights a "*lacunae in the* [planning] *permission*" when it comes to the *"consideration, assessment or regulation of this feature* [AM] *of WTN."* This omission then around AM, given that planning was granted in 2004, is understandable but it cannot be allowed to occur in 2024, knowing what we now know about AM/OAM and what I have clearly demonstrated. That is that the risk of OAM occurring at this proposed wind farm is real and should it occur will have extremely serious consequences.

The lacunae where AM/OAM is concerned still persists in planning guidance today, the out-of-date 2006 Wind Energy guidelines not even discussing the issue and because of this omission, fails in its key objective to achieve a balance between power generation and noise impact.

In recommending refusal in a recent wind farm application, the An Bord Pleanala inspector, acknowledges AM as an important issue and refers to the planning deficit when he states in his report[40]

> *"that* [wind turbine] *noise (and amplitude modulation in particular) is an important issue on which there is a significant and distinct lack of clarity...it could also reasonably include a ... reason for refusal as follows:*
>
> *Having regard to:*
>
> *(a) The acceptance of potential adverse noise impacts from the proposed development resulting from amplitude modulation,*
>
> *(b) The lack of any guidance in the Wind Energy Development Guidelines: Guidelines for Planning Authorities (June, 2006) on amplitude modulation, and*
>
> *(c) The lack of any proposed measures to mitigate impacts from amplitude modulation,*
>
> *the Board is not satisfied that the proposed wind farm, in itself and cumulatively with other wind energy development in the vicinity, would not seriously injure the amenities of residential property in the vicinity by way of adverse noise effects."*

Ms. Justice Egan and the ABP planner highlight the same deficit in planning and that same deficit exists in the applicant's EIAR documents which seriously mislead in relation to OAM's likely occurrence and proposes nothing whatsoever by way of meaningful mitigation.

7. <u>Inadequate Community Engagement</u>

The applicant details in Table 3.3 EIAR Volume II Main Report what, at first glance, seems an impressive list of community engagement activities. However, this aspect of the project was nothing more than a tick the box exercise, the chief goal being to minimise as much as possible any true meaningful interaction with the community.

A government advisory document on the subject, titled Code of Practice for Wind Energy Development in Ireland Guidelines for Community Engagement[41] is worth reading to understand what constitutes effective and well managed community engagement. Some key points include:

[40] An Bord Pleanala Inspector's Addendum Report ABP-315656-23

[41] Code of Practice for Wind Energy Development in Ireland Guidelines for Community Engagement https://assets.gov.ie/109110/b419a104-e6df-4a3e-a7ef-172166932bee.pdf

- Early engagement with the local community *"throughout each stage of the project, e.g., feasibility, design, EIAR and planning, tender, construction, and operation."*
- The need of project promotors *"to ensure the widest possible consultation with individuals and communities from the commencement of the project. Project promoters should make every effort to identify those to engage with and should be flexible and facilitative in the way they approach this engagement including, for example, in relation to the timing and venues for engagement."*

In short proper community engagement involves engagement at a very early stage and sharing as much detail as possible with as many people as possible within the community. In my view, the applicant failed to come anywhere close to meeting these government guidelines and here is why:

- According to the EIAR[42], the earliest engagement with the local community was in early January 2023, when local elected representatives were notified, and a letter and brochure were posted to each household within a 2km radius of the proposed project. If the applicant was serious about proper engagement, then
  - Why are so many local residents living within 2km complaining until very recently that they had heard nothing about the proposed project?
  - Why limit the correspondence to 2km? As stated earlier this is a gargantuan development which will massively disrupt and alter the local environment, the construction period alone will run for 18 months involving major road re-alignment, well over <u>four and a half thousand</u> large load deliveries according to the EIAR with cabling laying along 13.5km of local roads.
- It then appears that over three days in late January 2023, door to door visits took place within a 1km radius where the applicant managed to engage with 20 residents and deliver a note/leaflet to 22 residents.
  - Again, given the size and scale of the development, why only call to those within 1km???
  - This means the applicant successfully met a person from less than 50% of households within 1km or from just ~14% of households within 2km distance. And that assumes everyone they met was from a different household which may not even be the case. Assuming it is, <u>in three days going door to door, the applicant managed NOT to meet ~86% of households within a 2km radius.</u>
  - And what about the two nearest settlements, Lisgriffin and Ballyclough, which are only ~2km and ~3km from the nearest turbine respectively.

[42] EIAR Table 3.3 EIAR Volume II Chapter 3: Scoping, Consultations, Community Engagement and key issues

Why were there no door to door calls in these villages? Why no public notices? If the applicant really wanted to "engage" surely these villages should have been canvassed. As a Ballyclough resident, I only heard about the proposed wind farm accidently because I happen to walk my dog along L5302 near the proposed site entrance and met a resident who brought the subject up. Otherwise, I'd have been none the wiser.

- The one and only public meeting was held on Wednesday, February 8th 2023 in the late afternoon/early evening ending at about 8pm. Typically at this time, people are at work, picking up children from school, coming home from work, getting food prepared, milking cows etc. It was poorly advertised, the date and time chosen to ensure minimum participation I believe.
- Finally, it is clear from careful reading of the EIAR, that the project feasibility, wind farm design & layout and much of the EIAR groundwork had all been completed by the time the local community was approached. The photomontage files carry a date stamp of September 2022, meaning the turbine number, size and windfarm layout were decided well in advance of any community engagement. Ornithological field surveys of the wind farm site first commenced in 2020 according to Ornithology Baseline Report[43]

Little of the above comes even remotely close to meeting the Government's Code of Practice. Community engagement commenced two to three years <u>after</u> project feasibility commenced with the project design phase being completed well <u>before</u> engagement started. Engagement in reality meant nothing more than presenting the community with a fait acompli, which when I consult a dictionary means a thing that has already happened or been decided before those affected know, leaving them with little option but to accept it.

It must surely be clear that the community engagement aspect of this application was perfunctory at best and at worst deliberately disingenuous. I believe Cork County Council need to take this sharp practice into account during their deliberations.

<u>Final Summary</u>

I wish to object to the proposed planning application because

- My own personal experiences of exposure to intrusive wind turbine noise at distances of over 1km tells me that there is a very real risk of the same thing happening to a large number of homes if this planning is approved.

- The EIAR terminology used risks misleading the planning authority and the public regarding the true impact of the proposed development.

[43] Section 2.2 Field survey overview EIAR Appendix 8.1 – Ornithology Baseline Report Tullacondra Windfarm Project

- Community engagement was grossly inadequate, coming nowhere near to meeting the Government's Code of Practice for Wind Energy Development in Ireland Guidelines for Community Engagement.

- The proposed development runs contrary to both objective 13-7 of the CCDP 2022 and the classification of the area as a "High Value Landscape and will have a profound negative impact on the visual quality of the surrounding landscape.

- This lowland high value landscape has managed to retain much of its traditional appearance and rural character. We need to protect these remaining areas, in particular this one, given its high value status and the fact that it is rather unique in largely escaping up until now the encroachment of large scale infrastructure and industry.

- The wind farm layout is much too tight, with turbines that are much too large, are too many in number and are packed much too closely together. In addition, the siting of the met mast is especially poor. This poor layout, as explained has serious negative consequences in terms of visual impact, and especially noise impact & noise mitigation.

- Noise monitoring details are either missing or inadequate and no calibration details are provided

- Noise monitoring results for BN4 may not be reliable.

- The area being exceptionally quiet, as shown by the EIAR background readings, means predicted turbine noise levels will cause significant adverse impact by day and a profound negative impact at night, potentially overwhelming the soundscape.

- The noise level limits proposed with reference to guidelines long out of date will allow up to a threefold increase in perceived noise level, submerging the area in dominant industrial which will certainly lead to noise complaints and distress.

- The proposed noise level mitigation is meaningless, will have no effect and in any case will not be implementable due to the poor positioning of the met mast.

- The EIAR seriously misleads in terms of the likelihood of OAM occurrence. I believe there is a significant risk, in particular because of the proposed turbine size and wind farm layout. Should OAM occur, the impact will be profound and extremely damaging.

- Given the seriousness of the issue and the likelihood of occurrence, the indifferent shrug of the shoulders approach to AM/OAM taken by the applicant is totally unacceptable. There seems to be little grasp or awareness by the applicant of how serious the issues will be for local residents should OAM manifest itself.

- The EIAR has no credible mitigation strategy should OAM arise, proposing a wait and see position where mitigation will then be explored even though there is no record anywhere of successful mitigation deployment for OAM.

- As pointed out by Ms. Justice Egan in the recent Wexford nuisance case, there is a significant gap in planning when it comes to AM/OAM and has been for twenty years. It is inconceivable that this proposal would receive approval when this very serious deficit in planning which had resulted in numerous noise nuisance cases and severe distress for many homes and families is known. The time for ignoring the issue and hiding behind patently outdated guidelines (as the applicant tries to do) must surely be over, especially in light of Justice Egan's views.

COOM GREEN ENERGY PARK

NOTE ON AMPLITUDE MODULATION (AM)

Section 7.2.3 of the EIAR discusses AM (or "blade swish"). I would like to clarify a few of the points in this section because, although nothing is incorrect, the overall impression given, that it is not a significant issue, is not consistent with the facts.

The first paragraph says in part "'*The Assessment and Rating of Noise from Wind Farms' (1996), which states that '... modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine... 'and that at distances further from the turbine where there are'... more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)'. It concludes that 'the noise levels (i.e. limits) recommended in this report take into account the character of noise described ... as blade swish'*"

This is a quote from Chapter 6 of ETSU-R-97. The quote in the last sentence of the paragraph above has 3 words missing. The full sentence is "*The noise levels recommended in this report take into account the character of noise described in Chapter 3 as blade swish.*" It does not refer to the text in Chapter 6. Chapter 3 describes blade swish that is taken into account in the limits in some detail and it needs to be read in full, but in summary it says blade swish is 2-3dB near the turbine falling off with distance. So, for example the noise limits in ETSU-R-97 do not take account of a 6dB blade swish where there are more than two reflective surfaces.

The second point I make is that the Salford study referred to is, as the footnote states, dated 2007. The suggestion that 4 out of 133 windfarms might have AM is far too old to be of any value. The turbines surveyed, for example, had an average height to blade tip of about 70m.

It is now recognised that the possibility of AM is significant in any modern windfarm. Penalty systems have been devised in the UK and proposed in 2019 Draft. The IEC, that publishes the IEC61400 standards for wind turbines is drafting a new standard for wind turbine noise at receptor positions which includes AM.

Dick Bowdler

6th February 2021

APPENDIX B

BN1: Predicted Noise Levels at Receptors (>35dB highlighted RED)

House Number	Monitor	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s
27	BN1	26.8	27.8	31.2	36.2	40	40.7
28	BN1	23.2	24.2	27.6	32.6	36.3	37
29	BN1	25.7	26.7	30.2	35.1	38.9	39.6
110	BN1	22.1	23.1	26.5	31.5	35.2	35.9
111	BN1	21.3	22.4	25.8	30.8	34.5	35.2
112	BN1	21.3	22.3	25.8	30.7	34.4	35.1
113	BN1	21.4	22.4	25.8	30.8	34.5	35.2
114	BN1	21.4	22.4	25.8	30.8	34.5	35.2
127	BN1	21.7	22.8	26.2	31.2	34.9	35.6
128	BN1	20.8	21.8	25.3	30.2	33.9	34.6
129	BN1	22.2	23.2	26.6	31.6	35.3	36
130	BN1	19.9	20.9	24.3	29.3	33	33.7
131	BN1	20.2	21.2	24.6	29.6	33.3	34
132	BN1	20	21	24.4	29.4	33.1	33.8
133	BN1	19.6	20.6	24	29	32.7	33.4
136	BN1	21.6	22.6	26	31	34.7	35.4
137	BN1	20.1	21.1	24.6	29.5	33.2	33.9
138	BN1	19.8	20.8	24.2	29.2	32.9	33.6
139	BN1	19.1	20.2	23.6	28.6	32.3	33
140	BN1	18.1	19.1	22.5	27.5	31.2	31.9
141	BN1	18.1	19.1	22.5	27.5	31.2	31.9
142	BN1	18.1	19.1	22.5	27.5	31.2	31.9
143	BN1	18.7	19.7	23.2	28.1	31.8	32.5
144	BN1	16.4	17.4	20.8	25.8	29.5	30.2
145	BN1	16.2	17.2	20.7	25.6	29.3	30
146	BN1	20.5	21.5	24.9	29.9	33.6	34.3
147	BN1	20.7	21.7	25.1	30.1	33.8	34.5
148	BN1	20.9	21.9	25.3	30.3	34	34.7
149	BN1	16.3	17.4	20.8	25.8	29.5	30.2
27A	BN1	26.8	27.8	31.2	36.2	39.9	40.6

BN2: Predicted Noise Levels at Receptors (>35dB highlighted RED)

House Number	Monitor	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s
1	BN2	24.2	25.2	28.6	33.6	37.3	38
31	BN2	21.3	22.3	25.8	30.7	34.5	35.2
33	BN2	20.5	21.5	24.9	29.9	33.6	34.3
34	BN2	21.4	22.4	25.8	30.8	34.5	35.2
35	BN2	23.3	24.3	27.8	32.7	36.5	37.2
36	BN2	21.3	22.3	25.7	30.7	34.4	35.1
37	BN2	21.3	22.3	25.7	30.7	34.4	35.1
38	BN2	21.6	22.6	26	31	34.7	35.4
39	BN2	22.4	23.4	26.8	31.8	35.5	36.2
40	BN2	22.6	23.6	27	32	35.7	36.4
41	BN2	22.6	23.6	27	32	35.7	36.4
42	BN2	22.3	23.3	26.7	31.7	35.4	36.1
43	BN2	20.7	21.7	25.2	30.1	33.8	34.5
44	BN2	17	18	21.4	26.4	30.1	30.8
45	BN2	16.2	17.2	20.6	25.6	29.3	30
46	BN2	16.1	17.1	20.5	25.5	29.2	29.9
47	BN2	15.7	16.8	20.2	25.2	28.9	29.6
150	BN2	19.9	20.9	24.3	29.3	33	33.7
151	BN2	15	16	19.4	24.4	28.1	28.8
152	BN2	16.6	17.6	21	26	29.7	30.4
153	BN2	16.9	17.9	21.3	26.3	30	30.7
154	BN2	17.1	18.1	21.6	26.5	30.2	30.9
155	BN2	18.7	19.8	23.2	28.2	31.9	32.6
156	BN2	19.3	20.3	23.8	28.7	32.4	33.1
157	BN2	15.8	16.8	20.3	25.2	28.9	29.6
158	BN2	14.7	15.8	19.2	24.1	27.9	28.6
159	BN2	20.3	21.3	24.7	29.7	33.4	34.1
157A	BN2	15.7	16.7	20.1	25.1	28.8	29.5
31A	BN2	21	22	25.4	30.4	34.1	34.8
37A	BN2	21.5	22.5	26	30.9	34.7	35.4

BN3: Predicted Noise Levels at Receptors (>35dB highlighted RED)

House Number	Monitor	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s
2	BN3	27.3	28.3	31.8	36.7	40.5	41.2
3	BN3	27.4	28.4	31.8	36.8	40.5	41.2
4	BN3	24.2	25.2	28.7	33.6	37.4	38.1
5	BN3	24	25	28.4	33.4	37.1	37.8
6	BN3	23.7	24.7	28.1	33.1	36.8	37.5
7	BN3	23	24	27.4	32.4	36.1	36.8
8	BN3	22.6	23.6	27	32	35.7	36.4
9	BN3	23.1	24.1	27.6	32.6	36.3	37
10	BN3	23.2	24.2	27.6	32.6	36.3	37
11	BN3	23.3	24.3	27.7	32.7	36.4	37.1
12	BN3	23.6	24.6	28	33	36.7	37.4
13	BN3	24	25	28.4	33.4	37.1	37.8
14	BN3	23.5	24.5	27.9	32.9	36.6	37.3
15	BN3	23.9	24.9	28.4	33.3	37.1	37.8
16	BN3	23.3	24.3	27.7	32.7	36.4	37.1
17	BN3	24.9	25.9	29.3	34.3	38	38.7
54	BN3	15.9	16.9	20.3	25.3	29	29.7
55	BN3	16.2	17.2	20.6	25.6	29.3	30
56	BN3	16	17.1	20.5	25.5	29.2	29.9
57	BN3	16.1	17.1	20.6	25.5	29.2	29.9
58	BN3	16.4	17.4	20.8	25.8	29.5	30.2
59	BN3	16.5	17.6	21	26	29.7	30.4
60	BN3	16.7	17.7	21.1	26.1	29.8	30.5
61	BN3	16.8	17.8	21.2	26.2	29.9	30.6
62	BN3	16.9	17.9	21.3	26.3	30	30.7
63	BN3	16.9	18	21.4	26.3	30.1	30.8
64	BN3	17	18	21.4	26.4	30.1	30.8
65	BN3	18.7	19.7	23.2	28.1	31.8	32.5
66	BN3	19.2	20.2	23.6	28.6	32.3	33
67	BN3	19.6	20.6	24	29	32.7	33.4
68	BN3	19.8	20.8	24.3	29.2	32.9	33.6
69	BN3	19.9	20.9	24.3	29.3	33	33.7
70	BN3	20.5	21.5	24.9	29.9	33.6	34.3
71	BN3	21	22	25.4	30.4	34.1	34.8
72	BN3	23.4	24.4	27.8	32.8	36.5	37.2
73	BN3	22	23	26.4	31.4	35.1	35.8
74	BN3	20.3	21.3	24.7	29.7	33.4	34.1
75	BN3	19.8	20.9	24.3	29.3	33	33.7
77	BN3	17.4	18.5	21.9	26.8	30.5	31.2
78	BN3	16.7	17.8	21.2	26.1	29.9	30.6
79	BN3	16.5	17.6	21	25.9	29.7	30.4
80	BN3	16.4	17.5	20.9	25.8	29.6	30.3
81	BN3	15.9	16.9	20.3	25.3	29	29.7
82	BN3	16	17	20.4	25.4	29.1	29.8
83	BN3	15.8	16.8	20.2	25.2	28.9	29.6
84	BN3	16.2	17.2	20.6	25.6	29.3	30
85	BN3	15	16.1	19.5	24.5	28.2	28.9
55A	BN3	16.3	17.3	20.7	25.7	29.4	30.1
7A	BN3	23.1	24.1	27.5	32.5	36.2	36.9

BN4: Predicted Noise Levels at Receptors (>35dB highlighted RED)

House Number	Monitor	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s
18	BN4	22.8	23.8	27.2	32.2	35.9	36.6
19	BN4	23.3	24.3	27.7	32.7	36.4	37.1
20	BN4	23	24	27.5	32.4	36.2	36.9
21	BN4	25.1	26.1	29.5	34.5	38.2	38.9
22	BN4	24.4	25.3	28.8	33.8	37.5	38.2
23	BN4	25.7	26.7	30.2	35.1	38.9	39.6
24	BN4	24.8	25.8	29.2	34.2	37.9	38.6
25	BN4	24.7	25.7	29.1	34.1	37.9	38.6
26	BN4	22.7	23.7	27.1	32.1	35.8	36.5
86	BN4	16.4	17.4	20.8	25.8	29.5	30.2
87	BN4	17.4	18.4	21.8	26.8	30.5	31.2
88	BN4	17.8	18.8	22.2	27.2	30.9	31.6
89	BN4	18	19	22.4	27.4	31.1	31.8
90	BN4	18.5	19.6	23	27.9	31.7	32.4
91	BN4	20.5	21.5	24.9	29.9	33.6	34.3
92	BN4	20.8	21.8	25.2	30.2	33.9	34.6
93	BN4	20.9	22	25.4	30.4	34.1	34.8
94	BN4	17	18	21.4	26.4	30.1	30.8
95	BN4	16.7	17.7	21.2	26.1	29.8	30.5
97	BN4	15.7	16.8	20.2	25.1	28.9	29.6
98	BN4	15.5	16.6	20	25	28.7	29.4
99	BN4	15	16	19.5	24.4	28.1	28.8
100	BN4	15.6	16.7	20.1	25	28.8	29.5
101	BN4	15.6	16.6	20	25	28.7	29.4
102	BN4	15.8	16.9	20.3	25.3	29	29.7
103	BN4	15.4	16.4	19.8	24.8	28.5	29.2
104	BN4	15.7	16.7	20.1	25.1	28.8	29.5
106	BN4	16.5	17.5	20.9	25.9	29.6	30.3
107	BN4	16.8	17.8	21.2	26.2	29.9	30.6
108	BN4	20.8	21.8	25.2	30.2	33.9	34.6
109	BN4	22.2	23.2	26.6	31.6	35.3	36
115	BN4	16.6	17.7	21.1	26	29.8	30.5
116	BN4	16.5	17.6	21	25.9	29.7	30.4
117	BN4	16.9	17.9	21.3	26.3	30	30.7
118	BN4	16.5	17.5	20.9	25.9	29.6	30.3
119	BN4	16.4	17.4	20.8	25.8	29.5	30.2
120	BN4	16.3	17.4	20.8	25.7	29.5	30.2
121	BN4	16.6	17.6	21	26	29.7	30.4
122	BN4	16.5	17.5	20.9	25.9	29.6	30.3
123	BN4	16.3	17.3	20.7	25.7	29.4	30.1
124	BN4	16.1	17.1	20.6	25.5	29.2	29.9
116A	BN4	16.5	17.6	21	26	29.7	30.4
121A	BN4	16.6	17.6	21.1	26	29.7	30.4
21A	BN4	24.7	25.7	29.2	34.2	37.9	38.6
24A	BN4	24.4	25.4	28.8	33.8	37.5	38.2
25A	BN4	24.7	25.7	29.1	34.1	37.8	38.5
87A	BN4	17.7	18.7	22.1	27.1	30.8	31.5
93A	BN4	20.6	21.6	25.1	30	33.7	34.4

BN1: Predicted Noise levels above Background Daytime

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	25.3	26.1	27.2	28.5	30	31.8	33.7	35.9	38.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	1.5	1.7	4	7.7	[illegible]	[illegible]	7	4.8	2.3
28	-2.1	-1.9	0.4	4.1	6.3	5.2	3.3	1.1	-1.4
29	0.4	0.6	3	6.6	[illegible]	7.8	5.9	3.7	1.2
110	-3.2	-3	-0.7	3	5.2	4.1	2.2	0	-2.5
111	-4	-3.7	-1.4	2.3	4.5	3.4	1.5	-0.7	-3.2
112	-4	-3.8	-1.4	2.2	4.4	3.3	1.4	-0.8	-3.3
113	-3.9	-3.7	-1.4	2.3	4.5	3.4	1.5	-0.7	-3.2
114	-3.9	-3.7	-1.4	2.3	4.5	3.4	1.5	-0.7	-3.2
127	-3.6	-3.3	-1	2.7	4.9	3.8	1.9	-0.3	-2.8
128	-4.5	-4.3	-1.9	1.7	3.9	2.8	0.9	-1.3	-3.8
129	-3.1	-2.9	-0.6	3.1	5.3	4.2	2.3	0.1	-2.4
130	-5.4	-5.2	-2.9	0.8	3	1.9	0	-2.2	-4.7
131	-5.1	-4.9	-2.6	1.1	3.3	2.2	0.3	-1.9	-4.4
132	-5.3	-5.1	-2.8	0.9	3.1	2	0.1	-2.1	-4.6
133	-5.7	-5.5	-3.2	0.5	2.7	1.6	-0.3	-2.5	-5
136	-3.7	-3.5	-1.2	2.5	4.7	3.6	1.7	-0.5	-3
137	-5.2	-5	-2.6	1	3.2	2.1	0.2	-2	-4.5
138	-5.5	-5.3	-3	0.7	2.9	1.8	-0.1	-2.3	-4.8
139	-6.2	-5.9	-3.6	0.1	2.3	1.2	-0.7	-2.9	-5.4
140	-7.2	-7	-4.7	-1	1.2	0.1	-1.8	-4	-6.5
141	-7.2	-7	-4.7	-1	1.2	0.1	-1.8	-4	-6.5
142	-7.2	-7	-4.7	-1	1.2	0.1	-1.8	-4	-6.5
143	-6.6	-6.4	-4	-0.4	1.8	0.7	-1.2	-3.4	-5.9
144	-8.9	-8.7	-6.4	-2.7	-0.5	-1.6	-3.5	-5.7	-8.2
145	-9.1	-8.9	-6.5	-2.9	-0.7	-1.8	-3.7	-5.9	-8.4
146	-4.8	-4.6	-2.3	1.4	3.6	2.5	0.6	-1.6	-4.1
147	-4.6	-4.4	-2.1	1.6	3.8	2.7	0.8	-1.4	-3.9
148	-4.4	-4.2	-1.9	1.8	4	2.9	1	-1.2	-3.7
149	-9	-8.7	-6.4	-2.7	-0.5	-1.6	-3.5	-5.7	-8.2
27A	1.5	1.7	4	7.7	[illegible]	[illegible]	6.9	4.7	2.2

BN1: Predicted Noise levels above Background Nighttime

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	22.8	23.1	23.2	23.4	24.2	25.7	28.3	32.3	38
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	4	4.7	[illegible]	12.8	15.8	15	12.4	[illegible]	2.7
28	0.4	1.1	4.4	[illegible]	12.1	[illegible]	[illegible]	4.7	-1
29	2.9	3.6	7	[illegible]	14.7	13.9	[illegible]	7.3	1.6
110	-0.7	0	3.3	[illegible]	[illegible]	[illegible]	7.6	3.6	-2.1
111	-1.5	-0.7	2.6	7.4	[illegible]	[illegible]	6.9	2.9	-2.8
112	-1.5	-0.8	2.6	7.3	[illegible]	[illegible]	6.8	2.8	-2.9
113	-1.4	-0.7	2.6	7.4	[illegible]	[illegible]	6.9	2.9	-2.8
114	-1.4	-0.7	2.6	7.4	[illegible]	[illegible]	6.9	2.9	-2.8
127	-1.1	-0.3	3	7.8	[illegible]	[illegible]	7.3	3.3	-2.4
128	-2	-1.3	2.1	6.8	[illegible]	[illegible]	6.3	2.3	-3.4
129	-0.6	0.1	3.4	[illegible]	[illegible]	[illegible]	7.7	3.7	-2
130	-2.9	-2.2	1.1	5.9	[illegible]	[illegible]	5.4	1.4	-4.3
131	-2.6	-1.9	1.4	6.2	[illegible]	[illegible]	5.7	1.7	-4
132	-2.8	-2.1	1.2	6	[illegible]	[illegible]	5.5	1.5	-4.2
133	-3.2	-2.5	0.8	5.6	[illegible]	7.7	5.1	1.1	-4.6
136	-1.2	-0.5	2.8	7.6	[illegible]	[illegible]	7.1	3.1	-2.6
137	-2.7	-2	1.4	6.1	[illegible]	[illegible]	5.6	1.6	-4.1
138	-3	-2.3	1	5.8	[illegible]	7.9	5.3	1.3	-4.4
139	-3.7	-2.9	0.4	5.2	[illegible]	7.3	4.7	0.7	-5
140	-4.7	-4	-0.7	4.1	7	6.2	3.6	-0.4	-6.1
141	-4.7	-4	-0.7	4.1	7	6.2	3.6	-0.4	-6.1
142	-4.7	-4	-0.7	4.1	7	6.2	3.6	-0.4	-6.1
143	-4.1	-3.4	0	4.7	7.6	6.8	4.2	0.2	-5.5
144	-6.4	-5.7	-2.4	2.4	5.3	4.5	1.9	-2.1	-7.8
145	-6.6	-5.9	-2.5	2.2	5.1	4.3	1.7	-2.3	-8
146	-2.3	-1.6	1.7	6.5	[illegible]	[illegible]	6	2	-3.7
147	-2.1	-1.4	1.9	6.7	[illegible]	[illegible]	6.2	2.2	-3.5
148	-1.9	-1.2	2.1	6.9	[illegible]	[illegible]	6.4	2.4	-3.3
149	-6.5	-5.7	-2.4	2.4	5.3	4.5	1.9	-2.1	-7.8
27A	4	4.7	[illegible]	12.8	15.7	14.9	12.3	[illegible]	2.6

BN1: Predicted Noise levels above Background Daytime (+3dB penalty for just perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	25.3	26.1	27.2	28.5	30	31.8	33.7	35.9	38.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	4.5	4.7	7	[illegible]	13	[illegible]	[illegible]	7.8	5.3
28	0.9	1.1	3.4	7.1	[illegible]	[illegible]	6.3	4.1	1.6
29	3.4	3.6	6	[illegible]	[illegible]	[illegible]	[illegible]	6.7	4.2
110	-0.2	0	2.3	6	[illegible]	7.1	5.2	3	0.5
111	-1	-0.7	1.6	5.3	7.5	6.4	4.5	2.3	-0.2
112	-1	-0.8	1.6	5.2	7.4	6.3	4.4	2.2	-0.3
113	-0.9	-0.7	1.6	5.3	7.5	6.4	4.5	2.3	-0.2
114	-0.9	-0.7	1.6	5.3	7.5	6.4	4.5	2.3	-0.2
127	-0.6	-0.3	2	5.7	7.9	6.8	4.9	2.7	0.2
128	-1.5	-1.3	1.1	4.7	6.9	5.8	3.9	1.7	-0.8
129	-0.1	0.1	2.4	6.1	[illegible]	7.2	5.3	3.1	0.6
130	-2.4	-2.2	0.1	3.8	6	4.9	3	0.8	-1.7
131	-2.1	-1.9	0.4	4.1	6.3	5.2	3.3	1.1	-1.4
132	-2.3	-2.1	0.2	3.9	6.1	5	3.1	0.9	-1.6
133	-2.7	-2.5	-0.2	3.5	5.7	4.6	2.7	0.5	-2
136	-0.7	-0.5	1.8	5.5	7.7	6.6	4.7	2.5	0
137	-2.2	-2	0.4	4	6.2	5.1	3.2	1	-1.5
138	-2.5	-2.3	0	3.7	5.9	4.8	2.9	0.7	-1.8
139	-3.2	-2.9	-0.6	3.1	5.3	4.2	2.3	0.1	-2.4
140	-4.2	-4	-1.7	2	4.2	3.1	1.2	-1	-3.5
141	-4.2	-4	-1.7	2	4.2	3.1	1.2	-1	-3.5
142	-4.2	-4	-1.7	2	4.2	3.1	1.2	-1	-3.5
143	-3.6	-3.4	-1	2.6	4.8	3.7	1.8	-0.4	-2.9
144	-5.9	-5.7	-3.4	0.3	2.5	1.4	-0.5	-2.7	-5.2
145	-6.1	-5.9	-3.5	0.1	2.3	1.2	-0.7	-2.9	-5.4
146	-1.8	-1.6	0.7	4.4	6.6	5.5	3.6	1.4	-1.1
147	-1.6	-1.4	0.9	4.6	6.8	5.7	3.8	1.6	-0.9
148	-1.4	-1.2	1.1	4.8	7	5.9	4	1.8	-0.7
149	-6	-5.7	-3.4	0.3	2.5	1.4	-0.5	-2.7	-5.2
27A	4.5	4.7	7	[illegible]	12.9	[illegible]	[illegible]	7.7	5.2

BN1: Predicted Noise levels above Background Nighttime (+3dB penalty for just perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	22.8	23.1	23.2	23.4	24.2	25.7	28.3	32.3	38
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	7	7.7	[illegible]	15.8	18.8	18	15.4	[illegible]	5.7
28	3.4	4.1	7.4	12.2	15.1	14.3	[illegible]	7.7	2
29	5.9	6.6	[illegible]	14.7	17.7	16.9	14.3	[illegible]	4.6
110	2.3	3	6.3	[illegible]	14	13.2	[illegible]	6.6	0.9
111	1.5	2.3	5.6	[illegible]	13.3	12.5	[illegible]	5.9	0.2
112	1.5	2.2	5.6	[illegible]	13.2	12.4	[illegible]	5.8	0.1
113	1.6	2.3	5.6	[illegible]	13.3	12.5	[illegible]	5.9	0.2
114	1.6	2.3	5.6	[illegible]	13.3	12.5	[illegible]	5.9	0.2
127	1.9	2.7	6	[illegible]	13.7	12.9	[illegible]	6.3	0.6
128	1	1.7	5.1	[illegible]	12.7	[illegible]	[illegible]	5.3	-0.4
129	2.4	3.1	6.4	[illegible]	14.1	13.3	[illegible]	6.7	1
130	0.1	0.8	4.1	[illegible]	[illegible]	[illegible]	[illegible]	4.4	-1.3
131	0.4	1.1	4.4	[illegible]	12.1	[illegible]	[illegible]	4.7	-1
132	0.2	0.9	4.2	[illegible]	[illegible]	[illegible]	[illegible]	4.5	-1.2
133	-0.2	0.5	3.8	[illegible]	[illegible]	[illegible]	[illegible]	4.1	-1.6
136	1.8	2.5	5.8	[illegible]	13.5	12.7	[illegible]	6.1	0.4
137	0.3	1	4.4	[illegible]	[illegible]	[illegible]	[illegible]	4.6	-1.1
138	0	0.7	4	[illegible]	[illegible]	[illegible]	[illegible]	4.3	-1.4
139	-0.7	0.1	3.4	[illegible]	[illegible]	[illegible]	7.7	3.7	-2
140	-1.7	-1	2.3	7.1	[illegible]	[illegible]	6.6	2.6	-3.1
141	-1.7	-1	2.3	7.1	[illegible]	[illegible]	6.6	2.6	-3.1
142	-1.7	-1	2.3	7.1	[illegible]	[illegible]	6.6	2.6	-3.1
143	-1.1	-0.4	3	7.7	[illegible]	[illegible]	7.2	3.2	-2.5
144	-3.4	-2.7	0.6	5.4	[illegible]	7.5	4.9	0.9	-4.8
145	-3.6	-2.9	0.5	5.2	[illegible]	7.3	4.7	0.7	-5
146	0.7	1.4	4.7	[illegible]	12.4	[illegible]	[illegible]	5	-0.7
147	0.9	1.6	4.9	[illegible]	12.6	[illegible]	[illegible]	5.2	-0.5
148	1.1	1.8	5.1	[illegible]	12.8	[illegible]	[illegible]	5.4	-0.3
149	-3.5	-2.7	0.6	5.4	[illegible]	7.5	4.9	0.9	-4.8
27A	7	7.7	[illegible]	15.8	18.7	17.9	15.3	[illegible]	5.6

BN1: Predicted Noise levels above Background Daytime (+6dB penalty for clearly perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	25.3	26.1	27.2	28.5	30	31.8	33.7	35.9	38.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	7.5	7.7	[illegible]	13.7	16	14.9	13	[illegible]	[illegible]
28	3.9	4.1	6.4	[illegible]	12.3	[illegible]	[illegible]	7.1	4.6
29	6.4	6.6	[illegible]	12.6	14.9	13.8	[illegible]	[illegible]	7.2
110	2.8	3	5.3	[illegible]	[illegible]	[illegible]	[illegible]	6	3.5
111	2	2.3	4.6	[illegible]	[illegible]	[illegible]	7.5	5.3	2.8
112	2	2.2	4.6	[illegible]	[illegible]	[illegible]	7.4	5.2	2.7
113	2.1	2.3	4.6	[illegible]	[illegible]	[illegible]	7.5	5.3	2.8
114	2.1	2.3	4.6	[illegible]	[illegible]	[illegible]	7.5	5.3	2.8
127	2.4	2.7	5	[illegible]	[illegible]	[illegible]	7.9	5.7	3.2
128	1.5	1.7	4.1	7.7	[illegible]	[illegible]	6.9	4.7	2.2
129	2.9	3.1	5.4	[illegible]	[illegible]	[illegible]	[illegible]	6.1	3.6
130	0.6	0.8	3.1	6.8	[illegible]	7.9	6	3.8	1.3
131	0.9	1.1	3.4	7.1	[illegible]	[illegible]	6.3	4.1	1.6
132	0.7	0.9	3.2	6.9	[illegible]	[illegible]	6.1	3.9	1.4
133	0.3	0.5	2.8	6.5	[illegible]	7.6	5.7	3.5	1
136	2.3	2.5	4.8	[illegible]	[illegible]	[illegible]	7.7	5.5	3
137	0.8	1	3.4	7	[illegible]	[illegible]	6.2	4	1.5
138	0.5	0.7	3	6.7	[illegible]	7.8	5.9	3.7	1.2
139	-0.2	0.1	2.4	6.1	[illegible]	7.2	5.3	3.1	0.6
140	-1.2	-1	1.3	5	7.2	6.1	4.2	2	-0.5
141	-1.2	-1	1.3	5	7.2	6.1	4.2	2	-0.5
142	-1.2	-1	1.3	5	7.2	6.1	4.2	2	-0.5
143	-0.6	-0.4	2	5.6	7.8	6.7	4.8	2.6	0.1
144	-2.9	-2.7	-0.4	3.3	5.5	4.4	2.5	0.3	-2.2
145	-3.1	-2.9	-0.5	3.1	5.3	4.2	2.3	0.1	-2.4
146	1.2	1.4	3.7	7.4	[illegible]	[illegible]	6.6	4.4	1.9
147	1.4	1.6	3.9	7.6	[illegible]	[illegible]	6.8	4.6	2.1
148	1.6	1.8	4.1	7.8	[illegible]	[illegible]	7	4.8	2.3
149	-3	-2.7	-0.4	3.3	5.5	4.4	2.5	0.3	-2.2
27A	7.5	7.7	[illegible]	13.7	15.9	14.8	12.9	[illegible]	[illegible]

BN1: Predicted Noise levels above Background Nighttime (+6dB penalty for clearly perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	22.8	23.1	23.2	23.4	24.2	25.7	28.3	32.3	38
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	[illegible]	[illegible]	14	18.8	21.8	21	18.4	14.4	[illegible]
28	6.4	7.1	[illegible]	15.2	18.1	17.3	14.7	[illegible]	5
29	[illegible]	[illegible]	13	17.7	20.7	19.9	17.3	13.3	7.6
110	5.3	6	[illegible]	14.1	17	16.2	13.6	[illegible]	3.9
111	4.5	5.3	[illegible]	13.4	16.3	15.5	12.9	[illegible]	3.2
112	4.5	5.2	[illegible]	13.3	16.2	15.4	12.8	[illegible]	3.1
113	4.6	5.3	[illegible]	13.4	16.3	15.5	12.9	[illegible]	3.2
114	4.6	5.3	[illegible]	13.4	16.3	15.5	12.9	[illegible]	3.2
127	4.9	5.7	[illegible]	13.8	16.7	15.9	13.3	[illegible]	3.6
128	4	4.7	[illegible]	12.8	15.7	14.9	12.3	[illegible]	2.6
129	5.4	6.1	[illegible]	14.2	17.1	16.3	13.7	[illegible]	4
130	3.1	3.8	7.1	[illegible]	14.8	14	[illegible]	7.4	1.7
131	3.4	4.1	7.4	12.2	15.1	14.3	[illegible]	7.7	2
132	3.2	3.9	7.2	[illegible]	14.9	14.1	[illegible]	7.5	1.8
133	2.8	3.5	6.8	[illegible]	14.5	13.7	[illegible]	7.1	1.4
136	4.8	5.5	[illegible]	13.6	16.5	15.7	13.1	[illegible]	3.4
137	3.3	4	7.4	12.1	15	14.2	[illegible]	7.6	1.9
138	3	3.7	7	[illegible]	14.7	13.9	[illegible]	7.3	1.6
139	2.3	3.1	6.4	[illegible]	14.1	13.3	[illegible]	6.7	1
140	1.3	2	5.3	[illegible]	13	12.2	[illegible]	5.6	-0.1
141	1.3	2	5.3	[illegible]	13	12.2	[illegible]	5.6	-0.1
142	1.3	2	5.3	[illegible]	13	12.2	[illegible]	5.6	-0.1
143	1.9	2.6	6	[illegible]	13.6	12.8	[illegible]	6.2	0.5
144	-0.4	0.3	3.6	[illegible]	[illegible]	[illegible]	7.9	3.9	-1.8
145	-0.6	0.1	3.5	[illegible]	[illegible]	[illegible]	7.7	3.7	-2
146	3.7	4.4	7.7	12.5	15.4	14.6	[illegible]	[illegible]	2.3
147	3.9	4.6	7.9	12.7	15.6	14.8	12.2	[illegible]	2.5
148	4.1	4.8	[illegible]	12.9	15.8	15	12.4	[illegible]	2.7
149	-0.5	0.3	3.6	[illegible]	[illegible]	[illegible]	7.9	3.9	-1.8
27A	[illegible]	[illegible]	14	18.8	21.7	20.9	18.3	14.3	[illegible]

BN2: Predicted Noise levels above Background Daytime

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	24.2	25.7	27	28.3	29.4	30.4	31.3	32.1	32.8
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
1	0	-0.5	1.6	5.3	7.9	7.6	6.7	5.9	5.2
31	-2.9	-3.4	-1.2	2.4	5.1	4.8	3.9	3.1	2.4
33	-3.7	-4.2	-2.1	1.6	4.2	3.9	3	2.2	1.5
34	-2.8	-3.3	-1.2	2.5	5.1	4.8	3.9	3.1	2.4
35	-0.9	-1.4	0.8	4.4	7.1	6.8	5.9	5.1	4.4
36	-2.9	-3.4	-1.3	2.4	5	4.7	3.8	3	2.3
37	-2.9	-3.4	-1.3	2.4	5	4.7	3.8	3	2.3
38	-2.6	-3.1	-1	2.7	5.3	5	4.1	3.3	2.6
39	-1.8	-2.3	-0.2	3.5	6.1	5.8	4.9	4.1	3.4
40	-1.6	-2.1	0	3.7	6.3	6	5.1	4.3	3.6
41	-1.6	-2.1	0	3.7	6.3	6	5.1	4.3	3.6
42	-1.9	-2.4	-0.3	3.4	6	5.7	4.8	4	3.3
43	-3.5	-4	-1.8	1.8	4.4	4.1	3.2	2.4	1.7
44	-7.2	-7.7	-5.6	-1.9	0.7	0.4	-0.5	-1.3	-2
45	-8	-8.5	-6.4	-2.7	-0.1	-0.4	-1.3	-2.1	-2.8
46	-8.1	-8.6	-6.5	-2.8	-0.2	-0.5	-1.4	-2.2	-2.9
47	-8.5	-8.9	-6.8	-3.1	-0.5	-0.8	-1.7	-2.5	-3.2
150	-4.3	-4.8	-2.7	1	3.6	3.3	2.4	1.6	0.9
151	-9.2	-9.7	-7.6	-3.9	-1.3	-1.6	-2.5	-3.3	-4
152	-7.6	-8.1	-6	-2.3	0.3	0	-0.9	-1.7	-2.4
153	-7.3	-7.8	-5.7	-2	0.6	0.3	-0.6	-1.4	-2.1
154	-7.1	-7.6	-5.4	-1.8	0.8	0.5	-0.4	-1.2	-1.9
155	-5.5	-5.9	-3.8	-0.1	2.5	2.2	1.3	0.5	-0.2
156	-4.9	-5.4	-3.2	0.4	3	2.7	1.8	1	0.3
157	-8.4	-8.9	-6.7	-3.1	-0.5	-0.8	-1.7	-2.5	-3.2
158	-9.5	-9.9	-7.8	-4.2	-1.5	-1.8	-2.7	-3.5	-4.2
159	-3.9	-4.4	-2.3	1.4	4	3.7	2.8	2	1.3
157A	-8.5	-9	-6.9	-3.2	-0.6	-0.9	-1.8	-2.6	-3.3
31A	-3.2	-3.7	-1.6	2.1	4.7	4.4	3.5	2.7	2
37A	-2.7	-3.2	-1	2.6	5.3	5	4.1	3.3	2.6

BN2: Predicted Noise levels above Background NighttimeHighlighted Orange greater than 5dB & less than 8dB above BG

Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	19.4	20	20.9	22	23.4	25.2	27.4	30.1	33.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	4.8	5.2	7.7	[illegible]	13.9	12.8	[illegible]	7.9	4.7
28	1.9	2.3	4.9	[illegible]	[illegible]	[illegible]	7.8	5.1	1.9
29	1.1	1.5	4	7.9	[illegible]	[illegible]	6.9	4.2	1
110	2	2.4	4.9	[illegible]	[illegible]	[illegible]	7.8	5.1	1.9
111	3.9	4.3	6.9	[illegible]	13.1	[illegible]	[illegible]	7.1	3.9
112	1.9	2.3	4.8	[illegible]	[illegible]	[illegible]	7.7	5	1.8
113	1.9	2.3	4.8	[illegible]	[illegible]	[illegible]	7.7	5	1.8
114	2.2	2.6	5.1	[illegible]	[illegible]	[illegible]	[illegible]	5.3	2.1
127	3	3.4	5.9	[illegible]	12.1	[illegible]	[illegible]	6.1	2.9
128	3.2	3.6	6.1	[illegible]	12.3	[illegible]	[illegible]	6.3	3.1
129	3.2	3.6	6.1	[illegible]	12.3	[illegible]	[illegible]	6.3	3.1
130	2.9	3.3	5.8	[illegible]	[illegible]	[illegible]	[illegible]	6	2.8
131	1.3	1.7	4.3	[illegible]	[illegible]	[illegible]	7.1	4.4	1.2
132	-2.4	-2	0.5	4.4	6.7	5.6	3.4	0.7	-2.5
133	-3.2	-2.8	-0.3	3.6	5.9	4.8	2.6	-0.1	-3.3
136	-3.3	-2.9	-0.4	3.5	5.8	4.7	2.5	-0.2	-3.4
137	-3.7	-3.2	-0.7	3.2	5.5	4.4	2.2	-0.5	-3.7
138	0.5	0.9	3.4	7.3	[illegible]	[illegible]	6.3	3.6	0.4
139	-4.4	-4	-1.5	2.4	4.7	3.6	1.4	-1.3	-4.5
140	-2.8	-2.4	0.1	4	6.3	5.2	3	0.3	-2.9
141	-2.5	-2.1	0.4	4.3	6.6	5.5	3.3	0.6	-2.6
142	-2.3	-1.9	0.7	4.5	6.8	5.7	3.5	0.8	-2.4
143	-0.7	-0.2	2.3	6.2	[illegible]	7.4	5.2	2.5	-0.7
144	-0.1	0.3	2.9	6.7	[illegible]	7.9	5.7	3	-0.2
145	-3.6	-3.2	-0.6	3.2	5.5	4.4	2.2	-0.5	-3.7
146	-4.7	-4.2	-1.7	2.1	4.5	3.4	1.2	-1.5	-4.7
147	0.9	1.3	3.8	7.7	[illegible]	[illegible]	6.7	4	0.8
148	-3.7	-3.3	-0.8	3.1	5.4	4.3	2.1	-0.6	-3.8
149	1.6	2	4.5	[illegible]	[illegible]	[illegible]	7.4	4.7	1.5
27A	2.1	2.5	5.1	[illegible]	[illegible]	[illegible]	[illegible]	5.3	2.1

BN2: Predicted Noise levels above Background Daytime (+3dB penalty for just perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	24.2	25.7	27	28.3	29.4	30.4	31.3	32.1	32.8
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	3	2.5	4.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	0.1	-0.4	1.8	5.4	[illegible]	7.8	6.9	6.1	5.4
29	-0.7	-1.2	0.9	4.6	7.2	6.9	6	5.2	4.5
110	0.2	-0.3	1.8	5.5	[illegible]	7.8	6.9	6.1	5.4
111	2.1	1.6	3.8	7.4	[illegible]	[illegible]	[illegible]	[illegible]	7.4
112	0.1	-0.4	1.7	5.4	[illegible]	7.7	6.8	6	5.3
113	0.1	-0.4	1.7	5.4	[illegible]	7.7	6.8	6	5.3
114	0.4	-0.1	2	5.7	[illegible]	[illegible]	7.1	6.3	5.6
127	1.2	0.7	2.8	6.5	[illegible]	[illegible]	7.9	7.1	6.4
128	1.4	0.9	3	6.7	[illegible]	[illegible]	[illegible]	7.3	6.6
129	1.4	0.9	3	6.7	[illegible]	[illegible]	[illegible]	7.3	6.6
130	1.1	0.6	2.7	6.4	[illegible]	[illegible]	7.8	7	6.3
131	-0.5	-1	1.2	4.8	7.4	7.1	6.2	5.4	4.7
132	-4.2	-4.7	-2.6	1.1	3.7	3.4	2.5	1.7	1
133	-5	-5.5	-3.4	0.3	2.9	2.6	1.7	0.9	0.2
136	-5.1	-5.6	-3.5	0.2	2.8	2.5	1.6	0.8	0.1
137	-5.5	-5.9	-3.8	-0.1	2.5	2.2	1.3	0.5	-0.2
138	-1.3	-1.8	0.3	4	6.6	6.3	5.4	4.6	3.9
139	-6.2	-6.7	-4.6	-0.9	1.7	1.4	0.5	-0.3	-1
140	-4.6	-5.1	-3	0.7	3.3	3	2.1	1.3	0.6
141	-4.3	-4.8	-2.7	1	3.6	3.3	2.4	1.6	0.9
142	-4.1	-4.6	-2.4	1.2	3.8	3.5	2.6	1.8	1.1
143	-2.5	-2.9	-0.8	2.9	5.5	5.2	4.3	3.5	2.8
144	-1.9	-2.4	-0.2	3.4	6	5.7	4.8	4	3.3
145	-5.4	-5.9	-3.7	-0.1	2.5	2.2	1.3	0.5	-0.2
146	-6.5	-6.9	-4.8	-1.2	1.5	1.2	0.3	-0.5	-1.2
147	-0.9	-1.4	0.7	4.4	7	6.7	5.8	5	4.3
148	-5.5	-6	-3.9	-0.2	2.4	2.1	1.2	0.4	-0.3
149	-0.2	-0.7	1.4	5.1	7.7	7.4	6.5	5.7	5
27A	0.3	-0.2	2	5.6	[illegible]	[illegible]	7.1	6.3	5.6

BN2: Predicted Noise levels above Background Nighttime (+3dB penalty for just perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	19.4	20	20.9	22	23.4	25.2	27.4	30.1	33.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	7.8	[illegible]	[illegible]	14.6	16.9	15.8	13.6	[illegible]	7.7
28	4.9	5.3	7.9	[illegible]	14.1	13	[illegible]	[illegible]	4.9
29	4.1	4.5	7	[illegible]	13.2	12.1	[illegible]	7.2	4
110	5	5.4	7.9	[illegible]	14.1	13	[illegible]	[illegible]	4.9
111	6.9	7.3	[illegible]	13.7	16.1	15	12.8	[illegible]	6.9
112	4.9	5.3	7.8	[illegible]	14	12.9	[illegible]	[illegible]	4.8
113	4.9	5.3	7.8	[illegible]	14	12.9	[illegible]	[illegible]	4.8
114	5.2	5.6	[illegible]	[illegible]	14.3	13.2	[illegible]	[illegible]	5.1
127	6	6.4	[illegible]	12.8	15.1	14	[illegible]	[illegible]	5.9
128	6.2	6.6	[illegible]	13	15.3	14.2	[illegible]	[illegible]	6.1
129	6.2	6.6	[illegible]	13	15.3	14.2	[illegible]	[illegible]	6.1
130	5.9	6.3	[illegible]	12.7	15	13.9	[illegible]	[illegible]	5.8
131	4.3	4.7	7.3	[illegible]	13.4	12.3	[illegible]	7.4	4.2
132	0.6	1	3.5	7.4	[illegible]	[illegible]	6.4	3.7	0.5
133	-0.2	0.2	2.7	6.6	[illegible]	7.8	5.6	2.9	-0.3
136	-0.3	0.1	2.6	6.5	[illegible]	7.7	5.5	2.8	-0.4
137	-0.7	-0.2	2.3	6.2	[illegible]	7.4	5.2	2.5	-0.7
138	3.5	3.9	6.4	[illegible]	12.6	[illegible]	[illegible]	6.6	3.4
139	-1.4	-1	1.5	5.4	7.7	6.6	4.4	1.7	-1.5
140	0.2	0.6	3.1	7	[illegible]	[illegible]	6	3.3	0.1
141	0.5	0.9	3.4	7.3	[illegible]	[illegible]	6.3	3.6	0.4
142	0.7	1.1	3.7	7.5	[illegible]	[illegible]	6.5	3.8	0.6
143	2.3	2.8	5.3	[illegible]	[illegible]	[illegible]	[illegible]	5.5	2.3
144	2.9	3.3	5.9	[illegible]	[illegible]	[illegible]	[illegible]	6	2.8
145	-0.6	-0.2	2.4	6.2	[illegible]	7.4	5.2	2.5	-0.7
146	-1.7	-1.2	1.3	5.1	7.5	6.4	4.2	1.5	-1.7
147	3.9	4.3	6.8	[illegible]	13	[illegible]	[illegible]	7	3.8
148	-0.7	-0.3	2.2	6.1	[illegible]	7.3	5.1	2.4	-0.8
149	4.6	5	7.5	[illegible]	13.7	12.6	[illegible]	7.7	4.5
27A	5.1	5.5	[illegible]	[illegible]	14.3	13.2	[illegible]	[illegible]	5.1

BN2: Predicted Noise levels above Background Daytime (+6dB penalty for clearly perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	24.2	25.7	27	28.3	29.4	30.4	31.3	32.1	32.8
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	6	5.5	7.6	[illegible]	13.9	13.6	12.7	[illegible]	[illegible]
28	3.1	2.6	4.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	2.3	1.8	3.9	7.6	[illegible]	[illegible]	[illegible]	[illegible]	7.5
110	3.2	2.7	4.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
111	5.1	4.6	6.8	[illegible]	13.1	12.8	[illegible]	[illegible]	[illegible]
112	3.1	2.6	4.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
113	3.1	2.6	4.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
114	3.4	2.9	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
127	4.2	3.7	5.8	[illegible]	12.1	[illegible]	[illegible]	[illegible]	[illegible]
128	4.4	3.9	6	[illegible]	12.3	[illegible]	[illegible]	[illegible]	[illegible]
129	4.4	3.9	6	[illegible]	12.3	[illegible]	[illegible]	[illegible]	[illegible]
130	4.1	3.6	5.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
131	2.5	2	4.2	7.8	[illegible]	[illegible]	[illegible]	[illegible]	7.7
132	-1.2	-1.7	0.4	4.1	6.7	6.4	5.5	4.7	4
133	-2	-2.5	-0.4	3.3	5.9	5.6	4.7	3.9	3.2
136	-2.1	-2.6	-0.5	3.2	5.8	5.5	4.6	3.8	3.1
137	-2.5	-2.9	-0.8	2.9	5.5	5.2	4.3	3.5	2.8
138	1.7	1.2	3.3	7	[illegible]	[illegible]	[illegible]	7.6	6.9
139	-3.2	-3.7	-1.6	2.1	4.7	4.4	3.5	2.7	2
140	-1.6	-2.1	0	3.7	6.3	6	5.1	4.3	3.6
141	-1.3	-1.8	0.3	4	6.6	6.3	5.4	4.6	3.9
142	-1.1	-1.6	0.6	4.2	6.8	6.5	5.6	4.8	4.1
143	0.5	0.1	2.2	5.9	[illegible]	[illegible]	7.3	6.5	5.8
144	1.1	0.6	2.8	6.4	[illegible]	[illegible]	7.8	7	6.3
145	-2.4	-2.9	-0.7	2.9	5.5	5.2	4.3	3.5	2.8
146	-3.5	-3.9	-1.8	1.8	4.5	4.2	3.3	2.5	1.8
147	2.1	1.6	3.7	7.4	[illegible]	[illegible]	[illegible]	[illegible]	7.3
148	-2.5	-3	-0.9	2.8	5.4	5.1	4.2	3.4	2.7
149	2.8	2.3	4.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27A	3.3	2.8	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BN2: Predicted Noise levels above Background Nighttime (+6dB penalty for clearly perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	19.4	20	20.9	22	23.4	25.2	27.4	30.1	33.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
27	[illegible]	[illegible]	13.7	17.6	19.9	18.8	16.6	13.9	[illegible]
28	7.9	[illegible]	[illegible]	14.7	17.1	16	13.8	[illegible]	7.9
29	7.1	7.5	[illegible]	13.9	16.2	15.1	12.9	[illegible]	7
110	[illegible]	[illegible]	[illegible]	14.8	17.1	16	13.8	[illegible]	7.9
111	[illegible]	[illegible]	12.9	16.7	19.1	18	15.8	13.1	[illegible]
112	7.9	[illegible]	[illegible]	14.7	17	15.9	13.7	[illegible]	7.8
113	7.9	[illegible]	[illegible]	14.7	17	15.9	13.7	[illegible]	7.8
114	[illegible]	[illegible]	[illegible]	15	17.3	16.2	14	[illegible]	[illegible]
127	[illegible]	[illegible]	[illegible]	15.8	18.1	17	14.8	12.1	[illegible]
128	[illegible]	[illegible]	12.1	16	18.3	17.2	15	12.3	[illegible]
129	[illegible]	[illegible]	12.1	16	18.3	17.2	15	12.3	[illegible]
130	[illegible]	[illegible]	[illegible]	15.7	18	16.9	14.7	[illegible]	[illegible]
131	7.3	7.7	[illegible]	14.1	16.4	15.3	13.1	[illegible]	7.2
132	3.6	4	6.5	[illegible]	12.7	[illegible]	[illegible]	6.7	3.5
133	2.8	3.2	5.7	[illegible]	[illegible]	[illegible]	[illegible]	5.9	2.7
136	2.7	3.1	5.6	[illegible]	[illegible]	[illegible]	[illegible]	5.8	2.6
137	2.3	2.8	5.3	[illegible]	[illegible]	[illegible]	[illegible]	5.5	2.3
138	6.5	6.9	[illegible]	13.3	15.6	14.5	12.3	[illegible]	6.4
139	1.6	2	4.5	[illegible]	[illegible]	[illegible]	7.4	4.7	1.5
140	3.2	3.6	6.1	[illegible]	12.3	[illegible]	[illegible]	6.3	3.1
141	3.5	3.9	6.4	[illegible]	12.6	[illegible]	[illegible]	6.6	3.4
142	3.7	4.1	6.7	[illegible]	12.8	[illegible]	[illegible]	6.8	3.6
143	5.3	5.8	[illegible]	12.2	14.5	13.4	[illegible]	[illegible]	5.3
144	5.9	6.3	[illegible]	12.7	15	13.9	[illegible]	[illegible]	5.8
145	2.4	2.8	5.4	[illegible]	[illegible]	[illegible]	[illegible]	5.5	2.3
146	1.3	1.8	4.3	[illegible]	[illegible]	[illegible]	7.2	4.5	1.3
147	6.9	7.3	[illegible]	13.7	16	14.9	12.7	[illegible]	6.8
148	2.3	2.7	5.2	[illegible]	[illegible]	[illegible]	[illegible]	5.4	2.2
149	7.6	[illegible]	[illegible]	14.4	16.7	15.6	13.4	[illegible]	7.5
27A	[illegible]	[illegible]	[illegible]	14.9	17.3	16.2	14	[illegible]	[illegible]

BN3: Predicted Noise levels above Daytime Background(BG)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	23.5	24.7	26.3	28.1	29.9	31.7	33.3	34.5	35.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	3.8	3.6	5.5	[illegible]	[illegible]	[illegible]	7.9	6.7	5.8
3	3.9	3.7	5.5	[illegible]	[illegible]	[illegible]	7.9	6.7	5.8
4	0.7	0.5	2.4	5.5	7.5	6.4	4.8	3.6	2.7
5	0.5	0.3	2.1	5.3	7.2	6.1	4.5	3.3	2.4
6	0.2	0	1.8	5	6.9	5.8	4.2	3	2.1
7	-0.5	-0.7	1.1	4.3	6.2	5.1	3.5	2.3	1.4
8	-0.9	-1.1	0.7	3.9	5.8	4.7	3.1	1.9	1
9	-0.4	-0.6	1.3	4.5	6.4	5.3	3.7	2.5	1.6
10	-0.3	-0.5	1.3	4.5	6.4	5.3	3.7	2.5	1.6
11	-0.2	-0.4	1.4	4.6	6.5	5.4	3.8	2.6	1.7
12	0.1	-0.1	1.7	4.9	6.8	5.7	4.1	2.9	2
13	0.5	0.3	2.1	5.3	7.2	6.1	4.5	3.3	2.4
14	0	-0.2	1.6	4.8	6.7	5.6	4	2.8	1.9
15	0.4	0.2	2.1	5.2	7.2	6.1	4.5	3.3	2.4
16	-0.2	-0.4	1.4	4.6	6.5	5.4	3.8	2.6	1.7
17	1.4	1.2	3	6.2	[illegible]	7	5.4	4.2	3.3
54	-7.6	-7.8	-6	-2.8	-0.9	-2	-3.6	-4.8	-5.7
55	-7.3	-7.5	-5.7	-2.5	-0.6	-1.7	-3.3	-4.5	-5.4
56	-7.5	-7.6	-5.8	-2.6	-0.7	-1.8	-3.4	-4.6	-5.5
57	-7.4	-7.6	-5.7	-2.6	-0.7	-1.8	-3.4	-4.6	-5.5
58	-7.1	-7.3	-5.5	-2.3	-0.4	-1.5	-3.1	-4.3	-5.2
59	-7	-7.1	-5.3	-2.1	-0.2	-1.3	-2.9	-4.1	-5
60	-6.8	-7	-5.2	-2	-0.1	-1.2	-2.8	-4	-4.9
61	-6.7	-6.9	-5.1	-1.9	0	-1.1	-2.7	-3.9	-4.8
62	-6.6	-6.8	-5	-1.8	0.1	-1	-2.6	-3.8	-4.7
63	-6.6	-6.7	-4.9	-1.8	0.2	-0.9	-2.5	-3.7	-4.6
64	-6.5	-6.7	-4.9	-1.7	0.2	-0.9	-2.5	-3.7	-4.6
65	-4.8	-5	-3.1	0	1.9	0.8	-0.8	-2	-2.9
66	-4.3	-4.5	-2.7	0.5	2.4	1.3	-0.3	-1.5	-2.4
67	-3.9	-4.1	-2.3	0.9	2.8	1.7	0.1	-1.1	-2
68	-3.7	-3.9	-2	1.1	3	1.9	0.3	-0.9	-1.8
69	-3.6	-3.8	-2	1.2	3.1	2	0.4	-0.8	-1.7
70	-3	-3.2	-1.4	1.8	3.7	2.6	1	-0.2	-1.1
71	-2.5	-2.7	-0.9	2.3	4.2	3.1	1.5	0.3	-0.6
72	-0.1	-0.3	1.5	4.7	6.6	5.5	3.9	2.7	1.8
73	-1.5	-1.7	0.1	3.3	5.2	4.1	2.5	1.3	0.4
74	-3.2	-3.4	-1.6	1.6	3.5	2.4	0.8	-0.4	-1.3
75	-3.7	-3.8	-2	1.2	3.1	2	0.4	-0.8	-1.7
77	-6.1	-6.2	-4.4	-1.3	0.6	-0.5	-2.1	-3.3	-4.2
78	-6.8	-6.9	-5.1	-2	0	-1.1	-2.7	-3.9	-4.8
79	-7	-7.1	-5.3	-2.2	-0.2	-1.3	-2.9	-4.1	-5
80	-7.1	-7.2	-5.4	-2.3	-0.3	-1.4	-3	-4.2	-5.1
81	-7.6	-7.8	-6	-2.8	-0.9	-2	-3.6	-4.8	-5.7
82	-7.5	-7.7	-5.9	-2.7	-0.8	-1.9	-3.5	-4.7	-5.6
83	-7.7	-7.9	-6.1	-2.9	-1	-2.1	-3.7	-4.9	-5.8
84	-7.3	-7.5	-5.7	-2.5	-0.6	-1.7	-3.3	-4.5	-5.4
85	-8.5	-8.6	-6.8	-3.6	-1.7	-2.8	-4.4	-5.6	-6.5
55A	-7.2	-7.4	-5.6	-2.4	-0.5	-1.6	-3.2	-4.4	-5.3
7A	-0.4	-0.6	1.2	4.4	6.3	5.2	3.6	2.4	1.5

BN3: Predicted Noise levels above Nighttime Background(BG)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	19	19.4	19.9	20.7	22	23.9	26.5	29.9	34.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	[illegible]	[illegible]	[illegible]	16	18.5	17.3	14.7	[illegible]	6.9
3	[illegible]	[illegible]	[illegible]	16.1	18.5	17.3	14.7	[illegible]	6.9
4	5.2	5.8	[illegible]	12.9	15.4	14.2	[illegible]	[illegible]	3.8
5	5	5.6	[illegible]	12.7	15.1	13.9	[illegible]	7.9	3.5
6	4.7	5.3	[illegible]	12.4	14.8	13.6	[illegible]	7.6	3.2
7	4	4.6	7.5	[illegible]	14.1	12.9	[illegible]	6.9	2.5
8	3.6	4.2	7.1	[illegible]	13.7	12.5	[illegible]	6.5	2.1
9	4.1	4.7	7.7	[illegible]	14.3	13.1	[illegible]	7.1	2.7
10	4.2	4.8	7.7	[illegible]	14.3	13.1	[illegible]	7.1	2.7
11	4.3	4.9	7.8	[illegible]	14.4	13.2	[illegible]	7.2	2.8
12	4.6	5.2	[illegible]	12.3	14.7	13.5	[illegible]	7.5	3.1
13	5	5.6	[illegible]	12.7	15.1	13.9	[illegible]	7.9	3.5
14	4.5	5.1	[illegible]	12.2	14.6	13.4	[illegible]	7.4	3
15	4.9	5.5	[illegible]	12.6	15.1	13.9	[illegible]	7.9	3.5
16	4.3	4.9	7.8	[illegible]	14.4	13.2	[illegible]	7.2	2.8
17	5.9	6.5	[illegible]	13.6	16	14.8	12.2	[illegible]	4.4
54	-3.1	-2.5	0.4	4.6	7	5.8	3.2	-0.2	-4.6
55	-2.8	-2.2	0.7	4.9	7.3	6.1	3.5	0.1	-4.3
56	-3	-2.3	0.6	4.8	7.2	6	3.4	0	-4.4
57	-2.9	-2.3	0.7	4.8	7.2	6	3.4	0	-4.4
58	-2.6	-2	0.9	5.1	7.5	6.3	3.7	0.3	-4.1
59	-2.5	-1.8	1.1	5.3	7.7	6.5	3.9	0.5	-3.9
60	-2.3	-1.7	1.2	5.4	7.8	6.6	4	0.6	-3.8
61	-2.2	-1.6	1.3	5.5	7.9	6.7	4.1	0.7	-3.7
62	-2.1	-1.5	1.4	5.6	[illegible]	6.8	4.2	0.8	-3.6
63	-2.1	-1.4	1.5	5.6	[illegible]	6.9	4.3	0.9	-3.5
64	-2	-1.4	1.5	5.7	[illegible]	6.9	4.3	0.9	-3.5
65	-0.3	0.3	3.3	7.4	[illegible]	[illegible]	6	2.6	-1.8
66	0.2	0.8	3.7	7.9	[illegible]	[illegible]	6.5	3.1	-1.3
67	0.6	1.2	4.1	[illegible]	[illegible]	[illegible]	6.9	3.5	-0.9
68	0.8	1.4	4.4	[illegible]	[illegible]	[illegible]	7.1	3.7	-0.7
69	0.9	1.5	4.4	[illegible]	[illegible]	[illegible]	7.2	3.8	-0.6
70	1.5	2.1	5	[illegible]	[illegible]	[illegible]	7.8	4.4	0
71	2	2.6	5.5	[illegible]	12.1	[illegible]	[illegible]	4.9	0.5
72	4.4	5	7.9	12.1	14.5	13.3	[illegible]	7.3	2.9
73	3	3.6	6.5	[illegible]	13.1	[illegible]	[illegible]	5.9	1.5
74	1.3	1.9	4.8	[illegible]	[illegible]	[illegible]	7.6	4.2	-0.2
75	0.8	1.5	4.4	[illegible]	[illegible]	[illegible]	7.2	3.8	-0.6
77	-1.6	-0.9	2	6.1	[illegible]	7.3	4.7	1.3	-3.1
78	-2.3	-1.6	1.3	5.4	7.9	6.7	4.1	0.7	-3.7
79	-2.5	-1.8	1.1	5.2	7.7	6.5	3.9	0.5	-3.9
80	-2.6	-1.9	1	5.1	7.6	6.4	3.8	0.4	-4
81	-3.1	-2.5	0.4	4.6	7	5.8	3.2	-0.2	-4.6
82	-3	-2.4	0.5	4.7	7.1	5.9	3.3	-0.1	-4.5
83	-3.2	-2.6	0.3	4.5	6.9	5.7	3.1	-0.3	-4.7
84	-2.8	-2.2	0.7	4.9	7.3	6.1	3.5	0.1	-4.3
85	-4	-3.3	-0.4	3.8	6.2	5	2.4	-1	-5.4
55A	-2.7	-2.1	0.8	5	7.4	6.2	3.6	0.2	-4.2
7A	4.1	4.7	7.6	[illegible]	14.2	13	[illegible]	7	2.6

BN3: Predicted Noise levels above Background Daytime (BS4142 secton 9.2: +3dB penalty for just perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	23.5	24.7	26.3	28.1	29.9	31.7	33.3	34.5	35.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	6.8	6.6	[illegible]	[illegible]	13.6	12.5	[illegible]	[illegible]	[illegible]
3	6.9	6.7	[illegible]	[illegible]	13.6	12.5	[illegible]	[illegible]	[illegible]
4	3.7	3.5	5.4	[illegible]	[illegible]	[illegible]	7.8	6.6	5.7
5	3.5	3.3	5.1	[illegible]	[illegible]	[illegible]	7.5	6.3	5.4
6	3.2	3	4.8	[illegible]	[illegible]	[illegible]	7.2	6	5.1
7	2.5	2.3	4.1	7.3	[illegible]	[illegible]	6.5	5.3	4.4
8	2.1	1.9	3.7	6.9	[illegible]	7.7	6.1	4.9	4
9	2.6	2.4	4.3	7.5	[illegible]	[illegible]	6.7	5.5	4.6
10	2.7	2.5	4.3	7.5	[illegible]	[illegible]	6.7	5.5	4.6
11	2.8	2.6	4.4	7.6	[illegible]	[illegible]	6.8	5.6	4.7
12	3.1	2.9	4.7	7.9	[illegible]	[illegible]	7.1	5.9	5
13	3.5	3.3	5.1	[illegible]	[illegible]	[illegible]	7.5	6.3	5.4
14	3	2.8	4.6	7.8	[illegible]	[illegible]	7	5.8	4.9
15	3.4	3.2	5.1	[illegible]	[illegible]	[illegible]	7.5	6.3	5.4
16	2.8	2.6	4.4	7.6	[illegible]	[illegible]	6.8	5.6	4.7
17	4.4	4.2	6	[illegible]	[illegible]	[illegible]	[illegible]	7.2	6.3
54	-4.6	-4.8	-3	0.2	2.1	1	-0.6	-1.8	-2.7
55	-4.3	-4.5	-2.7	0.5	2.4	1.3	-0.3	-1.5	-2.4
56	-4.5	-4.6	-2.8	0.4	2.3	1.2	-0.4	-1.6	-2.5
57	-4.4	-4.6	-2.7	0.4	2.3	1.2	-0.4	-1.6	-2.5
58	-4.1	-4.3	-2.5	0.7	2.6	1.5	-0.1	-1.3	-2.2
59	-4	-4.1	-2.3	0.9	2.8	1.7	0.1	-1.1	-2
60	-3.8	-4	-2.2	1	2.9	1.8	0.2	-1	-1.9
61	-3.7	-3.9	-2.1	1.1	3	1.9	0.3	-0.9	-1.8
62	-3.6	-3.8	-2	1.2	3.1	2	0.4	-0.8	-1.7
63	-3.6	-3.7	-1.9	1.2	3.2	2.1	0.5	-0.7	-1.6
64	-3.5	-3.7	-1.9	1.3	3.2	2.1	0.5	-0.7	-1.6
65	-1.8	-2	-0.1	3	4.9	3.8	2.2	1	0.1
66	-1.3	-1.5	0.3	3.5	5.4	4.3	2.7	1.5	0.6
67	-0.9	-1.1	0.7	3.9	5.8	4.7	3.1	1.9	1
68	-0.7	-0.9	1	4.1	6	4.9	3.3	2.1	1.2
69	-0.6	-0.8	1	4.2	6.1	5	3.4	2.2	1.3
70	0	-0.2	1.6	4.8	6.7	5.6	4	2.8	1.9
71	0.5	0.3	2.1	5.3	7.2	6.1	4.5	3.3	2.4
72	2.9	2.7	4.5	7.7	[illegible]	[illegible]	6.9	5.7	4.8
73	1.5	1.3	3.1	6.3	[illegible]	7.1	5.5	4.3	3.4
74	-0.2	-0.4	1.4	4.6	6.5	5.4	3.8	2.6	1.7
75	-0.7	-0.8	1	4.2	6.1	5	3.4	2.2	1.3
77	-3.1	-3.2	-1.4	1.7	3.6	2.5	0.9	-0.3	-1.2
78	-3.8	-3.9	-2.1	1	3	1.9	0.3	-0.9	-1.8
79	-4	-4.1	-2.3	0.8	2.8	1.7	0.1	-1.1	-2
80	-4.1	-4.2	-2.4	0.7	2.7	1.6	4E-15	-1.2	-2.1
81	-4.6	-4.8	-3	0.2	2.1	1	-0.6	-1.8	-2.7
82	-4.5	-4.7	-2.9	0.3	2.2	1.1	-0.5	-1.7	-2.6
83	-4.7	-4.9	-3.1	0.1	2	0.9	-0.7	-1.9	-2.8
84	-4.3	-4.5	-2.7	0.5	2.4	1.3	-0.3	-1.5	-2.4
85	-5.5	-5.6	-3.8	-0.6	1.3	0.2	-1.4	-2.6	-3.5
55A	-4.2	-4.4	-2.6	0.6	2.5	1.4	-0.2	-1.4	-2.3
7A	2.6	2.4	4.2	7.4	[illegible]	[illegible]	6.6	5.4	4.5

BN3: Predicted Noise levels above Background Nighttime (+3dB penalty for just perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	19	19.4	19.9	20.7	22	23.9	26.5	29.9	34.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	[illegible]	[illegible]	14.9	19	21.5	20.3	17.7	14.3	[illegible]
3	[illegible]	[illegible]	14.9	19.1	21.5	20.3	17.7	14.3	[illegible]
4	[illegible]	[illegible]	[illegible]	15.9	18.4	17.2	14.6	[illegible]	6.8
5	[illegible]	[illegible]	[illegible]	15.7	18.1	16.9	14.3	[illegible]	6.5
6	7.7	[illegible]	[illegible]	15.4	17.8	16.6	14	[illegible]	6.2
7	7	7.6	[illegible]	14.7	17.1	15.9	13.3	[illegible]	5.5
8	6.6	7.2	[illegible]	14.3	16.7	15.5	12.9	[illegible]	5.1
9	7.1	7.7	[illegible]	14.9	17.3	16.1	13.5	[illegible]	5.7
10	7.2	7.8	[illegible]	14.9	17.3	16.1	13.5	[illegible]	5.7
11	7.3	7.9	[illegible]	15	17.4	16.2	13.6	[illegible]	5.8
12	7.6	[illegible]	[illegible]	15.3	17.7	16.5	13.9	[illegible]	6.1
13	[illegible]	[illegible]	[illegible]	15.7	18.1	16.9	14.3	[illegible]	6.5
14	7.5	[illegible]	[illegible]	15.2	17.6	16.4	13.8	[illegible]	6
15	7.9	[illegible]	[illegible]	15.6	18.1	16.9	14.3	[illegible]	6.5
16	7.3	7.9	[illegible]	15	17.4	16.2	13.6	[illegible]	5.8
17	[illegible]	[illegible]	12.4	16.6	19	17.8	15.2	[illegible]	7.4
54	-0.1	0.5	3.4	7.6	[illegible]	[illegible]	6.2	2.8	-1.6
55	0.2	0.8	3.7	7.9	[illegible]	[illegible]	6.5	3.1	-1.3
56	0	0.7	3.6	7.8	[illegible]	[illegible]	6.4	3	-1.4
57	0.1	0.7	3.7	7.8	[illegible]	[illegible]	6.4	3	-1.4
58	0.4	1	3.9	[illegible]	[illegible]	[illegible]	6.7	3.3	-1.1
59	0.5	1.2	4.1	[illegible]	[illegible]	[illegible]	6.9	3.5	-0.9
60	0.7	1.3	4.2	[illegible]	[illegible]	[illegible]	7	3.6	-0.8
61	0.8	1.4	4.3	[illegible]	[illegible]	[illegible]	7.1	3.7	-0.7
62	0.9	1.5	4.4	[illegible]	[illegible]	[illegible]	7.2	3.8	-0.6
63	0.9	1.6	4.5	[illegible]	[illegible]	[illegible]	7.3	3.9	-0.5
64	1	1.6	4.5	[illegible]	[illegible]	[illegible]	7.3	3.9	-0.5
65	2.7	3.3	6.3	[illegible]	12.8	[illegible]	[illegible]	5.6	1.2
66	3.2	3.8	6.7	[illegible]	13.3	12.1	[illegible]	6.1	1.7
67	3.6	4.2	7.1	[illegible]	13.7	12.5	[illegible]	6.5	2.1
68	3.8	4.4	7.4	[illegible]	13.9	12.7	[illegible]	6.7	2.3
69	3.9	4.5	7.4	[illegible]	14	12.8	[illegible]	6.8	2.4
70	4.5	5.1	[illegible]	12.2	14.6	13.4	[illegible]	7.4	3
71	5	5.6	[illegible]	12.7	15.1	13.9	[illegible]	7.9	3.5
72	7.4	[illegible]	[illegible]	15.1	17.5	16.3	13.7	[illegible]	5.9
73	6	6.6	[illegible]	13.7	16.1	14.9	12.3	[illegible]	4.5
74	4.3	4.9	7.8	[illegible]	14.4	13.2	[illegible]	7.2	2.8
75	3.8	4.5	7.4	[illegible]	14	12.8	[illegible]	6.8	2.4
77	1.4	2.1	5	[illegible]	[illegible]	[illegible]	7.7	4.3	-0.1
78	0.7	1.4	4.3	[illegible]	[illegible]	[illegible]	7.1	3.7	-0.7
79	0.5	1.2	4.1	[illegible]	[illegible]	[illegible]	6.9	3.5	-0.9
80	0.4	1.1	4	[illegible]	[illegible]	[illegible]	6.8	3.4	-1
81	-0.1	0.5	3.4	7.6	[illegible]	[illegible]	6.2	2.8	-1.6
82	0	0.6	3.5	7.7	[illegible]	[illegible]	6.3	2.9	-1.5
83	-0.2	0.4	3.3	7.5	[illegible]	[illegible]	6.1	2.7	-1.7
84	0.2	0.8	3.7	7.9	[illegible]	[illegible]	6.5	3.1	-1.3
85	-1	-0.3	2.6	6.8	[illegible]	[illegible]	5.4	2	-2.4
55A	0.3	0.9	3.8	[illegible]	[illegible]	[illegible]	6.6	3.2	-1.2
7A	7.1	7.7	[illegible]	14.8	17.2	16	13.4	[illegible]	5.6

BN3: Predicted Noise levels above Background Daytime (+6dB penalty for clearly perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	23.5	24.7	26.3	28.1	29.9	31.7	33.3	34.5	35.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2				14.6	16.6	15.5	13.9	12.7	
3				14.7	16.6	15.5	13.9	12.7	
4	6.7	6.5			13.5	12.4			
5	6.5	6.3			13.2	12.1			
6	6.2	6	7.8		12.9				
7	5.5	5.3	7.1		12.2				7.4
8	5.1	4.9	6.7					7.9	7
9	5.6	5.4	7.3		12.4				7.6
10	5.7	5.5	7.3		12.4				7.6
11	5.8	5.6	7.4		12.5				7.7
12	6.1	5.9	7.7		12.8				
13	6.5	6.3			13.2	12.1			
14	6	5.8	7.6		12.7				7.9
15	6.4	6.2			13.2	12.1			
16	5.8	5.6	7.4		12.5				7.7
17	7.4	7.2		12.2	14.1	13			
54	-1.6	-1.8	0	3.2	5.1	4	2.4	1.2	0.3
55	-1.3	-1.5	0.3	3.5	5.4	4.3	2.7	1.5	0.6
56	-1.5	-1.6	0.2	3.4	5.3	4.2	2.6	1.4	0.5
57	-1.4	-1.6	0.3	3.4	5.3	4.2	2.6	1.4	0.5
58	-1.1	-1.3	0.5	3.7	5.6	4.5	2.9	1.7	0.8
59	-1	-1.1	0.7	3.9	5.8	4.7	3.1	1.9	1
60	-0.8	-1	0.8	4	5.9	4.8	3.2	2	1.1
61	-0.7	-0.9	0.9	4.1	6	4.9	3.3	2.1	1.2
62	-0.6	-0.8	1	4.2	6.1	5	3.4	2.2	1.3
63	-0.6	-0.7	1.1	4.2	6.2	5.1	3.5	2.3	1.4
64	-0.5	-0.7	1.1	4.3	6.2	5.1	3.5	2.3	1.4
65	1.2	1	2.9	6	7.9	6.8	5.2	4	3.1
66	1.7	1.5	3.3	6.5		7.3	5.7	4.5	3.6
67	2.1	1.9	3.7	6.9		7.7	6.1	4.9	4
68	2.3	2.1	4	7.1		7.9	6.3	5.1	4.2
69	2.4	2.2	4	7.2			6.4	5.2	4.3
70	3	2.8	4.6	7.8			7	5.8	4.9
71	3.5	3.3	5.1				7.5	6.3	5.4
72	5.9	5.7	7.5		12.6				7.8
73	4.5	4.3	6.1					7.3	6.4
74	2.8	2.6	4.4	7.6			6.8	5.6	4.7
75	2.3	2.2	4	7.2			6.4	5.2	4.3
77	-0.1	-0.2	1.6	4.7	6.6	5.5	3.9	2.7	1.8
78	-0.8	-0.9	0.9	4	6	4.9	3.3	2.1	1.2
79	-1	-1.1	0.7	3.8	5.8	4.7	3.1	1.9	1
80	-1.1	-1.2	0.6	3.7	5.7	4.6	3	1.8	0.9
81	-1.6	-1.8	0	3.2	5.1	4	2.4	1.2	0.3
82	-1.5	-1.7	0.1	3.3	5.2	4.1	2.5	1.3	0.4
83	-1.7	-1.9	-0.1	3.1	5	3.9	2.3	1.1	0.2
84	-1.3	-1.5	0.3	3.5	5.4	4.3	2.7	1.5	0.6
85	-2.5	-2.6	-0.8	2.4	4.3	3.2	1.6	0.4	-0.5
55A	-1.2	-1.4	0.4	3.6	5.5	4.4	2.8	1.6	0.7
7A	5.6	5.4	7.2		12.3				7.5

BN3: Predicted Noise levels above Background Nighttime (+6dB penalty for clearly perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	19	19.4	19.9	20.7	22	23.9	26.5	29.9	34.3
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
2	14.3	14.9	17.9	22	24.5	23.3	20.7	17.3	12.9
3	14.4	15	17.9	22.1	24.5	23.3	20.7	17.3	12.9
4			14.8	18.9	21.4	20.2	17.6	14.2	
5			14.5	18.7	21.1	19.9	17.3	13.9	
6			14.2	18.4	20.8	19.6	17	13.6	
7			13.5	17.7	20.1	18.9	16.3	12.9	
8			13.1	17.3	19.7	18.5	15.9	12.5	
9			13.7	17.9	20.3	19.1	16.5	13.1	
10			13.7	17.9	20.3	19.1	16.5	13.1	
11			13.8	18	20.4	19.2	16.6	13.2	
12			14.1	18.3	20.7	19.5	16.9	13.5	
13			14.5	18.7	21.1	19.9	17.3	13.9	
14			14	18.2	20.6	19.4	16.8	13.4	
15			14.5	18.6	21.1	19.9	17.3	13.9	
16			13.8	18	20.4	19.2	16.6	13.2	
17		12.5	15.4	19.6	22	20.8	18.2	14.8	
54	2.9	3.5	6.4		13			5.8	1.4
55	3.2	3.8	6.7		13.3	12.1		6.1	1.7
56	3	3.7	6.6		13.2			6	1.6
57	3.1	3.7	6.7		13.2			6	1.6
58	3.4	4	6.9		13.5	12.3		6.3	1.9
59	3.5	4.2	7.1		13.7	12.5		6.5	2.1
60	3.7	4.3	7.2		13.8	12.6		6.6	2.2
61	3.8	4.4	7.3		13.9	12.7		6.7	2.3
62	3.9	4.5	7.4		14	12.8		6.8	2.4
63	3.9	4.6	7.5		14.1	12.9		6.9	2.5
64	4	4.6	7.5		14.1	12.9		6.9	2.5
65	5.7	6.3		13.4	15.8	14.6			4.2
66	6.2	6.8		13.9	16.3	15.1	12.5		4.7
67	6.6	7.2		14.3	16.7	15.5	12.9		5.1
68	6.8	7.4		14.5	16.9	15.7	13.1		5.3
69	6.9	7.5		14.6	17	15.8	13.2		5.4
70	7.5			15.2	17.6	16.4	13.8		6
71				15.7	18.1	16.9	14.3		6.5
72			13.9	18.1	20.5	19.3	16.7	13.3	
73			12.5	16.7	19.1	17.9	15.3		7.5
74	7.3	7.9		15	17.4	16.2	13.6		5.8
75	6.8	7.5		14.6	17	15.8	13.2		5.4
77	4.4	5.1		12.1	14.5	13.3		7.3	2.9
78	3.7	4.4	7.3		13.9	12.7		6.7	2.3
79	3.5	4.2	7.1		13.7	12.5		6.5	2.1
80	3.4	4.1	7		13.6	12.4		6.4	2
81	2.9	3.5	6.4		13			5.8	1.4
82	3	3.6	6.5		13.1			5.9	1.5
83	2.8	3.4	6.3		12.9			5.7	1.3
84	3.2	3.8	6.7		13.3	12.1		6.1	1.7
85	2	2.7	5.6		12.2			5	0.6
55A	3.3	3.9	6.8		13.4	12.2		6.2	1.8
7A			13.6	17.8	20.2	19	16.4	13	

BN4: Predicted Noise levels above Background Daytime

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	26.8	28.5	30.3	32.2	34.3	36.4	38.6	41	43.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
18	-4	-4.7	-3.1	0	1.6	0.2	-2	-4.4	-6.8
19	-3.5	-4.2	-2.6	0.5	2.1	0.7	-1.5	-3.9	-6.3
20	-3.8	-4.5	-2.8	0.2	1.9	0.5	-1.7	-4.1	-6.5
21	-1.7	-2.4	-0.8	2.3	3.9	2.5	0.3	-2.1	-4.5
22	-2.4	-3.2	-1.5	1.6	3.2	1.8	-0.4	-2.8	-5.2
23	-1.1	-1.8	-0.1	2.9	4.6	3.2	1	-1.4	-3.8
24	-2	-2.7	-1.1	2	3.6	2.2	0	-2.4	-4.8
25	-2.1	-2.8	-1.2	1.9	3.6	2.2	0	-2.4	-4.8
26	-4.1	-4.8	-3.2	-0.1	1.5	0.1	-2.1	-4.5	-6.9
86	-10.4	-11.1	-9.5	-6.4	-4.8	-6.2	-8.4	-10.8	-13.2
87	-9.4	-10.1	-8.5	-5.4	-3.8	-5.2	-7.4	-9.8	-12.2
88	-9	-9.7	-8.1	-5	-3.4	-4.8	-7	-9.4	-11.8
89	-8.8	-9.5	-7.9	-4.8	-3.2	-4.6	-6.8	-9.2	-11.6
90	-8.3	-8.9	-7.3	-4.3	-2.6	-4	-6.2	-8.6	-11
91	-6.3	-7	-5.4	-2.3	-0.7	-2.1	-4.3	-6.7	-9.1
92	-6	-6.7	-5.1	-2	-0.4	-1.8	-4	-6.4	-8.8
93	-5.9	-6.5	-4.9	-1.8	-0.2	-1.6	-3.8	-6.2	-8.6
94	-9.8	-10.5	-8.9	-5.8	-4.2	-5.6	-7.8	-10.2	-12.6
95	-10.1	-10.8	-9.1	-6.1	-4.5	-5.9	-8.1	-10.5	-12.9
97	-11.1	-11.7	-10.1	-7.1	-5.4	-6.8	-9	-11.4	-13.8
98	-11.3	-11.9	-10.3	-7.2	-5.6	-7	-9.2	-11.6	-14
99	-11.8	-12.5	-10.8	-7.8	-6.2	-7.6	-9.8	-12.2	-14.6
100	-11.2	-11.8	-10.2	-7.2	-5.5	-6.9	-9.1	-11.5	-13.9
101	-11.2	-11.9	-10.3	-7.2	-5.6	-7	-9.2	-11.6	-14
102	-11	-11.6	-10	-6.9	-5.3	-6.7	-8.9	-11.3	-13.7
103	-11.4	-12.1	-10.5	-7.4	-5.8	-7.2	-9.4	-11.8	-14.2
104	-11.1	-11.8	-10.2	-7.1	-5.5	-6.9	-9.1	-11.5	-13.9
106	-10.3	-11	-9.4	-6.3	-4.7	-6.1	-8.3	-10.7	-13.1
107	-10	-10.7	-9.1	-6	-4.4	-5.8	-8	-10.4	-12.8
108	-6	-6.7	-5.1	-2	-0.4	-1.8	-4	-6.4	-8.8
109	-4.6	-5.3	-3.7	-0.6	1	-0.4	-2.6	-5	-7.4
115	-10.2	-10.8	-9.2	-6.2	-4.5	-5.9	-8.1	-10.5	-12.9
116	-10.3	-10.9	-9.3	-6.3	-4.6	-6	-8.2	-10.6	-13
117	-9.9	-10.6	-9	-5.9	-4.3	-5.7	-7.9	-10.3	-12.7
118	-10.3	-11	-9.4	-6.3	-4.7	-6.1	-8.3	-10.7	-13.1
119	-10.4	-11.1	-9.5	-6.4	-4.8	-6.2	-8.4	-10.8	-13.2
120	-10.5	-11.1	-9.5	-6.5	-4.8	-6.2	-8.4	-10.8	-13.2
121	-10.2	-10.9	-9.3	-6.2	-4.6	-6	-8.2	-10.6	-13
122	-10.3	-11	-9.4	-6.3	-4.7	-6.1	-8.3	-10.7	-13.1
123	-10.5	-11.2	-9.6	-6.5	-4.9	-6.3	-8.5	-10.9	-13.3
124	-10.7	-11.4	-9.7	-6.7	-5.1	-6.5	-8.7	-11.1	-13.5
116A	-10.3	-10.9	-9.3	-6.2	-4.6	-6	-8.2	-10.6	-13
121A	-10.2	-10.9	-9.2	-6.2	-4.6	-6	-8.2	-10.6	-13
21A	-2.1	-2.8	-1.1	2	3.6	2.2	0	-2.4	-4.8
24A	-2.4	-3.1	-1.5	1.6	3.2	1.8	-0.4	-2.8	-5.2
25A	-2.1	-2.8	-1.2	1.9	3.5	2.1	-0.1	-2.5	-4.9
87A	-9.1	-9.8	-8.2	-5.1	-3.5	-4.9	-7.1	-9.5	-11.9
93A	-6.2	-6.9	-5.2	-2.2	-0.6	-2	-4.2	-6.6	-9

BN4: Predicted Noise levels above Background Nighttime

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	24.9	25.1	26.1	27.6	29.9	32.8	36.4	40.6	45.5
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
18	-2.1	-1.3	1.1	4.6	6	3.8	0.2	-4	-8.9
19	-1.6	-0.8	1.6	5.1	6.5	4.3	0.7	-3.5	-8.4
20	-1.9	-1.1	1.4	4.8	6.3	4.1	0.5	-3.7	-8.6
21	0.2	1	3.4	6.9	8.3	6.1	2.5	-1.7	-6.6
22	-0.5	0.2	2.7	6.2	7.6	5.4	1.8	-2.4	-7.3
23	0.8	1.6	4.1	7.5	9	6.8	3.2	-1	-5.9
24	-0.1	0.7	3.1	6.6	8	5.8	2.2	-2	-6.9
25	-0.2	0.6	3	6.5	8	5.8	2.2	-2	-6.9
26	-2.2	-1.4	1	4.5	5.9	3.7	0.1	-4.1	-9
86	-8.5	-7.7	-5.3	-1.8	-0.4	-2.6	-6.2	-10.4	-15.3
87	-7.5	-6.7	-4.3	-0.8	0.6	-1.6	-5.2	-9.4	-14.3
88	-7.1	-6.3	-3.9	-0.4	1	-1.2	-4.8	-9	-13.9
89	-6.9	-6.1	-3.7	-0.2	1.2	-1	-4.6	-8.8	-13.7
90	-6.4	-5.5	-3.1	0.3	1.8	-0.4	-4	-8.2	-13.1
91	-4.4	-3.6	-1.2	2.3	3.7	1.5	-2.1	-6.3	-11.2
92	-4.1	-3.3	-0.9	2.6	4	1.8	-1.8	-6	-10.9
93	-4	-3.1	-0.7	2.8	4.2	2	-1.6	-5.8	-10.7
94	-7.9	-7.1	-4.7	-1.2	0.2	-2	-5.6	-9.8	-14.7
95	-8.2	-7.4	-4.9	-1.5	-0.1	-2.3	-5.9	-10.1	-15
97	-9.2	-8.3	-5.9	-2.5	-1	-3.2	-6.8	-11	-15.9
98	-9.4	-8.5	-6.1	-2.6	-1.2	-3.4	-7	-11.2	-16.1
99	-9.9	-9.1	-6.6	-3.2	-1.8	-4	-7.6	-11.8	-16.7
100	-9.3	-8.4	-6	-2.6	-1.1	-3.3	-6.9	-11.1	-16
101	-9.3	-8.5	-6.1	-2.6	-1.2	-3.4	-7	-11.2	-16.1
102	-9.1	-8.2	-5.8	-2.3	-0.9	-3.1	-6.7	-10.9	-15.8
103	-9.5	-8.7	-6.3	-2.8	-1.4	-3.6	-7.2	-11.4	-16.3
104	-9.2	-8.4	-6	-2.5	-1.1	-3.3	-6.9	-11.1	-16
106	-8.4	-7.6	-5.2	-1.7	-0.3	-2.5	-6.1	-10.3	-15.2
107	-8.1	-7.3	-4.9	-1.4	0	-2.2	-5.8	-10	-14.9
108	-4.1	-3.3	-0.9	2.6	4	1.8	-1.8	-6	-10.9
109	-2.7	-1.9	0.5	4	5.4	3.2	-0.4	-4.6	-9.5
115	-8.3	-7.4	-5	-1.6	-0.1	-2.3	-5.9	-10.1	-15
116	-8.4	-7.5	-5.1	-1.7	-0.2	-2.4	-6	-10.2	-15.1
117	-8	-7.2	-4.8	-1.3	0.1	-2.1	-5.7	-9.9	-14.8
118	-8.4	-7.6	-5.2	-1.7	-0.3	-2.5	-6.1	-10.3	-15.2
119	-8.5	-7.7	-5.3	-1.8	-0.4	-2.6	-6.2	-10.4	-15.3
120	-8.6	-7.7	-5.3	-1.9	-0.4	-2.6	-6.2	-10.4	-15.3
121	-8.3	-7.5	-5.1	-1.6	-0.2	-2.4	-6	-10.2	-15.1
122	-8.4	-7.6	-5.2	-1.7	-0.3	-2.5	-6.1	-10.3	-15.2
123	-8.6	-7.8	-5.4	-1.9	-0.5	-2.7	-6.3	-10.5	-15.4
124	-8.8	-8	-5.5	-2.1	-0.7	-2.9	-6.5	-10.7	-15.6
116A	-8.4	-7.5	-5.1	-1.6	-0.2	-2.4	-6	-10.2	-15.1
121A	-8.3	-7.5	-5	-1.6	-0.2	-2.4	-6	-10.2	-15.1
21A	-0.2	0.6	3.1	6.6	8	5.8	2.2	-2	-6.9
24A	-0.5	0.3	2.7	6.2	7.6	5.4	1.8	-2.4	-7.3
25A	-0.2	0.6	3	6.5	7.9	5.7	2.1	-2.1	-7
87A	-7.2	-6.4	-4	-0.5	0.9	-1.3	-4.9	-9.1	-14
93A	-4.3	-3.5	-1	2.4	3.8	1.6	-2	-6.2	-11.1

BN4: Predicted Noise levels above Background Daytime (+3dB penalty for just perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	26.8	28.5	30.3	32.2	34.3	36.4	38.6	41	43.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
18	-1	-1.7	-0.1	3	4.6	3.2	1	-1.4	-3.8
19	-0.5	-1.2	0.4	3.5	5.1	3.7	1.5	-0.9	-3.3
20	-0.8	-1.5	0.2	3.2	4.9	3.5	1.3	-1.1	-3.5
21	1.3	0.6	2.2	5.3	6.9	5.5	3.3	0.9	-1.5
22	0.6	-0.2	1.5	4.6	6.2	4.8	2.6	0.2	-2.2
23	1.9	1.2	2.9	5.9	7.6	6.2	4	1.6	-0.8
24	1	0.3	1.9	5	6.6	5.2	3	0.6	-1.8
25	0.9	0.2	1.8	4.9	6.6	5.2	3	0.6	-1.8
26	-1.1	-1.8	-0.2	2.9	4.5	3.1	0.9	-1.5	-3.9
86	-7.4	-8.1	-6.5	-3.4	-1.8	-3.2	-5.4	-7.8	-10.2
87	-6.4	-7.1	-5.5	-2.4	-0.8	-2.2	-4.4	-6.8	-9.2
88	-6	-6.7	-5.1	-2	-0.4	-1.8	-4	-6.4	-8.8
89	-5.8	-6.5	-4.9	-1.8	-0.2	-1.6	-3.8	-6.2	-8.6
90	-5.3	-5.9	-4.3	-1.3	0.4	-1	-3.2	-5.6	-8
91	-3.3	-4	-2.4	0.7	2.3	0.9	-1.3	-3.7	-6.1
92	-3	-3.7	-2.1	1	2.6	1.2	-1	-3.4	-5.8
93	-2.9	-3.5	-1.9	1.2	2.8	1.4	-0.8	-3.2	-5.6
94	-6.8	-7.5	-5.9	-2.8	-1.2	-2.6	-4.8	-7.2	-9.6
95	-7.1	-7.8	-6.1	-3.1	-1.5	-2.9	-5.1	-7.5	-9.9
97	-8.1	-8.7	-7.1	-4.1	-2.4	-3.8	-6	-8.4	-10.8
98	-8.3	-8.9	-7.3	-4.2	-2.6	-4	-6.2	-8.6	-11
99	-8.8	-9.5	-7.8	-4.8	-3.2	-4.6	-6.8	-9.2	-11.6
100	-8.2	-8.8	-7.2	-4.2	-2.5	-3.9	-6.1	-8.5	-10.9
101	-8.2	-8.9	-7.3	-4.2	-2.6	-4	-6.2	-8.6	-11
102	-8	-8.6	-7	-3.9	-2.3	-3.7	-5.9	-8.3	-10.7
103	-8.4	-9.1	-7.5	-4.4	-2.8	-4.2	-6.4	-8.8	-11.2
104	-8.1	-8.8	-7.2	-4.1	-2.5	-3.9	-6.1	-8.5	-10.9
106	-7.3	-8	-6.4	-3.3	-1.7	-3.1	-5.3	-7.7	-10.1
107	-7	-7.7	-6.1	-3	-1.4	-2.8	-5	-7.4	-9.8
108	-3	-3.7	-2.1	1	2.6	1.2	-1	-3.4	-5.8
109	-1.6	-2.3	-0.7	2.4	4	2.6	0.4	-2	-4.4
115	-7.2	-7.8	-6.2	-3.2	-1.5	-2.9	-5.1	-7.5	-9.9
116	-7.3	-7.9	-6.3	-3.3	-1.6	-3	-5.2	-7.6	-10
117	-6.9	-7.6	-6	-2.9	-1.3	-2.7	-4.9	-7.3	-9.7
118	-7.3	-8	-6.4	-3.3	-1.7	-3.1	-5.3	-7.7	-10.1
119	-7.4	-8.1	-6.5	-3.4	-1.8	-3.2	-5.4	-7.8	-10.2
120	-7.5	-8.1	-6.5	-3.5	-1.8	-3.2	-5.4	-7.8	-10.2
121	-7.2	-7.9	-6.3	-3.2	-1.6	-3	-5.2	-7.6	-10
122	-7.3	-8	-6.4	-3.3	-1.7	-3.1	-5.3	-7.7	-10.1
123	-7.5	-8.2	-6.6	-3.5	-1.9	-3.3	-5.5	-7.9	-10.3
124	-7.7	-8.4	-6.7	-3.7	-2.1	-3.5	-5.7	-8.1	-10.5
116A	-7.3	-7.9	-6.3	-3.2	-1.6	-3	-5.2	-7.6	-10
121A	-7.2	-7.9	-6.2	-3.2	-1.6	-3	-5.2	-7.6	-10
21A	0.9	0.2	1.9	5	6.6	5.2	3	0.6	-1.8
24A	0.6	-0.1	1.5	4.6	6.2	4.8	2.6	0.2	-2.2
25A	0.9	0.2	1.8	4.9	6.5	5.1	2.9	0.5	-1.9
87A	-6.1	-6.8	-5.2	-2.1	-0.5	-1.9	-4.1	-6.5	-8.9
93A	-3.2	-3.9	-2.2	0.8	2.4	1	-1.2	-3.6	-6

BN4: Predicted Noise levels above Background Nighttime (+3dB penalty for just perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	24.9	25.1	26.1	27.6	29.9	32.8	36.4	40.6	45.5
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
18	0.9	1.7	4.1	7.6	[illegible]	6.8	3.2	-1	-5.9
19	1.4	2.2	4.6	[illegible]	[illegible]	7.3	3.7	-0.5	-5.4
20	1.1	1.9	4.4	7.8	[illegible]	7.1	3.5	-0.7	-5.6
21	3.2	4	6.4	[illegible]	[illegible]	[illegible]	5.5	1.3	-3.6
22	2.5	3.2	5.7	[illegible]	[illegible]	[illegible]	4.8	0.6	-4.3
23	3.8	4.6	7.1	[illegible]	[illegible]	[illegible]	6.2	2	-2.9
24	2.9	3.7	6.1	[illegible]	[illegible]	[illegible]	5.2	1	-3.9
25	2.8	3.6	6	[illegible]	[illegible]	[illegible]	5.2	1	-3.9
26	0.8	1.6	4	7.5	[illegible]	6.7	3.1	-1.1	-6
86	-5.5	-4.7	-2.3	1.2	2.6	0.4	-3.2	-7.4	-12.3
87	-4.5	-3.7	-1.3	2.2	3.6	1.4	-2.2	-6.4	-11.3
88	-4.1	-3.3	-0.9	2.6	4	1.8	-1.8	-6	-10.9
89	-3.9	-3.1	-0.7	2.8	4.2	2	-1.6	-5.8	-10.7
90	-3.4	-2.5	-0.1	3.3	4.8	2.6	-1	-5.2	-10.1
91	-1.4	-0.6	1.8	5.3	6.7	4.5	0.9	-3.3	-8.2
92	-1.1	-0.3	2.1	5.6	7	4.8	1.2	-3	-7.9
93	-1	-0.1	2.3	5.8	7.2	5	1.4	-2.8	-7.7
94	-4.9	-4.1	-1.7	1.8	3.2	1	-2.6	-6.8	-11.7
95	-5.2	-4.4	-1.9	1.5	2.9	0.7	-2.9	-7.1	-12
97	-6.2	-5.3	-2.9	0.5	2	-0.2	-3.8	-8	-12.9
98	-6.4	-5.5	-3.1	0.4	1.8	-0.4	-4	-8.2	-13.1
99	-6.9	-6.1	-3.6	-0.2	1.2	-1	-4.6	-8.8	-13.7
100	-6.3	-5.4	-3	0.4	1.9	-0.3	-3.9	-8.1	-13
101	-6.3	-5.5	-3.1	0.4	1.8	-0.4	-4	-8.2	-13.1
102	-6.1	-5.2	-2.8	0.7	2.1	-0.1	-3.7	-7.9	-12.8
103	-6.5	-5.7	-3.3	0.2	1.6	-0.6	-4.2	-8.4	-13.3
104	-6.2	-5.4	-3	0.5	1.9	-0.3	-3.9	-8.1	-13
106	-5.4	-4.6	-2.2	1.3	2.7	0.5	-3.1	-7.3	-12.2
107	-5.1	-4.3	-1.9	1.6	3	0.8	-2.8	-7	-11.9
108	-1.1	-0.3	2.1	5.6	7	4.8	1.2	-3	-7.9
109	0.3	1.1	3.5	7	[illegible]	6.2	2.6	-1.6	-6.5
115	-5.3	-4.4	-2	1.4	2.9	0.7	-2.9	-7.1	-12
116	-5.4	-4.5	-2.1	1.3	2.8	0.6	-3	-7.2	-12.1
117	-5	-4.2	-1.8	1.7	3.1	0.9	-2.7	-6.9	-11.8
118	-5.4	-4.6	-2.2	1.3	2.7	0.5	-3.1	-7.3	-12.2
119	-5.5	-4.7	-2.3	1.2	2.6	0.4	-3.2	-7.4	-12.3
120	-5.6	-4.7	-2.3	1.1	2.6	0.4	-3.2	-7.4	-12.3
121	-5.3	-4.5	-2.1	1.4	2.8	0.6	-3	-7.2	-12.1
122	-5.4	-4.6	-2.2	1.3	2.7	0.5	-3.1	-7.3	-12.2
123	-5.6	-4.8	-2.4	1.1	2.5	0.3	-3.3	-7.5	-12.4
124	-5.8	-5	-2.5	0.9	2.3	0.1	-3.5	-7.7	-12.6
116A	-5.4	-4.5	-2.1	1.4	2.8	0.6	-3	-7.2	-12.1
121A	-5.3	-4.5	-2	1.4	2.8	0.6	-3	-7.2	-12.1
21A	2.8	3.6	6.1	[illegible]	[illegible]	[illegible]	5.2	1	-3.9
24A	2.5	3.3	5.7	[illegible]	[illegible]	[illegible]	4.8	0.6	-4.3
25A	2.8	3.6	6	[illegible]	[illegible]	[illegible]	5.1	0.9	-4
87A	-4.2	-3.4	-1	2.5	3.9	1.7	-1.9	-6.1	-11
93A	-1.3	-0.5	2	5.4	6.8	4.6	1	-3.2	-8.1

BN4: Predicted Noise levels above Background Daytime (+6dB penalty for clearly perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Day	26.8	28.5	30.3	32.2	34.3	36.4	38.6	41	43.4
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
18	2	1.3	2.9	6	7.6	6.2	4	1.6	-0.8
19	2.5	1.8	3.4	6.5	8.2	6.7	4.5	2.1	-0.3
20	2.2	1.5	3.2	6.2	7.9	6.5	4.3	1.9	-0.5
21	4.3	3.6	5.2	8.2	9.9	8.6	6.3	3.9	1.5
22	3.6	2.8	4.5	7.6	9.2	7.8	5.6	3.2	0.8
23	4.9	4.2	5.9	8.9	10.6	9.1	7	4.6	2.2
24	4	3.3	4.9	8	9.6	8.1	6	3.6	1.2
25	3.9	3.2	4.8	7.9	9.6	8.1	6	3.6	1.2
26	1.9	1.2	2.8	5.9	7.5	6.1	3.9	1.5	-0.9
86	-4.4	-5.1	-3.5	-0.4	1.2	-0.2	-2.4	-4.8	-7.2
87	-3.4	-4.1	-2.5	0.6	2.2	0.8	-1.4	-3.8	-6.2
88	-3	-3.7	-2.1	1	2.6	1.2	-1	-3.4	-5.8
89	-2.8	-3.5	-1.9	1.2	2.8	1.4	-0.8	-3.2	-5.6
90	-2.3	-2.9	-1.3	1.7	3.4	2	-0.2	-2.6	-5
91	-0.3	-1	0.6	3.7	5.3	3.9	1.7	-0.7	-3.1
92	0	-0.7	0.9	4	5.6	4.2	2	-0.4	-2.8
93	0.1	-0.5	1.1	4.2	5.8	4.4	2.2	-0.2	-2.6
94	-3.8	-4.5	-2.9	0.2	1.8	0.4	-1.8	-4.2	-6.6
95	-4.1	-4.8	-3.1	-0.1	1.5	0.1	-2.1	-4.5	-6.9
97	-5.1	-5.7	-4.1	-1.1	0.6	-0.8	-3	-5.4	-7.8
98	-5.3	-5.9	-4.3	-1.2	0.4	-1	-3.2	-5.6	-8
99	-5.8	-6.5	-4.8	-1.8	-0.2	-1.6	-3.8	-6.2	-8.6
100	-5.2	-5.8	-4.2	-1.2	0.5	-0.9	-3.1	-5.5	-7.9
101	-5.2	-5.9	-4.3	-1.2	0.4	-1	-3.2	-5.6	-8
102	-5	-5.6	-4	-0.9	0.7	-0.7	-2.9	-5.3	-7.7
103	-5.4	-6.1	-4.5	-1.4	0.2	-1.2	-3.4	-5.8	-8.2
104	-5.1	-5.8	-4.2	-1.1	0.5	-0.9	-3.1	-5.5	-7.9
106	-4.3	-5	-3.4	-0.3	1.3	-0.1	-2.3	-4.7	-7.1
107	-4	-4.7	-3.1	-4E-15	1.6	0.2	-2	-4.4	-6.8
108	0	-0.7	0.9	4	5.6	4.2	2	-0.4	-2.8
109	1.4	0.7	2.3	5.4	7	5.6	3.4	1	-1.4
115	-4.2	-4.8	-3.2	-0.2	1.5	0.1	-2.1	-4.5	-6.9
116	-4.3	-4.9	-3.3	-0.3	1.4	0	-2.2	-4.6	-7
117	-3.9	-4.6	-3	0.1	1.7	0.3	-1.9	-4.3	-6.7
118	-4.3	-5	-3.4	-0.3	1.3	-0.1	-2.3	-4.7	-7.1
119	-4.4	-5.1	-3.5	-0.4	1.2	-0.2	-2.4	-4.8	-7.2
120	-4.5	-5.1	-3.5	-0.5	1.2	-0.2	-2.4	-4.8	-7.2
121	-4.2	-4.9	-3.3	-0.2	1.4	0	-2.2	-4.6	-7
122	-4.3	-5	-3.4	-0.3	1.3	-0.1	-2.3	-4.7	-7.1
123	-4.5	-5.2	-3.6	-0.5	1.1	-0.3	-2.5	-4.9	-7.3
124	-4.7	-5.4	-3.7	-0.7	0.9	-0.5	-2.7	-5.1	-7.5
116A	-4.3	-4.9	-3.3	-0.2	1.4	0	-2.2	-4.6	-7
121A	-4.2	-4.9	-3.2	-0.2	1.4	0	-2.2	-4.6	-7
21A	3.9	3.2	4.9	8	9.6	8.1	6	3.6	1.2
24A	3.6	2.9	4.5	7.6	9.2	7.8	5.6	3.2	0.8
25A	3.9	3.2	4.8	7.9	9.6	8.1	5.9	3.5	1.1
87A	-3.1	-3.8	-2.2	0.9	2.5	1.1	-1.1	-3.5	-5.9
93A	-0.2	-0.9	0.8	3.8	5.4	4	1.8	-0.6	-3

BN4: Predicted Noise levels above Background Nighttime (+6dB penalty for clearly perceptable impulsivity)

Highlighted Orange greater than 5dB & less than 8dB above BG
Highlighted Red greater than 8dB & less than 12dB above BG
Highlighted Purple greater than 12dB above BG

Night	24.9	25.1	26.1	27.6	29.9	32.8	36.4	40.6	45.5
House Number	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
18	3.9	4.7	7.1	10.6	12	9.8	6.2	2	-2.9
19	4.4	5.2	7.6	11.1	12.5	10.3	6.7	2.5	-2.4
20	4.1	4.9	7.4	10.8	12.3	10	6.5	2.3	-2.6
21	6.2	7	9.4	12.9	14.3	12.1	8.6	4.3	-0.6
22	5.5	6.2	8.7	12.2	13.6	11.4	7.8	3.6	-1.3
23	6.8	7.6	10.1	13.5	15	12.8	9.1	5	0.1
24	5.9	6.7	9.1	12.6	14	11.8	8.1	4	-0.9
25	5.8	6.6	9	12.5	14	11.7	8.1	4	-0.9
26	3.8	4.6	7	10.5	11.9	9.7	6.1	1.9	-3
86	-2.5	-1.7	0.7	4.2	5.6	3.4	-0.2	-4.4	-9.3
87	-1.5	-0.7	1.7	5.2	6.6	4.4	0.8	-3.4	-8.3
88	-1.1	-0.3	2.1	5.6	7	4.8	1.2	-3	-7.9
89	-0.9	-0.1	2.3	5.8	7.2	5	1.4	-2.8	-7.7
90	-0.4	0.5	2.9	6.3	7.8	5.6	2	-2.2	-7.1
91	1.6	2.4	4.8	8.3	9.7	7.5	3.9	-0.3	-5.2
92	1.9	2.7	5.1	8.6	10	7.8	4.2	0	-4.9
93	2	2.9	5.3	8.8	10.1	8	4.4	0.2	-4.7
94	-1.9	-1.1	1.3	4.8	6.2	4	0.4	-3.8	-8.7
95	-2.2	-1.4	1.1	4.5	5.9	3.7	0.1	-4.1	-9
97	-3.2	-2.3	0.1	3.5	5	2.8	-0.8	-5	-9.9
98	-3.4	-2.5	-0.1	3.4	4.8	2.6	-1	-5.2	-10.1
99	-3.9	-3.1	-0.6	2.8	4.2	2	-1.6	-5.8	-10.7
100	-3.3	-2.4	0	3.4	4.9	2.7	-0.9	-5.1	-10
101	-3.3	-2.5	-0.1	3.4	4.8	2.6	-1	-5.2	-10.1
102	-3.1	-2.2	0.2	3.7	5.1	2.9	-0.7	-4.9	-9.8
103	-3.5	-2.7	-0.3	3.2	4.6	2.4	-1.2	-5.4	-10.3
104	-3.2	-2.4	0	3.5	4.9	2.7	-0.9	-5.1	-10
106	-2.4	-1.6	0.8	4.3	5.7	3.5	-0.1	-4.3	-9.2
107	-2.1	-1.3	1.1	4.6	6	3.8	0.2	-4	-8.9
108	1.9	2.7	5.1	8.6	10	7.8	4.2	0	-4.9
109	3.3	4.1	6.5	10	11.4	9.2	5.6	1.4	-3.5
115	-2.3	-1.4	1	4.4	5.9	3.7	0.1	-4.1	-9
116	-2.4	-1.5	0.9	4.3	5.8	3.6	0	-4.2	-9.1
117	-2	-1.2	1.2	4.7	6.1	3.9	0.3	-3.9	-8.8
118	-2.4	-1.6	0.8	4.3	5.7	3.5	-0.1	-4.3	-9.2
119	-2.5	-1.7	0.7	4.2	5.6	3.4	-0.2	-4.4	-9.3
120	-2.6	-1.7	0.7	4.1	5.6	3.4	-0.2	-4.4	-9.3
121	-2.3	-1.5	0.9	4.4	5.8	3.6	0	-4.2	-9.1
122	-2.4	-1.6	0.8	4.3	5.7	3.5	-0.1	-4.3	-9.2
123	-2.6	-1.8	0.6	4.1	5.5	3.3	-0.3	-4.5	-9.4
124	-2.8	-2	0.5	3.9	5.3	3.1	-0.5	-4.7	-9.6
116A	-2.4	-1.5	0.9	4.4	5.8	3.6	0	-4.2	-9.1
121A	-2.3	-1.5	1	4.4	5.8	3.6	0	-4.2	-9.1
21A	5.8	6.6	9.1	12.6	14	11.8	8.1	4	-0.9
24A	5.5	6.3	8.7	12.2	13.6	11.4	7.8	3.6	-1.3
25A	5.8	6.6	9	12.5	13.9	11.7	8.1	3.9	-1
87A	-1.2	-0.4	2	5.5	6.9	4.7	1.1	-3.1	-8
93A	1.7	2.5	5	8.3	9.7	7.6	4	-0.2	-5.1

THE HIGH COURT

[2024] IEHC 136

[2018 8457 P]

BETWEEN:

MARGARET WEBSTER AND KEITH ROLLO

PLAINTIFFS

AND

MEENACLOGHSPAR (WIND) LIMITED

DEFENDANT

AND

[2018 8458 P]

BETWEEN:

ROSS SHORTEN AND JOAN CARTY

PLAINTIFFS

AND

MEENACLOGHSPAR (WIND) LIMITED

DEFENDANT

JUDGMENT of Ms. Justice Emily Egan delivered on the 8th day of March 2024

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Glossary

GLOSSARY Term	Definition
Aerodynamic Noise	Noise emitted by a wind turbine due to the passage of air over the blades.
Amplitude modulation, AM	In the context of wind turbine acoustics, this normally refers to a periodic variation in the sound level of the broadband spectrum of the aerodynamic sound.
AM Value	In broad terms I refer to this as the measurement of the peak to trough differential in AM noise levels
Background Noise	The ambient noise level already present within the environment in the absence of wind farm operation.
Bin	A bin is a subset or group into which data can be sorted; in the case of windspeeds, bins are often centred on integer windspeeds with a width of 1 m/s. For example, the 4m/s windspeed bin would include all data with windspeeds of 3.5 to 4.5 m/s.
Blade Pitch	The pitch motor turns (or pitches) blades out of the wind to control the rotor speed, and to keep the rotor from turning in winds that are too high or too low to produce electricity.
Broadband	A wide range of sound frequencies

BS 4142	*BS4142: 2014 Method for rating and assessing industrial and commercial sound.* BS 4142 is a method to assess the impact on humans in residential premises. It is appropriate for assessing sound levels outside a building that are from: industrial premises, manufacturing premises or fixed installations, mobile plants, vehicles, trains or ship movements.
Cut-in Windspeed	The windspeed at which a turbine produces a net power output.
dB	Decibel, the unit of measure of sound.
dBA	A-weighted decibels, the unit of measure of sound adjusted to reflect the perception of sound to the human ear.
Defra Guidance	*Windfarm Noise Statutory Complaint Methodology, 2011* A methodology developed by the Department for Environment, Food and Rural Affairs for the assessment of statutory noise nuisance complaints pertaining to wind turbine noise.
Draft WEDG 2019	Draft revised Wind Energy Development Guidelines issued by the Department of Housing, Local Government and Heritage in December 2019 and since withdrawn.
EPA	Environmental Protection Agency

EPA NG3	*EPA Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites, EPA NG3* (June, 2011).
EPA NG4	*Environmental Protection Agency Office of Environmental Enforcement (OEE) Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities* (January, 2016)
ETSU	*ETSU-R-97: The Assessment and Rating of Noise from Wind Farms* published by the Department of Trade and Industry in 1996. ETSU is the primary framework by which planning conditions pertaining to wind farms are set in the United Kingdom
ETSU Review	*A Review of Noise Guidance for Onshore Wind Turbines produced by WSP UK Limited* commissioned by the Department for Business, Energy and Industrial Strategy and published in February 2023.
Façade Level	The noise level closer to a façade of a building which is subject to a higher noise level than in an open area (free field conditions) due to reflections.
Fixed noise limit	A noise condition in a planning permission which does not limit WTN by reference to background noise levels but instead sets a fixed limit (or a range of fixed limits)

Free Field	An environment in which there are no reflective surfaces affecting measurements within the frequency region of interest.
GPG	*A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise*' published by the Institute of Acoustics (IOA) in 2013.
Hertz (Hz)	Hertz, the unit of measure for the frequency of a sound in cycles per second.
Hub	The centre of the rotor
Hub Height	Height of wind turbine tower from the ground to the centre-line of the turbine rotor.
10-metre standardised windspeed	A formula pursuant to which, irrespective of the hub height of the turbine, windspeed is extrapolated down to a 10 metre height using a standard wind shear profile.
Hub Height Windspeed	The windspeed at the hub height of the turbine or at the centre of the rotor.
IOA	The Institute of Acoustics
IOA RM	A reference method published by the Institute of Acoustics in 2016 for measuring and rating amplitude modulation in wind turbine noise.
ISO 1996-2	A standard published in 1996 by the International Organization for the

	standardisation of measurements "*Acquisition of data pertinent to land use*" ("ISO 1996-2")"
ISO 1996-2, 2017	The 2017 edition of ISO 1996-2
L5	The sound level exceeded for 5% of the measurement period.
L90	The sound level exceeded for 90% of the measurement period. For example, L90 (10 min) is the level exceeded for 90% of the measurement time of 10 minutes.
L95	The sound level exceeded for 95% of the measurement period.
Lden	This is a composite of long term leq valued for day, evening and night. It is determined by averaging the L day with the L evening plus a 5 dB penalty and the L night plus a 10 dB penalty.
Leq T, energy time-averaged sound level	A sound level measurement index, which averages all of the sound energy in a period over the measurement time T. For example, Leq 10 is the average sound level over a 10 minute period.
Lmax	This represents the upper value of the sound pressure levels measured in a given period.

Low frequency noise	The definition of low frequency noise can vary, but it is generally accepted to be within the range of 10Hz to 150Hz.
Masking	The process by which the threshold of audibility of one sound is raised by the presence of another (masking) sound.
Mechanical Noise	Noise emitted by a wind turbine from machinery usually within the nacelle.
m/s	Metres per second.
Night Hours	2300-0700 hours on all days
Noise	Sound that is subjectively judged to be undesired in a given context.
Phase 2 Report	*Wind turbine AM review: Phase 2 report.* 3514482A Issue 3 WSP | Parsons Brinckerhoff, 2016. Department for Business, Energy & Industrial Strategy. A study suggesting a range of decibel penalties by reference to **AM values** for inclusion in planning permissions for wind turbines.
Quiet Waking Hours	1800-2300 hours on all days plus 0700-1800 hours on Sundays and 1300-1800 hours on Saturdays.
Relative noise limit	A noise condition in a planning permission which limits WTN to a certain level above background noise.

SCADA data	SCADA is a computer system with software tools used for controlling and monitoring the wind turbine. It measures *inter alia* windspeed, speed of rotation, blade pitch and decibel level. SCADA data is retained and can be re-produced. The SCADA data for both T1 and T2 was included in the defendant's discovery.
Shadow Flicker	Term used to describe the short-lived effect of shadows cast by rotating blades of wind turbines when the sun passes behind them, which occurs under certain combinations of geographical positions and time of day.
Sound	Energy that is transmitted by pressure waves in air or other materials and is the objective cause of the sensation of hearing. Commonly called noise if it is unwanted.
Sound Frequency	Sound comprises a range of frequencies extending from the very low, such as a rumble of thunder, to high frequencies, such as those generated by a small bell. Allowing for individual variation, the audible range of frequencies for the human ear is generally in the region of 20Hz to 20,000Hz.
Sound Pressure	Sound pressure is usually measured in A-weighted decibels, which are generally denoted as dBA. The decibel scale is logarithmic and not linear in nature. This means that if, for example, two instances of the same sound level occur at the same time and each has a sound

	level of 30dBA, their combined level will be 33dBA, and not 60dBA.
Spectrogram	A visual representation of the spectrum of frequencies in a signal as it varies with time. In acoustic terms it shows the acoustic frequency content of the raw noise data which is helpful in identifying the main sources of noise and clarifying whether it is wind turbine related.
Spectrum, spectral content	Sounds are typically made up of acoustic energy present in many frequencies of the audible spectrum. The frequency spectrum describes this signal 'content'.
Stable atmospheric conditions	Conditions under which the mixing of layers in the atmosphere is minimised. This leads to a much greater increase in wind speed with height.
Supplemental Guidance Note 5	One of six Supplementary Guidance Notes to the GPG published by the IOA in 2014. *Supplementary Guidance Note 5 on Post Completion Measures* governs the technical aspects of ETSU planning compliance assessments.
Total operational noise (level)	In the context of wind turbine acoustics, this normally refers to the total sound environment considered at a given location. In the present case, total operational noise comprises the wind turbine noise and the background noise.

WEDG 1996	*The Wind Farm Development Guidelines for Planning Authorities* issued by the Department of Local Government in 1996.
WEDG 2006	*The Wind Energy Development Guidelines 2006*, issued by the Department of the Environment, Heritage and Local Government in December, 2006.
WHO 2009	*Night Noise Guidelines for Europe* (2009) ISBN 978 92 890 4173 7
WHO ENGER	*Environmental Noise Guidelines for the European Region* (2018)
Wind Shear	A description of the increase in windspeed with height above ground level.

Introduction

1. The plaintiffs are two couples[1] who claim they have been interfered with, over a substantial period of time, in the use and enjoyment of their homes, at Ballyduff, Enniscorthy County Wexford. The claim is for private nuisance in the form of noise and vibration generated by two nearby wind turbines, owned and operated by the defendant. The plaintiffs also complain of shadow flicker.

2. Ms. Webster and Mr. Rollo ("the Webster Rollos"), own Hill House (HH), and until recently Ms. Carty and Mr. Shorten ("the Carty Shortens") owned Nettlefield (NF). The nearer of the two turbines, Turbine 2, ("T2") is located some 359 m from the Carty Shorten house and some 369 m from the Webster Rollo house and the further turbine, Turbine 1, ("T1") is some 652 m from the Carty Shorten house and some 655 m from the Webster Rollo house. Each of the turbines are 74.5 m in hub height and as they are located on a height, the height difference between the plaintiffs' houses and T1 and T2 respectively is 169 m and 152 m. The relative locations of the turbines and the plaintiffs' houses means that the prevailing south westerly winds blow from the direction of the turbines towards the plaintiffs' houses. It is also common case that because the plaintiffs' houses are located in the lee of a hill (on which the turbines are placed), they are sheltered from the prevailing wind and are in a "wind shadow" (which I understand to mean a location that is generally calm and sheltered).

3. The windfarm was built on foot of a grant of planning permission dated 16th April, 2004. Condition 15 states that noise levels from the turbines when measured at the nearest inhabited house shall not exceed 40dBA (15 minute leq[2]) at a windspeed of 5 m/s and 45dBA (15 minute leq) at a windspeed in excess of 10 m/s. Due to grid connection difficulties, there was a delay in the implementation of this planning permission and the two turbines did not become operational until February 2017.

4. In addition to seeking damages for nuisance and an injunction to prevent nuisance, the plaintiffs maintain that the windfarm is operating otherwise then in compliance with its planning

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[1] Although the Webster Rollos have since separated.

[2] In this judgment, I will in general refer to this as "leq" regardless of the time interval involved. This is primarily to distinguish this measurement from L90.

permission and seek relief pursuant to section 160 of the Planning Development Act, 2000 (as amended).

5. O'Moore J. directed that the trial of the proceedings would proceed in a modular fashion with module 1, which is the subject matter of this judgment, dealing only with the issue of liability and module 2, if required, dealing with the issue of damages and remedy. However, during the course of the trial of module 1, it was agreed that this module would also determine the entitlement or otherwise of the Webster Rollos to damages for personal injuries[3] and that the assessment of the quantum of such damages (if any) would be taken up in module 2.

6. It was expected that module 1 would run for five weeks. However, it is clear that the parties' estimate of the time required to try the numerous factual, technical and legal issues in dispute was utterly unrealistic . It should be noted that this is the first private nuisance claim in relation to WTN that has run to judgment in this jurisdiction, or it appears in the United Kingdom. The only comparable authority cited to me by the parties is a judgment of the Supreme Court of Victoria of New Zealand of 12th March, 2022, *Noel Uren v Bland Hills Wind Farm Pty Ltd* [2022] VSC 145.

7. The trial of module 1 very significantly over-ran its original estimate and was heard over the course of 51 days between 22nd November, 2022 and 6th November, 2023. In total, the plaintiffs called 11 witnesses and the defendant called five witnesses. The combined book of transcripts of the hearing of the proceedings runs to over 6000 pages.

The nature of wind turbine noise ("WTN")

8. Wind turbine noise ("WTN") typically consists of both aerodynamic noise caused by the interaction of the rotors with the surrounding air and mechanical noise created by the mechanical elements of the turbine. It is the first of these that is in issue here.

9. Wind turbine aerodynamic noise is typically broadband in nature in the sense that it is evenly distributed across the frequency spectrum; but it can exhibit lower frequency content.

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[3] In the form of pure psychological injury.

Sound with significant lower frequency content is both more intrusive and less effectively attenuated by barriers such as windows, walls and insulation.

10. Although WTN can be constant it usually exhibits period fluctuations in level, the frequency[4] of which is related to the blade passing frequency of the turbine rotors. This volume change is known as amplitude modulation ("AM")[5].

11. Two categories of wind turbine AM have been identified in the literature and guidelines: The first is AM in the mid and upper frequency[6] ranges. The sound which this produces, is that which we commonly associate with windfarms and is best described as a swishing sound. This blade swish, which I will refer to as ("swish AM") is commonly described as "*normal AM*". The second category of AM has a lower frequency sound character and is best described as a "whoomph" or thump sound ("thump AM"). Thump AM is commonly described as *"abnormal AM", "adverse AM"* or *"excessive AM"*.

12. In broad terms[7], the extent to which AM fluctuates as the rotors turn is measured by the differential between the peak and the trough of the sound levels – i.e., the peak to trough differential ("the AM value"). If the AM value is high, then the perception will be of a louder sound changing to a quieter sound, and vice versa. This will increase the intrusiveness of the WTN. Conversely, if the AM value is low, then the perception will be of a sound which is more steady and monotonous. Swish AM and thump AM can each display either high or low AM values.

13. In addition to variations in its spectral content (swish AM/thump AM), and its AM value (high or low values), AM can also exhibit other distinct characteristics such as:

- regular AM with little variation in rhythm.
- erratic AM with no clear periodicity or rhythm which exhibits sudden bursts or isolated peaks of noise and is often accompanied by high AM values.

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[4] Note the two different uses of the word frequency, i.e., to define spectral content and, as here, to describe the temporality of blade passing.
[5] Graphs prepared by one of the plaintiffs' experts derived from the noise monitoring on site which are attached at paras 434 and 435 might be helpful in illustrating AM.
[6] Here "frequency" refers to spectral content.
[7] There are some nuances to this which I will outline below when discussing eh IOA RM.

- Intermittent or variable AM which disappears and returns again, or which fades in and out.

14. Although the plaintiffs complain that the WTN causes an unwelcome general increase in noise levels at their properties, the key feature of their case is that the AM associated with these turbines (but primarily the closest turbine, T2) renders it objectively unreasonable.

Summary of plaintiffs' and defendant's case

Plaintiffs' case

15. In brief, the plaintiffs' case is that whilst the assessment of WTN nuisance is an objective and not a subjective exercise, it is not determined by decibel level alone but by reference to all of the characteristics of the WTN. The assessment is not purely quantitative but also qualitative. Close attention must therefore be paid to all the characteristics of the WTN such as its decibel level, whether there is swish or thump AM, its AM values, the erraticism, impulsivity or variability of its AM and the duration, frequency and timing of the intrusion occasioned thereby.

16. The plaintiffs maintain that even if a windfarm benefits from planning permission, the noise conditions in the permission cannot provide the litmus test for determining whether the WTN constitutes an unreasonable interference with amenity.

17. To demonstrate the features of the WTN complained of in this case, the plaintiffs' experts carried out noise monitoring over extensive periods both externally and internally at HH and NF. The plaintiffs present the results of this noise monitoring in audio recordings and in graphical format. They maintain that, when assessed against relevant quantitative and qualitative criteria, this data supports the contention that the WTN poses a substantial nuisance.

Defendant's case

18. The defendant argues that the noise conditions in the windfarm planning permission comprise a wholly reliable indicator as to what levels of WTN are objectively reasonable at this location. Therefore, because the WTN is said to comply with the conditions in the planning permission, nuisance cannot be established.

19. The defendant argues that the plaintiffs' experts' audio recordings and graphs were not recorded or analysed in accordance with established methodologies. It maintains that the plaintiffs' experts' approach is novel and bespoke and therefore of little assistance to the court.

20. A further overarching argument of the defendant is that the plaintiffs' complaints are subjective only and that the test for nuisance is objective. The defendant relies on three key items of evidence that it submits established that the expectations of an objectively reasonable ordinary person have not been *"exceeded"* in this instance:

i. The evidence of its acoustic experts, to the effect that the noise conditions incorporated into the planning permission for the windfarm comprise a reasonable objective standard in respect of noise emissions.
ii. Evidence said to demonstrate that the windfarm is operating in compliance with the said noise conditions.
iii. The evidence of Ms. McGinn the purchaser/occupier of NF to the effect that in general the WTN is not adversely affecting her enjoyment of the property.

Structure of this judgment

21. At the outset, I will summarise my findings on the issues to be tried in this case. After outlining the legal test for nuisance, I will set out the key factual evidence and then detail the court's site visit. Next, I will provide a brief overview of the expert evidence.

22. To place the arguments of the parties in context, it will then be necessary to review the regulatory framework under which planning authorities set noise conditions for wind farm developments.

23. Moving on to the main body of the judgment, I will first consider the defendant's argument that the noise conditions in the planning permission for this windfarm are binding on the court because they comprise a wholly reliable indicator of what constitutes objectively reasonable WTN at this location. The defendant also contends that the WTN complies with these noise conditions. This means that if this argument were to succeed, it would be dispositive of the claim.

24. Thereafter, I will consider the reliability of evidence of the plaintiffs' experts, including the audio recordings (and associated graphs) derived from their noise monitoring at the plaintiffs' homes. After this, I will consider what criteria ought to best guide this court in the nuisance assessment and then analyse the WTN as against a range of relevant quantitative and qualitative criteria.

25. After making certain findings of fact, I set out my reasons for concluding that nuisance is established in this case.

26. I will then explain why I direct the parties to re-engage in mediation in an attempt to identify appropriate and proportionate mitigation measures. Finally, I will examine the plaintiffs' claim to damages for personal injuries and close by briefly considering the plaintiffs' application pursuant to s. 160 of the Planning and Development Act 2000.

Issues to be tried and summary of the court's findings

27. I set out below the issues for determination together with an overview of my conclusions in relation to each issue. It should be emphasised that this is only a very brief summary of my reasons for those conclusions and that the real analysis thereof is set out in the body of the judgment.

> **Issue 1: Is the court bound by the noise condition in the planning permission in assessing what is objectively reasonable for the purposes of determining a claim for nuisance? Is the noise condition in the planning permission a wholly reliable indicator of what WTN is reasonable?**
>
> No.
>
> **Is the permission binding on the court in its nuisance assessment?**
>
> The defendant argues that, *as a matter of law*, a permission which specifically regulates the matter complained of – in this instance, WTN – prevents the court from concluding that operation in accordance therewith constitutes a nuisance. The defendant relies upon *Smyth v Railway Procurement Agency and anor* [2010] IEHC 291 (*"Smyth v RPA"*) in which Laffoy J. held that, if operated in accordance with the Line B order, the operation

of the LUAS would be in accordance with law and could not constitute a nuisance. Effectively, the defendant seeks to equate the legal impact of the Ballyduff planning permission with that of the Line B Order in *Smyth v RPA.* However, the two cannot be equated. This aspect of Laffoy J.'s reasoning is concerned with the defence of statutory authority in respect of a development authorised by legislation. Its logic cannot be read across to a decision made by a planning authority in the form of a single planning permission.

Is the permission a wholly reliable indicator of what WTN is reasonable?

In any event, I am not satisfied that the permission does specifically regulate the matter complained of by the plaintiffs. The Ballyduff permission regulates WTN by way of decibel levels only and cannot establish an objective yardstick for the particular aspects of the WTN complained of by the plaintiffs in this case – the AM.

Neither the Ballyduff permission nor the planning file as a whole reveal any consideration, assessment or regulation of this feature of WTN. The permission cannot therefore be seen as a wholly reliable indicator of what AM values and other AM characteristics are objectively reasonable.

This lacunae in the permission may be contrasted with the evidence in *Smyth v RPA.* The process under consideration in *Smyth v RPA* incorporated a searching and comprehensive investigation, analysis and assessment of all noise aspects of the project. On the evidence therefore, Laffoy J. was satisfied that the noise conditions thereby derived were a wholly reliable indicator as to what the ordinary person whose requirements[8] are objectively reasonable would expect in terms of noise control.

Furthermore, I do not accept that in the circumstances of this case the defendant can profit from an argument that the court must show curial deference to the Ballyduff planning permission. Curial deference was urged on the court because, it is said, the Ballyduff permission reflects prevailing standards and expertise pertaining to WTN at the time of the grant of permission (and indeed to date). However, the interpretation of the permission argued for by the defendant does not reflect prevailing planning guidance at the time of the grant of the Ballyduff permission - the 1996 Wind Energy

[8] Even if I am wrong in this, I am not in any event satisfied that the defendant has demonstrated that the WTN complies with the noise limits set out in the permission. See para 341 for a summary of why this is so, with the full analysis preceding that.

Development Guidelines (WEDG 1996) [9]. Conversely, if the Ballyduff permission is interpreted in harmony with WEDG 1996, then I am far from being satisfied that the WTN complies therewith. Further, contrary to the defendant's argument, the noise limits laid down in the Ballyduff permission do not reflect current expertise on the impact of the relevant characteristics of the WTN complained of here-such as high AM values and thump AM.

Issue 2: Is compliance with the planning permission demonstrated?

2 (a): For the purposes of the nuisance case, which party bears the onus of demonstrating compliance or non-compliance (as the case may be) with the noise condition set out in the planning permission?

In the nuisance action, the defendant bears the onus of proving the defence advanced; namely that the WTN complies with the noise condition in the Ballyduff permission when correctly interpreted.

2 (b): What is the correct interpretation of the noise condition in the permission?

There is an ambiguity in the planning permission. It is clear that at a windspeed of 5m/s, WTN may not exceed 40 dBA leq. It is also clear that at windspeeds in excess of 10m/s WTN may not exceed 45 dBA leq. However, the permission does not specify the applicable limit at windspeeds between 5 m/s and 10 m/s.

The correct interpretation of the planning permission is that noise levels from the turbine may not exceed 40 dBA leq at windspeeds between 5 m/s and 10m/s. The higher limit of 45 dBA leq only applies for windspeeds in excess of 10 m/s.

2 (c): What does the compliance data show?

The defendant seeks to demonstrate compliance with the Ballyduff noise condition by reference to noise monitoring conducted at HH, rather than at NF. However, compliance with the noise condition cannot be demonstrated by noise measurements taken at HH because NF is the measurement location designated in the permission.

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[9] Which provided that noise levels measured externally at any dwelling house should not exceed 40 dBA Leq as to which see para 184 below.

On the correct interpretation of the noise condition in the Ballyduff permission, compliance is not demonstrated by reference to the NF data because total operational noise- i.e., WTN and background noise - at night-time exceeds 40 dBA leq from windspeeds of 7m/s. Total operational noise also exceeds 45 dBA leq at windspeeds in excess of 9.5 m/s. Although the defendant argues that this is not attributable to WTN, but to other factors, it bears the onus of so demonstrating by refence to background noise studies. No such studies have been tendered to the court.

Even if one overlooked the fact that HH is the incorrect measurement location, there is a paucity of data at HH during night-time at windspeeds in excess of 8m/s such that the HH data could not reliably demonstrate planning compliance. Further, even if one were to overlook this frailty, total operational noise at HH exceeds the limit of 40 dBA leq set in the noise condition at windspeeds in excess of 6m/s. Therefore, in the absence of background noise studies, compliance cannot be demonstrated.

Issue 3: Is the character of the locality to be assessed on a "windfarm basis" or a "no windfarm basis"?

Nuisance is to be assessed by reference to the character of the relevant locality. There is permission for a windfarm at this location. Because of the planning permission, the plaintiffs cannot fairly contend that audible WTN (with some degree of AM) is in and of itself an unreasonable interference. On the other hand, the defendants cannot contend that because WTN is known to occasionally demonstrate certain particularly intrusive characteristics – for example high AM values or thump AM - these characteristics are necessarily part of the locality. WTN which entirely dominates the plaintiffs' sound environment could not have been reasonably anticipated by the grant of permission. Therefore, whilst a windfarm at this location is part of the locality, WTN with the characteristics identified above cannot be said to form part of the locality.

Issue 4: What criteria ought the court consider in the assessment of nuisance?

The methodology developed by the (United Kingdom) Department for Environment, Food and Rural Affairs for the assessment of statutory noise nuisance complaints pertaining to WTN, the *Windfarm Noise Statutory Complaint Methodology, 2011* ("the Defra Guidance") is of considerable assistance in establishing an assessment framework. The Defra Guidance identifies both quantitative and qualitative criteria

("the Defra criteria") to be weighed and assessed with care and professionalism in adjudicating upon statutory WTN nuisance complaints.

Issue 5: Does the court accept that the criticisms advanced by the defendant undermine the reliability of the plaintiffs' acoustic experts' evidence and the data on which same is based?

In general, no.

In so far as concerns the 2017 external NF data, the 2017 internal HH data and the 2021 internal NF and HH data, the court is satisfied that the audio recordings and associated time domain graphs presented by the plaintiffs' experts, MAS Environmental Ltd ("MAS"), reliably present the general noise character at the plaintiffs' homes.

The IOA RM published by the Institute of Acoustics for "rating" AM values is not the exclusive permissible method for presenting and analysing AM. In considering AM values and the general impact of AM on site, regard may therefore be had to the MAS audio recordings (and associated graphs) prepared on foot of the 2017 external NF data, the 2017 internal HH data and the 2021 internal NF and HH data.

MAS's calculation of AM values as derived from the time-domain graphs is sufficiently reliable to inform this court's analysis. The AM levels thereby derived will differ by a reasonably modest extent from those likely to be derived over the same time intervals under the IOA RM.

Furthermore, the impression of AM gained from the audio recordings and time domain graphs is confirmed by the IOA RM analysis performed by MAS of the internal 2021 HH and NF data. Although precise AM values cannot be calculated for the HH master bedroom specifically, one can approximate the relevant AM values by reference to the AM values presenting in another room in the same house.

Due to an inadvertent error, the external NF 2021 audio recordings were recorded at façade level rather than in the free field and furthermore a double skinned windshield was not used. I will therefore have no regard to these audio recordings, to the MAS time domain graphs pertaining to these audio recordings or to MAS's purported IOA RM analysis of this data.

Issue 6: Does an analysis under the Defra criteria support the argument that the characteristics of the WTN amount to a substantial interference with the plaintiffs' use and enjoyment of their land?

Yes, for the reasons which follow:

Sensitivity of the complainant

To quote Henchy J. in *Hanrahan v. Merck Sharp Dohme (Ireland) Ltd* [1988] ILRM 629 ("*Hanrahan*") the *"notions and standards of behaviour and responsibility* [of all four plaintiffs] *correspond with those generally pertaining among ordinary people in our society at the present time, who seldom allows his emotions to overbear his reason, whose habits are moderate and whose disposition is equable."* In short, the plaintiffs are "*ordinary persons with reasonable objective expectations*".

Level of the noise/ loudness

The noise levels presenting, when combined with other features, give rise to significant potential for dominance and unacceptable intrusiveness.

Type of noise

Even on the most conservative analysis, the MAS audio recordings and time domain graphs show that, at the time of measurement, the WTN at the plaintiffs' homes exhibits AM values in excess of 5 or 6dBA. I accept that this is a regular and sustained state of affairs. Regular and sustained peak to trough differentials of 5 or 6 dBA, if audible at a sufficient level will suggest an unreasonable impact. I find that clearly audible AM values of this order (and higher) are a substantial feature of the WTN at the plaintiffs' homes. Indeed, AM values of 10 dBA are regularly present both externally and internally.

Irrespective entirely of its high AM values, the WTN displays considerable intermittency/variability (when the AM disappears and returns again or fades in and out), impulsivity (sudden changes in sound level) and erraticism (i.e., when AM exhibits no clear periodicity or rhythm). These characteristics are particularly evident in light of the high AM values. The WTN also commonly presents as a clear whoomphing sound and exhibits distinct thump AM, both of which are highly variable

and unpredictable. This is WTN that an objectively reasonable person should not be expected to tolerate.

Aggravating features - Spectral content of the noise

Whilst lower frequency noise is not the dominant characteristic of this WTN, there is a significant element of audible lower frequency noise which manifests as thump AM.

Characteristics of the neighbourhood

The character of this quiet rural locality includes a permitted windfarm development. However, the characteristics of the neighbourhood do not include WTN which dominates the plaintiffs' sound environment or WTN which displays excessive AM values, thump AM and other particularly attention drawing characteristics.

The exceedance of WTN over background noise

Planning guidance for wind turbines commonly recommends a "relative noise limit" of 5 dBA over background noise for each windspeed bin. The plaintiffs have not proven on the balance of probabilities that the WTN exceeds background noise by in excess of 5 dBA at a range of windspeeds. On the other hand, as a result of the characteristics of its AM, the WTN regularly dominates the plaintiffs' sound environment.

The impact of the noise on basic needs such as sleep

The World Health Organisation Night Noise Guidelines, 2009 and its Environmental Noise Guidelines for the European Region, 2018 are not of particular assistance in deciding whether this WTN is such as to unreasonably impact upon sleep. I find that the WTN displays characteristics of high AM values and thump AM which have a very high potential to disturb sleep. I find as a fact that, particularly when turning at moderate to higher speeds of rotation, the turbine regularly disturbs the plaintiffs' sleep.

How easily the noise can be avoided/ Measures to reduce or modify the noise

The plaintiffs' ability to avoid the WTN externally is extremely limited. Internally, shutting the windows and attempting to mask the noise may assist. However, such measures will often be ineffective to mitigate sleep impacts in particular.

How often the noise occurs and the time of day or night when the noise occurs

I accept the evidence of the plaintiffs' experts and the plaintiffs themselves that the conditions so demonstrated occur commonly and on a sustained basis. I also accept that these unreasonably intrusive conditions are particularly prevalent during the most sensitive times of the day; in the early morning and at night and in the evenings.

Issue 7: What is the response of the defendant and its experts to the plaintiffs' case? Does the evidence of the defendant's experts suggest that the WTN is not a substantial interference with the plaintiffs' use and enjoyment of their land?

No. The defendant's experts have provided no persuasive evidence in response to the points discussed in the above analysis. The defendant's experts did not engage in any meaningful way with the characteristics of the WTN as demonstrated on the audio recordings, time domain graphs and spectrograms prepared by MAS which are identified as amounting to unreasonable interference with amenity.

Issue 8: Did the acoustics experts fail to discharge their duties to the court?

No. I do not find that either Mr. Stigwood (one of the plaintiffs' two acoustic experts) or Mr. Carr (one of the defendant's two acoustic experts) failed to discharge their duties as experts to the court. However, the testimony of both these witnesses, displayed less of a sense of balance than one would expect, which inevitably impacts to some degree upon the weight to be afforded to their evidence.

The defendant's second acoustic expert (Mr. O'Reilly) gave evidence only in relation to planning compliance and offered no evidence on the issue of nuisance.

In assessing whether nuisance is present therefore, I have therefore placed considerable weight upon the evidence of the plaintiff's other acoustic expert, Ms. Large, who I find to be a non-partisan and reliable witness.

Issue 9: Does the court accept the plaintiffs' evidence as to the characteristics of the noise and that such characteristics occur commonly and on a sustained basis?

Yes, for the reasons set out above.

Issue 10: Does the court find that the WTN is a substantial interference with the plaintiffs' use and enjoyment of their land? Is liability in nuisance established?

Yes, for the reasons set out above. Two particular features of the WTN render the noise an unreasonable interference. First, there are frequent and sustained periods of WTN with AM values widely acknowledged to be associated with high levels of annoyance. Second, the WTN exhibits thump AM which is a characteristic known to lead to adverse reaction in the community.

I accept that the noise impact demonstrated on the audio recordings (and associated graphs) occurs commonly and for sustained periods. WTN which exhibits these characteristics on a regular and sustained basis is unreasonable and exceptional.

I find that the plaintiffs' complaints are objectively justified in that the WTN interferes with the ordinary comfort and enjoyment of their homes. When it occurs, this interference is a substantial interference.

While the WTN is liable to annoy during the working day, higher prevailing background noise levels and the fact that the occupants are not trying to relax, or sleep means that, objectively speaking it does not in general substantially interfere with the plaintiffs' enjoyment of their property.

On the other hand, I find that the WTN poses a nuisance to the plaintiffs in the evenings and at weekends when one could reasonably expect to be enjoying recreation in the garden and/or peace in one's dwelling.

Demonstrably the WTN also poses a nuisance at night and in the early morning when a quiet environment is at a premium.

The plaintiffs are entitled to damages for unreasonable interference with the enjoyment of their property. The measure of such damages is for module 2. The issue of whether an injunction ought to be granted and if so the terms of such injunction is also for module 2. Likewise, the issue of whether the plaintiffs ought to be confined to damages in lieu of an injunction is for module 2.

I direct the parties, in advance of module 2, to engage in mediation to devise appropriate mitigation measures and if possible, to resolve all outstanding issues between them.

Issue 11: Does the court accept the defendant's submission that the evidence of Ms. McGinn means that nuisance is not made out in this case?

No. Whether or not interference by way of noise is, to quote Henchy J. in *Hanrahan, "beyond what an objectively reasonable person should have to put up with"* will depend

on the objective nature of the noise and not on the reaction of particular individuals to the noise. Ms. McGinn's reaction to the WTN whilst undoubtedly of relevance to the issues in the case, does not outweigh the other evidence to the effect that objectively speaking, the WTN is intolerable and unreasonable.

Issue 12: Are Mr. Rollo and Ms. Webster entitled to an award of damages for personal injuries in the form of pure psychological injury?

No.

I reject the defendant's submission that the claim to personal injuries must be struck out as being in breach of s. 12 of the Personal Injuries Assessment Board Act 2003. However, I take the view that reasonable foreseeability of pure psychological injury is a precondition to the award of damages for such an injury. In my view, the defendant could not reasonably have foreseen a risk of either personal injury or recognisable psychiatric illness as a consequence of the noise emitted by the turbines. Mr. Rollo may not therefore recover damages for pure psychological injury even though same was caused by the WTN and its consequences.

Issue 13: Is the defendant guilty of negligence?

No. The parameters of the contended for duty of care and the specifics of any breach of such duty have not been identified with sufficient particularity to establish liability in negligence. In my view, therefore, the plaintiffs cannot succeed in a claim for negligence.

Issue 14: Have the plaintiffs made out a case for relief under s. 160?

Although for reasons already explored, I am not satisfied that the defendant has demonstrated that the WTN complies with the noise condition in the planning permission, this issue was not part of the pleaded case. I am not satisfied that the plaintiffs have made out a case of breach of planning permission on any of the grounds pleaded. As such, the present application pursuant to s.160 must fail.

The legal test for the tort of nuisance

28. As observed by Laffoy J. in *Smyth v RPA*, the definitive statement of what is required to establish the tort of private nuisance is to be found in the judgment of the Supreme Court in *Hanrahan*. Henchy J. identified the legal basis of the tort in nuisance as follows:-

> *"To provide a basis for the award of damages for the private nuisance relied on, the plaintiffs have to show that they have been interfered with, over a substantial period of time, in the use and enjoyment of their farm, as a result of the way the defendants conducted their operations in the factory..."*

29. Later in the judgment Henchy J. confirmed that:

> *"The plaintiff is not entitled to insist that his personal nicety of taste or fastidiousness of requirements should be treated as inviolable. The case for damages in nuisance... is made out if the interference is so pronounced and prolonged or repeated that a person of normal or average sensibilities should not be expected to put up with it. It is not necessary that an interference by objectionable smell should be so odious or damaging that it affects the plaintiffs' health. It is enough if it can be said that a reasonable person in the plaintiffs' circumstances should not be expected to tolerate the smell without requiring the defendants to make financial amends."*

30. Thus, to succeed in a claim for nuisance, the plaintiff must show interference with the ordinary use, enjoyment and comfort of their property. As I will come to at para 346 below, nuisance is always assessed by reference to the character of the particular locality.

31. The interference with the ordinary use, enjoyment and comfort of the property must be substantial in the sense that it is pronounced and prolonged or repeated. The intrusion must be "*pervasive, persistent, frequent and intolerable*", per Charleton J. describing noise nuisance in *Lanigan & ors v. Barry & ors* [2008] IEHC 29.

32. In *Lanigan v. Barry,* Charleton J. observed that *"There must be a real and definitive infringement on the comfort and convenience of the persons occupying or using the premises or land in order to establish as actionable wrong"*. Furthermore, the temporal quality of the alleged problem is of relevance. Close attention must be paid to the timing, duration and impact of the occurrence complained of.

33. Likewise, the frequency of occurrence must be considered. Occasional, temporary or fleeting events cannot in general give rise to a nuisance However, depending upon the nature of the particular interference in issue, there may be no requirement that the nuisance is

continuous and unremitting 24 hours a day. Provided the impact occurs with sufficient regularity and frequency, nuisance may be established even though the relevant interference waxes and wanes somewhat. Further, the same level or character of noise that may not be a nuisance during the day can be a nuisance in the evenings if it regularly disturbs rest and relaxation, or at night if it regularly disturbs sleep.

34. In *Hanrahan,* Henchy J. stated:

> *"...In so far as the nuisance alleged consists of interference with the ordinary comfort and enjoyment of the property of the plaintiff, his evidence must show sensible personal discomfort, including injurious affection of the nerves or senses of such a nature as would materially diminish the comfort and enjoyment of, or cause annoyance to, a reasonable man accustomed to living in the same locality..."*

35. Central to the assessment of whether nuisance is made out in a particular case is therefore the notion of the reasonable person, of which Henchy J. stated:

> *"To my mind the reasonable man connotes a person whose notions and standards of behaviour and responsibility correspond with those generally pertaining among ordinary people in our society at the present time, who seldom allows his emotions to overbear his reason, whose habits are moderate and whose disposition is equable.*
>
> *It is clear from the authorities on the law of nuisance that what an occupier of land is entitled to as against his neighbour is the comfortable and healthy enjoyment of the land to the degree that would be expected by an ordinary person whose requirements are objectively reasonable in all the particular circumstances. It is difficult to state the law more precisely than that."*

36. Later in the judgment to similar effect:

> *"As I have pointed out earlier in this judgment, by reference to the cited passage from the judgment of Gannon J in* Halpin and Ors v Tara Mines Ltd, *where the conduct relied on as constituting a nuisance is said to be an interference with the plaintiffs' comfort in the enjoyment of his property, the test is whether the interference is beyond what an objectively reasonable person should have to put up with in the circumstances of the case.*

37. The court must try to discern what could reasonably be "*expected by an ordinary person whose requirements are objectively reasonable in all the particular circumstances*". The court is concerned with what could reasonably be expected by an ordinary member of society - the putative objectively reasonable person.

38. What amounts to a material or substantial interference is not judged by what the plaintiff (or indeed any other identified individual) subjectively find annoying or inconvenient. As stated by Laffoy J. in *Smyth v RPA* the "*nub of the matter is whether the evidence establishes that the plaintiffs' complaints... [are] objectively justified*"..;

39. Society is entitled to expect that its ordinary members will exhibit a reasonable degree of tolerance, that they will be guided by a "live and let live" ideology. The question is whether making allowances for that, objectively unreasonable interference is established. The primary focus must remain on the objective nature of the interference itself, rather than on the response of the plaintiff (or indeed the response of any other identified individual). The question is whether the *interference* is objectively unreasonable. The court must hold the balance and the assessment is one of degree, applying the common sense of ordinary people.

40. The onus of proof in establishing nuisance is clearly on the plaintiff throughout. Once, however, nuisance is established, *"it is no defence to such a claim, if established, that the activities complained of were carried out with the highest standards of care, skill and supervision and equipment"* (Henchy J. in *Hanrahan*). Unlike a plaintiff who pursues a claim for negligence, it is not necessary to show any breach of duty of care to succeed in a nuisance action.

41. This case concerns the production of renewable energy, which is clearly of vital importance to the society and to everyone who lives in it. Nevertheless, and correctly in my view, the defendant does not argue that this factor carries decisive weight in determining whether nuisance is established[10]. In *Hanrahan*, Henchy J. stated that it is no defence to a nuisance claim, if established, *"that such activities are of great public importance and cannot conveniently be carried out in any other way"*.

42. On the other hand, however, the public interest may be of relevance in the context of remedy. Although a plaintiff who establishes nuisance has a *prima facie* right to an injunction such that the defendant bears the legal burden of demonstrating that damages rather than an injunction is an appropriate remedy, the public interest must inevitably be a factor in the court's

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[10] Note that I deal separately below with the legal relationship between a grant of permission and the entitlement to sue for nuisance arising from conduct that is said to be consistent with that permission.

assessment of an appropriate remedy. At the very least it means that a generalised injunction ought not to be granted where a tailored injunction more suitable to the particular interference held to constitute nuisance is warranted.

43. This case comes before the court at a time when existing planning guidance regulating, *inter alia*, the noise aspects of wind farm developments in Ireland, the Wind Energy Development Guidelines, 2006 ("WEDG 2006") is presently under review. Whilst draft revised *Wind Energy Development Guidelines* were published in 2019, ("draft WEDG 2019"), these have now been withdrawn. In the absence of clear policy guidance from the government on WTN, the assessment in an individual case is a classic matter of degree on which the court must exercise judgment. As Henchy J. states "*it. is difficult to state the law more precisely than that*".

44. In terms of damages, it appears that the approach of the Irish courts might differ from the courts of England and Wales in awarding damages for personal injuries to a plaintiff who succeeds in nuisance claim. In this case, choosing between these differing approaches would not be decisive. This is because, in my view, lack of foreseeability would in any event, prevent recovery for the particular personal injuries claimed here - pure psychological injury.

45. Finally, before closing out this brief review of the legal test for nuisance, it is convenient to deal with defendant's submission that the claim of the Carty Shortens for private nuisance should fail, *in limine,* because they no longer own, or occupy NF.

46. The defendant correctly submits that it is an essential element of the tort of nuisance that the plaintiff has a right to occupy the land affected and, further, that the plaintiffs have produced no authority for the proposition that a former owner of an interest in land has standing to maintain a claim for damages for historic nuisance even after the land in question has been sold to a third-party

47. The point, however, is that at the time of the institution of these proceedings in 2018, the Carty Shortens were the owners of NF. In my view, they do not lose *locus standi* as a result of having sold the property during the currency of the proceedings. Rather, they retain an entitlement to advance a claim to damages in nuisance for any unreasonable interference with amenity occasioned during the period of their ownership and potentially for diminution in the

sale price. Further argument on heads of damage, and quantum of damages, etc. is a matter for module 2.

Factual evidence

Evidence of Ms. Margaret Webster

General impact of turbines

48. HH and NF are situated in a quiet rural valley close to the Sliabh Bhuí mountains in County Wexford. It was put to Ms. Webster that there were other windfarms in the area, the closest of which is "*some two or three kilometres*" away. Ms. Webster's evidence is that, absent the Ballyduff turbines, ambient noise is generally characterised by the sounds of nature. The rear elevations of both HH and NF are sheltered from the prevailing south westerly winds by a high hill on which the turbines are placed.

49. Although the Ballyduff windfarm comprises two turbines, it is the closer turbine, T2 which is the source of complaint. When T2 is shut down for maintenance, one can still hear T1 turning; but it is not intrusive.

50. When they noticed the turbines being erected Ms. Webster and Mr. Rollo were initially optimistic. They assumed that because of their location in a sheltered valley some distance beneath the turbines, HH would be shielded from impact. However, their view is that the opposite is the case; because HH is so sheltered, the wind rarely approaches the house from a direction that would mask the sound of the turbine. Combined with the prevailing low level of other background noise, this substantially increases the impact of the turbines.

51. Ms. Webster's evidence is that the WTN is annoying and ever changing. The noise varies with wind direction and windspeed which dictate blade orientation and speed of rotation respectively. Windspeed is of more obvious influence than wind direction; in general, the faster the rotors turn, the worse the noise. In addition, time of day and weather impact on the intensity of the WTN. The noise is considerably louder at night and in winter. It also varies according to whether there is rain, cloud cover or clear skies. Taking into account atmospheric conditions, the effect of the WTN is more often than not *"very intense"*. Ms. Webster recounts that when the noise and vibrations from the turbine are intense, she experiences a feeling of anxiety and overall unease that she cannot shake off.

52. Ms. Webster's evidence was that, when turning quickly, T2 emits a range of distinctive sounds. In addition to a swishing sound, it emits *whoomph* and *whump* sounds and intermittent louder *thumping* or *whacking* noises. These sounds are often accompanied by disturbing vibration, meaning that she could regularly *"feel"* as well as hear the noise. This is perceived as pressure coming from the air as the blades rotate, which feels like *"a pummelling inside* [her] *body"*. All of this, Ms. Webster states, is a frequent characteristic of the WTN, particularly at night.

53. The noise is highly variable and unpredictable in loudness, intensity and character. It can change from a *thump thump* or a *whump whump* to a kind of *whack whack* noise within minutes or even seconds. The noise can dissipate overnight and then pick up in the morning or the opposite can happen.

54. In cross-examination, Ms. Webster fully accepted that there are periods, perhaps for several days at a time, when the noise is not intrusive. When turning slowly, T2 makes a light whooshing sound which is quite consistent. At times, particularly during the summer, this sound might be barely audible inside the house. However, she stated that, for the most part, particularly in the wintertime, the noise is more rather than less intrusive. As a very broad guess, Ms. Webster estimated that the noise is intrusive 80% of the time.

55. The turbine is audible both outside and inside the house at all times of the day including at night with the windows closed. It is audible in all rooms of the house even in the sitting room which was the furthest room away from the turbine. When the turbine is rotating quickly, the WTN is not merely audible but dominant both inside and outside the house, with the windows open and closed. The sounds of daily activities such as boiling a kettle, using the washing machine or watching television generally mask the WTN. However, without such masking noise, one can hear the WTN in all areas of the house, The WTN frequently intrudes to the extent that Ms. Webster finds it difficult to concentrate or relax. At its worst, and particularly at night, Ms. Webster described a sensation of being able to hear and feel every rotation of the turbine. Ms. Webster accepted that other sounds - such as passing cars or farm machinery- might also occasionally be heard in her bedroom with the window closed. However, such noise ceases at a certain point in the day. By contrast, when it is turning rapidly, the noise and vibrations of the turbine intrude into Ms. Webster's bedroom, even when the window is closed, on a "*24/7*" basis.

56. The HH master bedroom is at the front of the house, but its gable wall faces broadly (if obliquely) towards T2. It was put to Ms. Webster that the defendant's experts would say that it was "*beyond the realm of physics*" that the WTN could be heard in the master bedroom at the front of HH, but the defendant's experts did not give such evidence. Although Mr. Carr did not hear WTN in the master bedroom of HH at the time of his site visit, he only spent between five and ten minutes in the bedroom on this occasion.

57. Ms. Webster's evidence was that the WTN and vibrations pass through the gable wall into the master bedroom. She stated that, in her experience, the WTN was much louder, more annoying and more easily audible than it appeared on the internal audio recordings taken by her experts in HH in 2017 and 2020/2021.

58. Prior to the erection of the turbine, Ms. Webster had slept well. Her evidence is that the WTN causes three different kinds of sleep disturbance. The first is difficulty in falling asleep. Ms. Webster states that there have been countless nights when she can hear the WTN in her bedroom and needs to use music or other background sound to distract attention from this unpleasant sound and aid sleep. This occurs at least ten times a month. Second, when the WTN is at its worst, it can completely wake her up "*bolt upright*". What wakens her is not so much the absolute level of the noise but a change in its character which has a jarring effect, particularly if she is in a light sleep. These sudden awakenings occur ten to fifteen times a year. Third, even when the WTN is lower, there is a general detrimental impact on sleep quality; although she would sleep through the night, Ms. Webster nonetheless wakes exhausted. To mitigate the noise from the turbines, Ms. Webster tried to sleep with the windows closed as often as possible, which particularly, in the summer months can be quite uncomfortable.

59. Ms. Webster also described shadow flicker, which occurs in early spring and late summer, as follows; "*the light on a sunny day would change from the kind of dappling light that occurs when sunlight comes through trees to a full shadow falling suddenly followed by an instant return of light.*" This would herald alternate periods of darkening and lightening occurring with great rapidity. Shadow flicker occurs in the valley in front of HH, in their garden and on the walls or floors of rooms in their house. It is very difficult to escape the flicker which is visible even with the curtains drawn. Although shadow flicker would only be inside the house a couple of weeks a year, it is present in the valley and garden for longer periods which is still disconcerting.

Interactions with Mr. Brazil

60. In July 2017, the Webster Rollos alerted the director of the defendant company, Mr. Brazil to their experience of the noise. Initially, Mr. Brazil suggested improving their windows and insulation towards which he would contribute €4,000. The Webster Rollos felt that insulation was a large financial undertaking which would not in any event be effective as against low frequency WTN.

61. On 14th August, 2017, Mr. Brazil and Mr. Conor Brennan attended HH for a meeting with the Webster Rollos and the Carty Shortens. As an alternative to contributing towards the cost of insulation, Mr. Brazil suggested that the plaintiffs sign a "*noise acceptance agreement*" pursuant to which they would receive an annual inflation linked payment of €4,000 per annum for the duration of the planning permission for the turbine. This agreement would be noted on the title deeds of HH (and NF) and would bind all purchasers thereof. A further requirement of the agreement was that Mr. Brazil would have a right of first refusal if their property was ever put on the market.

62. The plaintiffs asked Mr. Brazil if the turbines could be turned off or turned down at night or at weekends. This request was not acceded to.

63. Mr. Brazil also informed the plaintiffs that it would be possible to install a computer programme to turn off the turbines when there was a risk of shadow flicker. However, this proposal was not actioned by the defendant.

64. A few days after the August 2017 meeting, Mr. Rollo telephoned Mr. Brazil to reject the proposal of a noise acceptance agreement, and an initiating letter followed from the plaintiffs' solicitor. It was suggested to Ms. Webster in cross examination that this rejection had been premature as the proposal of €4,000 per annum was "*just opening negotiations*" which could have continued were it not for their solicitor's correspondence. Ms. Webster's response was that they wanted to enjoy living in their house and did not want to be paid to endure the noise.

Impact on the Webster Rollo relationship

65. Ms. Webster's evidence was that after a few years of living with the turbine, her 16 year relationship with Mr. Rollo started to disintegrate. In Ms. Webster's view the pervasive

noise and ongoing lack of sleep caused by the WTN was a significant factor in the destruction of the relationship. Her belief is that the WTN brought the couple to the stage where they were both so exhausted, discouraged and low that they could no longer fight for the relationship. Ms Webster was worried for Mr. Rollo's safety and well-being, and she suffered episodes of panic and tearfulness.

66. By December 2020, it was obvious that Mr. Rollo needed to remove himself from the situation and wait out the legal process. In early 2021, the couple having made the decision to separate in any event, Mr. Rollo moved out of HH. This was clearly a very low point for both Ms. Webster and Mr. Rollo.

Noise diaries

67. Ms. Webster (and for the majority of this time, Mr. Rollo) kept a noise diary from August 2018 to October 2021. This diary chronicles their experience of the WTN, both day and night.

68. The Webster Rollo noise diary records intrusive, unpredictable WTN varying in intensity. In harmony with their oral evidence, the diary describes, whoomphing, thumping, banging, hacking, slapping and whacking sounds. It regularly records that the house vibrates and hums with these sounds which appear to hit the gable wall of the master bedroom and come through the walls and ceilings. The diary very regularly records the couple's inability to have a restful night's sleep and the exhaustion which follows.

69. An intermittent but consistent feature of the diary is that it records the Webster Rollo's relief and gratitude when the turbines are quiescent marred by trepidation of the inevitable recommencement of the noise. The strong impression is of being unable to control one's own private environment which is dominated by the turbine. Ms. Webster encapsulated this in stating that she and Mr. Rollo felt "*at the mercy of whatever way the turbine was going to be acting on a particular day to ensure that it produced a maximum output of energy.*"

70. Ms. Webster was cross-examined at length about entries in the couples' diary. Counsel for the defendant noted that she occasionally records "*I can hear the turbine*" (or words to similar effect) and suggested that she was therefore intolerant of any level of audible WTN,

particularly at night. Having reviewed all of the diary entries, it is abundantly clear that Ms. Webster and Mr. Rollo do not equate mere audibility with nuisance. The evidence is that, when turning slowly, the light noise produced by the turbine is not a cause of nuisance even if it can be heard internally. What primarily disturbs Ms. Webster's relaxation and sleep is when the turbine is turning "full tilt". At such times, there is no respite anywhere in the house irrespective of whether the windows are open or closed. Ms. Webster stated: *"I can tell you with honesty and with certainty it wakes me from my sleep"*. It was also suggested to Ms. Webster that her diaries were overly dramatic. She accepted that some of her entries focussed on her poor experience but that there were also other more routine entries. This is correct.

71. The primary theme of this cross-examination was by way of a compare and contrast exercise as between (a) particular diary entries, (b) a ten minute extract from the SCADA[11] data recorded at T2 pertaining to the same 24 hour period as the diary entry and (c) the SCADA data at the time of the court's site visit. Counsel noted that Ms. Webster - and indeed all of the plaintiffs - had confirmed that at the time of the court visit, the WTN was not intrusive either externally or internally. It was suggested to Ms. Webster that this compare and contrast exercise showed that, even when the SCADA data revealed identical conditions to those then pertaining at the time of the court's visit, the diaries still record high levels of nuisance[12].

72. However, any such exercise will be heavily influenced by the precise segment of SCADA data chosen as a comparator with the relevant diary entry. Given that the plaintiffs' unanimous experience is that the WTN can change in character within a matter of minutes, there is little weight to be attached to a disconnect between an isolated 10-minute segment of SCADA data and the correlating diary entry which seeks to summarise the main features of the WTN over the preceding 24 hour period. It is also important to bear in mind that, often several diary entries might even be completed together in a "clump" after a few days.

73. By way of example, Mr. Rollo's diary entry for 19th August, 2018 reads –"*Awakened by turbine again! Left for work at 5.30 extremely noisy. Turbine quiet late afternoon.*" Counsel for the defendant cross examined Ms. Webster (and not Mr. Rollo who authored the diary entry

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[11] The SCADA data records windspeed, speed of rotation, blade orientation and power output at ten minute intervals.

[12] I have been informed that the 10 m standardised windspeeds at the time of my visit varied between a minimum windspeed of 3m/s and a maximum windspeed of 6.2 m/s with 10 minutes averaging between 4.1 and 4.8 m/s over the time of the visit.

in question) by reference only to 10 minutes of SCADA data ending at 5.30 am. This SCADA data shows that windspeed, speed of rotation and wind direction were similar to those pertaining at the time of the court's visit. However, when plaintiffs' counsel re-examined Ms. Webster by reference to the full 24 hour SCADA data it became clear that earlier in the night, both windspeed and speed of rotation were significantly higher (particularly between midnight and 3 am approximately). It was also evident that, as noted by Mr. Rollo, both windspeed and speed of rotation dropped in the late afternoon.

74. The same limitation applies to the cross examination conducted by reference to Mr. Rollo's, dairy entry of 8th September, 2018 which records :"*Kept awake by turbine all night. Noise the same all day.*" The SCADA data for 4 am - on which Ms. Webster was cross examined - shows windspeed and speed of rotation only modestly above levels recorded at the time of the court visit. However, the complete SCADA data for the day in question reveals higher windspeeds and speeds of rotation for the night hours both before and after this particular time. It also records higher windspeeds and speeds of rotation throughout the bulk of the day (particularly from 2.30pm).

75. Ms. Webster also emphasised that in addition to windspeed and speed of rotation , wind direction and weather conditions have a huge impact on how noise and vibration would be experienced. The latter two of these factors are not captured by the SCADA data. She further emphasised that one should not interpret a particular diary entry in isolation. Rather, entries have to be placed in the context of the days that surround them. Several days of lack of sleep tend to wear one down, reduce tolerance and increase frustration levels which might naturally influence diary entries later in the relevant sequence.

76. This in my view is the case for Ms. Webster's diary entry of 3rd December, 2021 which records: "Turbine very loud all day and night. Turing very fast and "aggressive" almost when outside feels like I'm being pummelled by force from turbine if I stand in back yard near driveway". Counsel pressed Ms. Webster on a 10 minute segment of SCADA data captured at 2pm on 3rd December. Such an exercise entirely glosses over the fact that the preceding night's SCADA data - again only put to Ms. Webster in re-examination - shows that windspeed and speed of rotation were indeed high. This dovetails with Ms. Webster's diary entry for 2nd December which records "very loud" noise that night. A different picture however emerges during the day of 3rd December. Although I accept that Ms. Webster's experience of being

"pummelled" occurred when she went outside late in the evening (at which stage the wind had picked up), it is fair to say that the SCADA data suggests that during much of the day windspeed and speed of rotation were not high when compared to conditions at the time of the court's visit (indeed they are generally lower). The point, however, is that this entry followed what could fairly be described as a bad week. Ms. Webster describes the WTN during the preceding week as "very noisy", as making "whooshing and clapping" sounds at night and "very distracting". As stated, it is also recorded as "very loud" overnight on 2nd/3rd December. Ms. Webster was not challenged on any of these entries, whether by reference to the SCADA data or otherwise. Ms. Webster also records an earache for the whole of the preceding week which of course will accentuate the impact of WTN (and, I assume of all noise). In reality, the entry for 3rd December, 2021 is probably more consistent with Ms. Webster's experience of the week as a whole than with the specific day it records. The entry also supports the impression of Prof. Kevin Gournay, Chartered Psychologist - who gave evidence on behalf of the plaintiffs
- that Ms. Webster's level of tolerance of the WTN is decreasing over time. Overall, I find that the entry for 3rd December, 2021 represents a rare and uncharacteristic occasion on which Ms. Webster allowed her more generalised frustration – most likely accentuated by physical discomfort resulting from persistent earaches - to bleed into a specific diary entry. Whilst I accept Prof. Gournay's view that such increasing sensitivity is not unusual, I have nonetheless been cognisant of it.

77. In my view, the themes pursued in this part of the cross examination ought to have been put to the plaintiffs' experts-which did not occur. This is because, whilst it is clear that windspeed and speed of rotation heavily influence the level and characteristics of WTN, a range of other factors are also highly relevant. Such factors include relatively small changes in wind direction and blade pitch and, as Ms. Webster states, prevailing meteorological conditions. These factor all influence thump AM, which is described as the most intrusive aspect of the WTN at Ballyduff. Demonstrably, Ms. Webster, as a lay witness, is unqualified to explain such matters. Rather, she stated that the diary is intended to be experiential and deferred to experts to explain what factors might influence or explain the characteristics of the WTN which she records in her diary entries.

78. Overall, I find that Ms. Webster's diary entries, like her oral evidence, presented a balanced and truthful account of her experience of the WTN. I make a similar finding in relation

Mr Rollo's diary entries up until mid to late 2020[13]. From over three years of diary entries, the defendant pointed to only a handful of diary entries which it contends are inconsistent with the SCADA data. Of these, I find that only one – that of 3rd December, 2021 – can fairly be characterised as inconsistent with the SCADA data for the day on question. Further, this inconsistency pertains to only part of the relevant 24 hour SCADA data and further arises only if one considers the diary entry in isolation from the week of which it forms part. As Ms. Webster states: "*We are people living in our home; it is not a scientific experiment, it's our home and we are experiencing this on a continuous basis*". Bearing in mind the quality of other evidence supporting Ms. Webster's account of the overall characteristics of the WTN, I attach very little weight to a frailty in a single diary entry.

Evidence of Mr. Keith Rollo

79. Mr. Rollo has worked as a rigger for many years and is accustomed to heavy machinery and loud noise. The WTN is highly variable and unpredictable. He described it as horrendous during the winter months when its accompanying vibration penetrates the fabric of the building throughout the house. Mr. Rollo shared Ms. Webster's view that the internal audio recordings taken in HH under-represent the general impact of the WTN in the house. This is partly because, as Mr. Stigwood explains, human hearing is directional (in the sense that one is more conscious of a sound from a specific source) and also because the audio recordings could not convey the sense of vibration and pressure that is felt in the house.

80. The impact of the noise affected Mr. Rollo most profoundly through his sleep. At night, the turbine frequently makes a thumping, whacking and slapping noise; like the side of the house was being hit by something. When it was suggested to him that shutting the windows would diminish the sound, Mr. Rollo accepted that the turbine is less noisy with the windows closed. However, although on windy winter nights he would sleep with the windows closed, Mr. Rollo's general preference is to sleep with the windows slightly open. In any event, Mr. Rollo stated that, even with the windows closed, and despite wearing professional noise cancelling headphones, the noise and vibrations caused by the turbine still disturbed his sleep. Like Ms. Webster, Mr. Rollo's sense is that the noise and vibrations come though the walls of the house. At times, the whole house vibrates with the noise. As a result, all attempts to mask the WTN using both professional noise cancelling headphones and industrial earplugs (which

[13] See para 461for an analysis of Mr. Rollo's reaction to the turbine from mid to late 2020.

he had obtained from work) were unsuccessful because, he could still feel the noise "*through my bones*".

81. When unable to sleep, Mr. Rollo moved to the sitting room because it was at the front of the house and did not have a gable wall facing the turbine. Although the noise intruded, as it did in every room of the house, he would try to sleep with the television on to mask it. However, Mr. Rollo's sleep pattern remained extremely disrupted, and on many nights, he would get no more than two hours sleep. This meant that he frequently rose feeling exhausted and stressed. This exhaustion was hazardous as Mr. Rollo's job involves working at heights.

82. Mr. Rollo's evidence was that the constant noise and lack of sleep "*broke* [him] *down*". He developed mental health problems and ultimately contemplated suicide. In late 2020, Mr. Rollo's solicitor became concerned and referred him to Prof. Gournay who recommended that he see his General Practitioner, Dr. Ford. Dr. Ford in turn referred Mr. Rollo into a self-harm counselling programme where he attended ten or twelve sessions. After the conclusion of this programme, Mr. Rollo's employer arranged further counselling which concluded very recently.

83. In early 2021, Mr. Rollo accepted that because of the dark thoughts he was having, he had to leave the house urgently. He moved out in March 2021, initially staying with family friends. Mr. Rollo's current residence is about half an hour from HH in an estate in Wexford town.

84. On leaving the house, Mr. Rollo's sleep pattern initially improved but then disimproved again. He is still suffering from depression and continues to take anti-depressant medication.

Evidence of Ms. Joan Carty and Mr. Ross Shorten

85. Ms. Carty and Mr. Shorten owned NF until comparatively recently and sold it to Ms. Maura McGinn in August 2021 (as to which see further below). Ms. Carty described the range of sounds emanating from the turbine, the most difficult and intrusive of which is a loud whomping or thumping sound with associated reverberation and vibration. This loud whomping and thumping noise is very hard to listen to for any period of time and is audible from every room in the house. Mr. Shorten's evidence was to a similar effect; he recounted that the noise, the vibration and the sense of pressure in the air are overpowering and upsetting.

86. The couple's evidence was that as a result of the WTN, and its associated vibrations, it was impossible to sleep in the master bedroom, even with the window closed. The noise intrusion forced them to vacate the master bedroom which is a dormer and move to a somewhat quieter bedroom downstairs. However, the WTN still disturbed their sleep.

87. Because of the WTN, Ms. Carty and Mr. Shorten no longer enjoyed visiting NF. They found the WTN to be extremely intrusive during a 5 day period they spent working on the patio outside their house in August 2017. Even with a music speaker outside to try and mask the WTN (albeit at a volume at which they could still converse), they were disturbed by the whomp whomp sound as the blades cut through the air. Ms. Carty said that after the turbine started turning, she never again sat on the patio to read. In addition, they stopped having guests to the house because they were embarrassed about the noise and intrusion from the turbine.

88. When the couple raised these difficulties with Mr. Brazil, he indicated that he might, in due course, be prepared to buy NF as he had known that it had was previously on the market. He also arranged for monitoring equipment to be installed at NF on the understanding that the results would be furnished to the Carty Shortens. Although Mr. Shorten requested this data both verbally and in writing, it was never furnished.

89. The couple's evidence was that the house was placed on the market in September 2018 and was ultimately sold at a price significantly below its full value, to Ms. McGinn.

90. Two additional witnesses as to fact were called by the plaintiffs.

Evidence of Ms. Maura McGinn

91. The plaintiffs called Ms. Maura McGinn, the current occupant of NF. She purchased NF from the Carty Shortens on 12th April, 2021. Ms. McGinn stated that the WTN was pretty obvious when she viewed the house. She knew that she could not have afforded to buy the house were it not for the presence of the turbines.

92. On her first night in the house, Ms. McGinn was shocked by the WTN which was exceedingly loud and kept her awake. Ms. McGinn was concerned that she made a mistake in

purchasing the house and worried that she would be unable to sleep in the master bedroom upstairs. However, Ms. McGinn "persevered" and continues to sleep upstairs.

93. Ms. McGinn does not generally spend the whole week in the house as she works in Dublin a few days a week. When she is going to bed at night, the rhythmic nature of the noise can *"get in on"* her and it can be hard to fall asleep. Alternatively, she might wake to the WTN and then find it more difficult to get back to sleep. As she points out, when you hear the turbine, it is very difficult to un-hear it. Overall, although the turbine can interrupt her sleep, Ms. McGinn stated she was a good sleeper.

94. The turbine generally makes noise all the time, apart from on very still days. The noise outside is louder and stronger. Inside the noise is much quieter downstairs, but it can definitely be heard upstairs. Ms. McGinn describes the noise as a "*whoomph, whoomph, whoomph kind of noise*".

95. In general, Ms. McGinn is careful not to focus on the noise and tries not to let it bother her. She would be afraid that if she did focus on the WTN for too long, it would start to get in on her.

96. Ms. McGinn is from a large family and lots of people come to visit. She finds herself being quite defensive of the turbine and therefore warns her family about the turbine before they visit. Whenever workmen come to the property, they refer to the turbine and to the noise. Her surveyor recommended that she put in additional insulation for the house. Although she followed this advice, this made no real difference in the noise levels.

97. Under cross-examination, Ms. McGinn confirmed that she did not regret buying the property. Her first night in the property had been a particularly noisy night and her general approach is to try not to pay too much attention to the turbine. She has managed to get used to the noise or has learnt to ignore it such that she conceded[14] that *"it doesn't seem... to be creating a terribly great problem for[her]in [her]enjoyment of the property"*.

[14] In answer to a question posed by counsel for the defendant.

Evidence of Ms. Ashley Doran

98. Ms. Ashley Doran lives at Ballyduff. Ms. Doran's house is located 313 metres from the Webster Rollo's house. There is a distance of 601 metres between T2 and Ms. Doran's house and a distance of 808 metres between T1 and Ms. Doran's house.

99. Ms. Doran stated that the turbines make a deep, heavy reverberating noise which she describes as groaning and whomping sounds. Reverberations are experienced both inside and outside the house. The WTN is disturbing and disorientating making it hard to focus or concentrate. On occasion the intensity of the sound and vibration makes her dizzy and queasy. At times, the sound of the turbines hurts her ears. It is difficult to cope with the inconsistency of the WTN which varies from *"quiet"* to *"thunderous"* depending on the meteorological conditions. The WTN disturbs her sleep and Ms. Doran has started sleeping in the room furthest from the turbine. Both she and her husband sleep with earphones which they use to mask the sound of the turbines. Overall, although Ms. Doran's husband, finds the turbine "*a bit annoying*" he manages to put it out of his head and get on with things.

Evidence of Mr. John Brazil

100. Mr. Brazil, who is an experienced developer of on-shore windfarms, and director of the defendant company gave evidence to the following effect. WTN will always be greatest directly downwind. In his view, the higher noise levels on the MAS NF crosswind planning compliance graph[15] was not reflective of WTN but of extraneous noise. Mr. Brazil's view is that the Ballyduff WTN is not abnormal or out of the ordinary as regards either to its noise levels or its AM. In his experience, the AM was of normal "blade swish" variety. However, he accepted that he had only been on the plaintiffs' properties for very limited periods of time. Mr. Brazil accepted that from time to time, there would inevitably be audible windfarm noise internally at both HH and NF. He maintained however that there would be no real audible noise in the HH master bedroom or that it would be "*very very low*".

101. Mr. Brazil confirmed that although the audio recordings taken by the plaintiffs' experts accurately recorded the sound where the microphones were placed, these were only "snapshots" and would not necessarily be typical of the normal day to day experience of the

[15] As to which see para 115 above and para 335 -340 below.

windfarm. This assertion was not taken up by the defendant's experts who did not suggest that the audio recordings were unrepresentative of general WTN at the measurement locations.

102. Mr. Brazil accepted that he had not asked his experts to assess the character of the WTN. He had not requested them to either listen to or asses its AM or other characteristics. Rather, he had relied entirely upon the fact that the planning compliance graphs prepared by his experts showed that external noise measurements were compliant with the planning permission and with WEDG 2006. Mr. Brazil also confirmed that if WEDG 2006 had applied at the time of the Ballyduff planning application, planning permission would not have been granted for turbines within 500 metres of an existing house without consent of the householders.

103. Mr. Brazil also indicated that the average capacity factor for the windfarm would be in the mid-30s per cents. This means that most of the time, the wind is insufficient for the turbine to operate at full capacity. Even on a very windy week one would anticipate only a 50% capacity factor.

Site visit

104. As agreed, the court carried out a site visit on 1st December 2022.

105. The plaintiffs' residences are in the lee of a high hill on which the turbines are situate. T2 is clearly visible on a height behind the houses. The dwellings are off a minor road in a quiet and tranquil rural area, which is sparsely populated. The ambient sounds of the locality are those generated in the natural environment such as wind noise, foliage stirring and birdcalls. One could also expect the usual array of domestic sounds from human activities and the sounds of the Webster Rollo's dogs. In addition, although not apparent on the day of the court visit, I gather one encounters the sounds of farm machinery and local traffic. There are no other businesses in the area.

106. At the time of the court's site visit, it was a dry, mild day. One could discern that HH and NF are in a sheltered location almost scooped into the hill. The air was very still close to the plaintiffs' houses. Having said that, bearing in mind the clement day, the wind was generally quite calm even some short distance away from the plaintiffs' houses. Indeed, at the

time of my visit, average 10 minute 10 m standardised windspeeds for T2 varied between only 4.1 m/s and 4.8 m/s and T2 was rotating only slowly.

107. The WTN was audible outside and inside both houses including in the master bedroom at NF and in the master bedroom at HH with the windows open (but not with the windows closed). When asked, all four plaintiffs expressed the view that although it was audible both inside and outside their houses, they would not consider the WTN presenting at the time of the court's visit to be intrusive. I am in agreement with this assessment.

Brief Overview of Expert Evidence

Acoustics experts called by parties

108. The plaintiffs called two acoustics experts. Mr. Mike Stigwood, a qualified environmental health officer, is an Environmental Health Consultant and Acoustician and Director of MAS. At the time of reporting, Ms. Large was a Senior Acoustic Consultant at MAS.

109. The defendant also called two acoustic experts. Mr. Shane Carr, a qualified environmental health officer with a post graduate diploma in acoustics and is a Director of Irwin Carr Consulting. Mr. Brendan O'Reilly is an Acoustic Engineer and Director of Noise and Vibration Consultants Ltd.

110. Although I will now briefly summarise the evidence of the acousticians, I will in due course consider same in more detail as I proceed through my analysis of key issues in the case. This will unavoidably involve some repetition, which I will attempt to keep to a minimum.

111. Later in this judgment, I will also consider the arguments advanced by each party that the opposing acoustics experts failed in their duty to the court.

Noise data presented by plaintiffs' experts

112. Ms. Large carried out two noise surveys at the plaintiffs' houses between 10th November, 2017 and 15th December, 2017. Monitoring equipment was set up which recorded long term high quality - 100 milli-second audio - internally at HH (on foot of which the "2017

HH internal data"[16] was derived) and externally in the garden / patio area at the rear of NF, (on foot of which "the 2017 NF external data" was derived). The internal HH audio recordings were recorded by a microphone placed in a home office/bedroom on the ground floor at the back of HH. Audio was recorded with the window both open and closed. The external NF audio recordings were recorded with a microphone placed approximately 3.5m away from the house façade-which is an appropriate free field location. Where relevant, I refer to this collectively as "the MAS 2017 data".

113. The second noise survey was carried out in December 2020 and January 2021. Due to Covid restrictions, neither Ms. Large nor Mr. Stigwood could travel to Ireland and the monitoring equipment was sent to Ireland and set up under their instruction by the plaintiffs' solicitor. Audio recordings were recorded internally at HH between 4th December, 2020 and 19th February, 2021 (on foot of which the "2021 HH internal data" was derived) and internally at NF between 22nd February, 2021 and 10th March, 2021 (on foot of which "the 2021 NF internal data" was derived). Finally, there was also an external survey at NF between 10th March, 2021 and 21st May, 2021 (on foot of which "the 2021 NF external data" was derived). The internal HH audio recordings were recorded with a microphone placed in the same home office/bedroom as in 2017. The internal NF audio recordings were recorded with a microphone placed in the master bedroom of NF, which is a dormer at roof level. Once again, the windows were sometimes open and sometimes closed. The external NF audio recordings were recorded with a microphone which, inadvertently, was placed closer to the exterior façade than would be appropriate for free field measurements[17]. It also appears that, again inadvertently, the microphone was not protected with a double skinned windshield. Where relevant, I refer to this collectively as "the MAS 2021 data".

114. The evidence tendered on behalf of plaintiffs as describing or representing the WTN noise at HH and NF was therefore advanced in a number of ways, as follows:

i. The factual evidence of the plaintiffs, Ms. Doran and Ms. McGinn as to their experience of the noise on site

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[16] In each case, such data consists of audio recordings, time domain graphs of the said audio recordings and spectrograms showing the correlation between the noise and spectral frequency. Where applicable I refer to these graphs collectively together as "the associated graphs"

[17] It appears that this only came to light shortly before the trial.

ii. extracts from Webster Rollo diaries,

iii. factual and opinion evidence from Ms. Large and Mr. Stigwood as to their personal experience of the noise on site during their site visits in 2017 and 2021.

iv. (as just described at para 112 and 113 above) long term high quality 100 millisecond audio of the sound taken within the dwellings and in the patio of NF. Approximately 25 of these audio recordings were played to the court ranging in duration form 30 seconds to 10 minutes [18]Certain internal audio recordings were played to the court in a sound studio. These audio recordings were tendered to demonstrate the features of the WTN such as its dominance, the presence of both swish and thump AM and the erraticism of the AM;

v. 100 millisecond time-domain graphs (i.e., temporal graphs plotting the noise levels against time) presenting the audio recordings at iv above. The MAS reports included approximately 100 of these graphs[19] ranging in duration from 25 seconds to 25 minutes. These graphs were tendered to demonstrate the features of the WTN such as its AM values[20] and the presence of thump AM;

vi. graphs plotting the WTN by frequency spectra (spectrograms) together with graphs comparing the noise on site to permitted levels of low frequency noise. These graphs were tendered to demonstrate the presence and significance of thump AM;

vii. opinion evidence from Ms. Large and Mr. Stigwood and, to a limited extent Mr. Mayer, in respect of all of the aforesaid;

viii. in respect of the AM specifically, Mr. Stigwood prepared further graphs on foot of the MAS 2021 data by way of purported IOA RM analysis. The IOA RM is explained at paras 194 *et seq* below)[21].

ix. Mr. Stigwood also prepared a planning compliance graph in respect of NF demonstrating noise levels in crosswind conditions (at the wind quadrant northwest

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[18] Disregarding, the 2021 NF external audio recordings, approximately 25 external and internal audio recordings were played to the court. The vast majority of the internal audio recordings played to the Court were recorded with the window slightly ajar.

[19] Ms Large's first report includes approximately 55 separate time domain graphs- approximately 30 external NF graphs, and 25 internal HH graphs (most of which were recorded with the window ajar). Ms Large's second report includes approximately 20 further internal HH time domain graphs (with the window ajar). Mr Stigwood's first report includes approximately 10 further internal HH time domain graphs (with the window ajar) and approximately 20 internal NF time domain graphs (with the window ajar). As stated, I disregard, the 2021 NF external data.

[20] An example of two of these graphs is to be seen at paras 434 and 435 below.

[21] Mr Stigwood's IOA RM graphs of the internal NF and HH data as derived from the noise monitoring on site is attached at para 451.

through to northeast[22]). I will refer to this as "the MAS NF crosswind planning compliance graph"[23]

Evidence of Ms. Sarah Large and Mr. Mike Stigwood

115. Mr. Stigwood accepted that Mr. O'Reilly's planning compliance graphs demonstrated planning compliance in the downwind direction using the ETSU methodology. By contrast, his evidence was that the MAS NF crosswind planning compliance graph showed a fairly consistent exceedance of the noise limits in the permission.

116. However, MAS's overall opinion was that planning compliance (and planning guidance generally) was of limited relevance to the nuisance assessment. They view planning control and nuisance as separate frameworks with different aims and objectives. The purpose of the planning system is to regulate the development of land in the public interest. Planning authorities perform their functions by reference to a range of environmental, social, economic and policy considerations. Although they will consider the potential effect of proposed development on the amenity of any neighbouring properties, planning authorities are not obliged to give this factor any particular weight in the assessment. By contrast, MAS state that the impact on amenity will be the key consideration in a nuisance assessment.

117. Ms. Large and Mr. Stigwood consider that the Defra Guidance, which assesses both qualitative criteria (dominance, erraticism, impulsivity and variability etc) and quantitative criteria (decibel level, AM values) provides a more suitable methodology for the assessment of nuisance. In contrast to planning controls which proceed on the basis of external noise measurements only, the Defra Guidance recognises that as most complaints of noise nuisance relate to sleep disturbance, internal monitoring should be undertaken to see whether it corroborates complaints.

118. MAS also contended that *BS 4142:2014-Method for rating and assessing industrial and commercial sound* (BS 4142) provided a useful methodology of assessment of WTN nuisance.

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[22] In this respect, Mr. O'Reilly's planning compliance graphs all relate to directly downwind conditions.
[23] This is attached and further discussed at para 335 below.

119. The results of the 2017 and 2021 external and internal noise monitoring were presented and analysed in four separate expert reports prepared by Ms. Large and Mr. Stigwood [24] which were extensively opened in evidence to the court. As stated, Mr. Stigwood also played extracts from the audio recordings to the court.

120. Ms. Large and Mr. Stigwood observe that the plaintiffs' houses are in wind shadow and that the area is extremely quiet. In Mr. Stigwood's opinion, absent the windfarm, this would be a *"low noise environment"* as defined in WEDG 2006.

121. In Ms. Large's view, the plaintiffs' noise environment was entirely dominated by the WTN on every day of her lengthy noise survey. Moreover, the period of adverse impact was almost continuous. The WTN causes a stark and significant change in the sound environment which will be perceived as a doubling of the overall loudness, and at times, a quadrupling of the overall loudness. MAS was of the view that WTN exceeds background noise by considerably more than 5 dBA.

122. In Ms. Large's opinion, the impact is further exacerbated by excessive AM values, thump AM and the overall unpredictability of the WTN which means that one cannot predict and plan, adding a further layer of intrusion. MAS's evidence is that the 2017 and 2021 data demonstrates that long periods of high AM value are a very common feature of this WTN. In Ms. Large's view, the 2017 data shows that the levels of AM frequently modulate by 10 dBA and that AM values in excess of 13 to 15dBA are common. In MAS's view, the audio recordings also demonstrate prominent thump AM. Spectrum analysis confirms the presence of lower frequency noise, which is heard as thump AM, felt as vibration and perceived as a sense of pressure. This is a particular feature of the internal environment in HH. The 2017 and 2021 data also shows that the AM is impulsive (with a pattern of rapid rise and fall), erratic (with no clear periodicity or rhythm) and intermittent/variable (it disappears and returns again or fades in and out). Mr. Stigwood's view was that, due to stable atmospheric conditions enhancing sound propagation, this AM intrusion occurs more during the night.

123. Ms. Large did not apply the IOA RM to her data to "rate" the AM values as, in her view, such an exercise is directed only towards the calculation of a penalty for planning

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[24] MAS reports dated: 27th June, 2018, 12th January 2021, 3rd October, 2022 and 6th November, 2022.

purposes. As the IOA RM is a 10 minute averaging method, it tells one nothing about what is happening within each 10 minute segment in terms of spectral frequency or the character of the WTN. As such, Ms. Large felt that the IOA RM would not tell her anything that had not been already established from her own analysis of the data.

124. Mr. Stigwood accepts that the IOA RM analysis is "*pretty good at giving you certainly a first glance at whether there is an AM problem*". However, it is not the only method of evaluating AM values. Mr. Stigwood maintains that the application of the IOA RM analysis to the 2021 NF external audio recordings yields average AM values of 8 dBA which would attract an average 5dBA penalty pursuant to draft WEDG 2019. Mr. Stigwood also opines that, when a noise nuisance complaint relates to the indoor noise environment, the IOA RM analysis should be applied to internal measurements. In this case, doing so yields similar results to those derived externally.

125. In Ms. Large's view, the sleep disturbance reported by the plaintiffs was consistent with and supported by her noise data and by her own experience of the WTN on site which all demonstrated significant adverse noise impact. The WHO criteria[25] for night-time sleep disturbance (which is based on the Lmax[26] of noise rather than its average decibel level) are exceeded by the WTN. Indeed, due to low background noise and significant lower frequency energy, one would expect sleep impacts at even lower levels.

126. In Ms. Large's view, the WTN, which occurs all day and all night is dominant and oppressive both outside, and within the dwellings. There is no respite from the WTN, and its worst impact often coincides with the most sensitive times of the day. The sound character is highly changeable with multiple attention-drawing characteristics. At a basic level, the ability to be "quiet" in one's own home and undisturbed by unwanted noise is prevented by the operation of the wind farm. The WTN causes annoyance, disturbs sleep and then inhibits recovery by preventing subsequent rest and relaxation.

127. In MAS's view, the 2017 and 2021 data comprises objective evidence to corroborate the plaintiffs' complaints of significant adverse impact on the use and enjoyment of their

[25] WHO 2009 Night Noise Guidelines for Europe
[26] The maximum AM peaks of noise

dwellings. The WTN exceeds normal boundaries of acceptability and expected intrusion by a substantial margin. When compared to a substantial number of windfarms that she has previously assessed, Ms. Large views the Ballyduff WTN as exceptional. Overall, she viewed the noise intrusion from the Ballyduff turbine as worse than any other case of WTN that she had previously encountered.

Noise data presented by defendant's experts

128. The evidence tendered by the defendant as to the WTN at HH and NF was advanced in the following ways:

i. planning compliance graphs prepared by Mr. O'Reilly at both HH and NF[27]
ii. Mr. Carr's opinion evidence on the HH compliance graphs. Mr. Carr did not address the NF compliance graphs.
iii. the factual evidence of Mr. Carr as to his experience of the noise in the bedroom at HH for a period of 5 to 10 minutes on the day of the joint site inspection.
iv. Comment by Mr. Carr on some of the plaintiffs' experts' evidence.

Evidence of Mr. Shane Carr

129. Mr. Carr observes correctly that all WTN assessments assume that as windspeed increases so too does the background level. In comparing the "turbine on" and "turbine off" scenarios, MAS does not take account of the expected increase in background noise levels associated with windier conditions. MAS is therefore not comparing like with like. Mr. Carr also criticises MAS's failure to correlate its data with windspeeds, wind direction or meteorological conditions.

130. Mr. Carr's view was that the planning condition sets a fixed limit at different windspeeds, namely 40 dBA leq at 5 m/s and 45 dBA leq at 10 m/s. In his view, no noise limit applies between those windspeeds.

131. Mr. Carr assessed planning compliance by reference to Mr. O'Reilly's HH compliance graphs. In Mr. Carr's view, these show that total operational noise complies with the noise

[27] Mr. O'Reilly's planning compliance graph for night-time in downwind conditions at both NF and HH are attached at paras 326 and 308 below.

limits in the planning permission in directly downwind conditions. There was therefore no necessity for background noise measurements.

132. Further, Mr. Carr and Mr. O'Reilly (and indeed one of the plaintiffs' experts, Mr. Mayer) all gave evidence that WTN noise would be expected to be at its greatest in this downwind quadrant. In Mr. Carr's view, crosswind conditions are associated with a 2dBA reduction in turbine noise. In Mr. Carr's view therefore, any exceedances of the noise conditions in the planning permissions shown on the MAS NF crosswind planning compliance graph were not caused by turbine noise.

133. Mr. Carr also viewed the WTN as compliant with WEDG 2006. Further, Mr. O'Reilly's HH planning compliance graph for daytime hours showed that measured noise levels at low windspeeds without the windfarm operating, were above 30dBA L90. This was not therefore a *"low noise environment"* as defined in WEDG 2006.

134. Mr. Carr [28] also expressed the view that the measured noise levels at HH complied with the recommended limits set out in draft WEDG 2019. Indeed, he stated that the HH noise levels were so low as to ensure that there was "*sufficient headroom*" to incorporate any penalty for AM that might be imposed by draft WEDG 2019.

135. Mr. Carr's view is that a planning compliance assessment is a key aspect of a nuisance assessment. Both planning regulation and nuisance consider the impact on residential amenity within established frameworks.

136. By contrast, the MAS analysis is qualitative and *"generic"*. He also criticises the MAS approach as "*novel* "and "*bespoke"*. In Mr. Carr's opinion, MAS failed to rigorously apply any appropriate guidelines to the assessment of nuisance. Whist he noted that the Defra Guidance does not measure nuisance by reference to a particular fixed decibel limit, one must still assess nuisance in accordance with *"some recognised standards or guidance*" (such as the planning permission, WEDG 2006, the IOA RM or draft WEDG 2019).

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[28] The defendant's planning expert, Mr. Lawlor, agreed with Mr. Carr in this regard.

137. Under the Defra Guidance, the plaintiffs must, by reference to such guidance show that an established threshold of impact or "*threshold of significance*" is being exceeded. That "*threshold of significance*" was not exceeded in this case because, in Mr. Carr's view the overall noise levels at Ballyduff were generally "*very low*". This was not therefore a borderline or "*critical*" case requiring him to either carry out any further monitoring or to listen and form a view on the character of the noise. In any event, Mr. Carr rejected the view that one should or even could assess nuisance by listening to the noise. This is because various people have various different opinions about what constitutes an unreasonable interference. In essence therefore, whilst he accepted that the audio recordings accurately capture the sound environment where they were situated, Mr. Carr viewed them as of little value in determining whether nuisance was made out.

138. Mr. Carr rejected the relevance of BS 4142 as it applied to industrial noise generally but not specifically to WTN.

139. Mr. Carr's evidence was that MAS had also failed to ensure that their noise measurements were taken in accordance with best practice. Mr. Carr accepted that the MAS 2017 audio recordings (i.e., the HH internal audio recordings and the 2017 NF external audio recordings collected on foot of Ms. Large's noise survey) accurately measured sound levels at the point of the microphones. However, due to sound reflections, the 2017 HH internal audio recordings (and associated graphs) were not necessarily reflective of noise levels in the wider room or in different rooms in the same house.

140. Mr. Carr's most trenchant criticism was reserved for the MAS 2021 data which was recorded by the plaintiffs' solicitor who is not an appropriately qualified "*competent person*". As regards the 2021 NF external audio recordings, good practice requires that that measurements are made in the free field between 3.5 and 20 metres from a dwelling. However, due to inadvertence this did not occur, and the noise was recorded at façade level. As a result, although Mr. Carr accepts that the audio recordings accurately captured the noise environment where the microphones were placed, the use of façade level measurements (instead of free field measurements) increases overall noise levels. Moreover, the 2021 NF external audio recordings were gathered without the use of an appropriate windshield which means that wind contamination cannot be excluded. Mr. Carr noted that MAS had screened that part of the MAS 2021 data that was included in the expert reports and had also screened the audio recordings

played to the court. However, he does not accept that this screening is effective to exclude wind contamination because one cannot always hear how wind affects the microphone. Furthermore, Mr. Carr also stated that one cannot take façade measurements where there is a significant low frequency content to the noise.

141. As regards the 2021 NF internal audio recordings and the 2021 HH internal audio recordings, Mr. Carr again contended that the noise levels at the point of the microphone would not necessarily reflect noise levels in other parts of the house.

142. Mr. Carr was extremely critical of MAS's methodology in presenting AM. He stated that the IOA RM defines AM and sets out a strict methodology (in terms of measurement methodologies and postprocessing) for rating AM values. This in turn allows for consistent assessment. By contrast, the MAS approach to calculating AM values (computing the differential between AM peaks and AM troughs on the time domain graphs) exaggerates the level of AM. To explain this, Mr. Carr noted that Mr. Stigwood himself had accepted that the AM values as calculated on foot of the MAS time domain graphs would typically overstate the AM values when compared to those produced by the IAO RM by *"1 to 2 dB"*.

143. Mr. Carr noted that Mr. Stigwood also had purported to undertake an IOA RM analysis of the MAS 2021 data discussed above (the 2021 NF external audio recordings and the 2021 HH and NF internal audio recordings). In Mr. Carr's view, this data could not form the basis for a valid IOA RM assessment. This was for several reasons.

144. First the 2021 NF external audio recordings were taken at façade level which distorts AM. Related to this is the criticism that Mr. Carr maintains that one cannot take façade measurements where there is a significant low frequency content to the noise.

145. Second the 2021 NF external audio recordings were captured without the use of an appropriate windshield. In this latter respect, Mr. Carr opined that even if one were to accept that the screening exercise carried out by MAS was adequate to exclude contamination from the specific data included in their reports and from the audio recordings played to the court, this was irrelevant to the IOA RM assessment which was based on a far more extensive cache of data - 6 weeks of continuous data. Mr. Stigwood had not screened this more extensive cache of data for contamination and yet had input it all into the IOA RM analysis.

146. Third, as stated above, Mr. Carr viewed Mr. Stigwood's IOA RM analysis of the 2021 NF and HH internal data as of no value. This was because - in addition to the fact that the monitoring equipment was set up by the plaintiffs' solicitor rather than by MAS - the IOA RM analysis is not intended to be carried out on internal measurements.

Evidence of Mr. Brendan O'Reilly

147. Mr. O'Reilly confined himself to presenting the defendant's evidence in relation to compliance with the planning permission. Mr. O'Reilly's view was that the Defendant was fully compliant on both the HH and NF data. He accepted however that the polynomial line (or trendline) for the NF night-time graph was 43.5 dBA L90, which is above the planning permission limit of 43dBA L90. In Mr. O'Reilly's view this potential exceedance could be fully explained by the noise of the wind in the trees close to the NF measurement location.

148. Mr. O'Reilly also accepted that the MAS NF crosswind planning compliance graph shows an exceedance of total operational noise above the permission limits but stated that "*it had nothing to do with the turbine*" and was more likely noise from wind in the trees. In Mr. O'Reilly view, contributions from wind were evident on both the daytime and night-time compliance graphs. Although in rural Ireland, the biggest contribution to increased noise levels is the wind in the trees, people are generally habituated to it and therefore never complain about it or even notice it. Mr. O'Reilly accepted that the plaintiffs' properties were in a wind shadow and that the wind environment at hub height was very different to the wind environment at the properties.

Planning experts called by parties.

Evidence of Ms. Ann Mulcrone and Mr. Gavin Lawlor

149. The evidence of the plaintiffs' expert, Ms. Ann Mulcrone, a town planner and former president of the Irish Planning Institute, was restricted to the pleaded allegations of breach of the permission for the purposes of the s. 160 application. I will detail this evidence when considering issue 14 below.

150. Similarly, the evidence of the defendant's expert, Mr. Gavin Lawlor, a town planner recently elected to the Council of the Irish Planning Institute, was largely responsive to the s. 160 application. In addition, in harmony with Mr. Carr, he also expressed the view that the

whole purpose of the fixed noise limit in planning permissions is to protect the residential amenity of nearby residents. In essence, such a noise condition is inserted to eliminate nuisance. In his view, the noise limits in the permission carefully balance the acceptable noise and the desired outcome of renewable energy. He stated that the WTN was "*meticulously compliant*" with condition 15. In addition, Mr. Lawlor tendered a similar view to that of Mr. Carr in relation to the interpretation of the planning permission with which I deal with below.

Evidence of Mr. Dietrich Mayer

151. The plaintiffs led evidence from Mr. Dietrich Mayer, a qualified Mechanical and Automotive engineer who now operates as a Wind Energy Consultant advising on the execution of wind development. Although Mr. Mayer clearly has a high degree of practical experience in wind farm developments, I entertain some doubt as to whether he is sufficiently qualified to give expert evidence. I will therefore briefly summarise Mr. Mayer's evidence but will have regard to it for the purposes of context only.

152. Mr. Mayer's view is that bearing in mind their proximity to the plaintiffs' homes and the local topography it ought to have been recognised at the time of the installation of the turbines that there was a significant risk of unacceptable noise and high levels of AM.

153. In their present location, the usual proportionate relationship between noise levels at the receptors and at the rotor tips is distorted due to their respective heights and to the fact that the houses are in a wind shadow.

154. The speed of rotation of the blades is a critical factor for the generation of noise. If windspeeds accelerate steeply, the blade angle will change, and extra noise will be produced because of a disruption of the laminar flow. In gusty conditions the turbine has to exert a lot of control, producing frequent fast pitching activities and associated peaks in noise.

155. Other factors that can increase noise emission are the misalignment of blades and blade pitch. In addition, air inflow turbulence could play a role here because the operation of T1 will create a wave effect in the airflow towards T2 which will cause increased loads and sound emission from T2.

156. The WTN could be reduced by a number of methods. One ought first check that the rotors were clean, undamaged and properly aligned. The turbine rotors could be serrated, or appliances could be added to the blades to reduce the sound power level. One could also, if required, de-rate T2 at certain times and operate it in power reduced mode. As noted in the manufacturer's technical data sheet: *"For a noise sensitive site it is possible to operate the E70 with a reduced rotational speed and a reduced rate of power during the night."* Enercon can also provide a software programme to eliminate shadow flicker at impacted properties.

Evidence on shadow flicker

157. Although this is fundamentally a noise nuisance case, the plaintiffs also complain of nuisance in the form of shadow flicker.

158. By agreement, the parties submitted a shadow flicker report of Jennings O'Donovan & Partners dated 24th May, 2017 prepared by Mr. David Kielty. Mr. Kielty's report, which was based on modelling rather than on-site assessment, found that the plaintiffs' dwellings could potentially experience an impact from shadow flicker as they are within ten rotor diameters of the Ballyduff windfarm. The report shows that the total predicted hours per year of the shadow flicker at HH and NF on a *"worst case"* scenario is:

NF (34.2 Hours Per Year)
HH (35.6 Hours Per Year)

159. This calculation is based on topography alone and assumes that the sun is always shining and that there is no cloud cover. It also excludes vegetation, forestry, buildings and other man made buildings which in a *"real"* context would screen the flickering effect of the wind turbines. The report states that T2 is the largest contributor to shadow flicker occurrence.

160. The report then finds, by way of a desktop survey, that the actual hours of sunlight at Ballyduff represent 35% of the total hours of daylight and that therefore shadow flicker will only potentially occur for 35% of the predicted worst case time. Reduction factors were therefore applied which produced the following results:

NF (34.2 Hours Per Year) Reduction @ 35% = 12.0 Hours shadow flicker per year

HH (35.6 Hours Per Year) Reduction @ 35% = 12.5 Hours shadow flicker per year

161. The conclusion is as follows: *"Although there is no agreed standard for shadow flicker impact in Ireland, the [WEDG 2006] recommends that shadow flicker at dwellings within 500m of a turbine should not exceed either 30 hours per year or 30 minutes per day."*

162. The report concludes that the Ballyduff Windfarm has the potential to introduce shadow flicker impacts that may exceed this WEDG limit of 30 minutes per day when sunshine occurs. However, the predictions do not take into account weather conditions or the presence of natural features e.g., trees and hedges which will reduce sunlight. The report concludes that the impact of such factors renders it likely that the 30-hour guidance limit is satisfied in practice.

Medical evidence of Prof Kevin Gournay and Dr. Declan Murray

163. As Ms. Webster and Mr. Rollo seek damages for personal injuries, the psychological impact of the WTN was addressed by Prof. Kevin Gournay, Chartered Psychologist and Prof. of the Institute of Psychiatry, Psychology and Neuroscience, Kings College, London - who gave evidence on behalf of the plaintiff - and Dr. Declan Murray consultant psychiatrist of Glebeview Clinic- who gave evidence on behalf of the defendant. Both experts were eminently experienced and qualified and gave evidence in a measured, considered and independent manner.

Medical opinion in respect of Margaret Webster

164. There was a divergence of views as between the medical experts in relation to Ms. Webster. Prof. Gournay's view is that she satisfied the criteria for a recognisable psychiatric illness; a depressive disorder, which he classified as mild to moderate. This resulted from a complex range of synergies; principally anxiety concerning Mr. Rollo together with sleeplessness and irritability caused by the WTN.

165. Dr. Murray's view was that Ms. Webster had not suffered from an identifiable psychiatric disorder. Whilst there is no doubt that the WTN and the disintegration of her relationship with Mr. Rollo had imposed considerable stress on Ms. Webster, she has coped with that stress. Therefore, although Dr. Murray accepted that Ms. Webster experienced sleep difficulties, felt down in herself and had become tense and irritable, his key point is that her

reaction was understandable; she succeeded in managing her emotions and reactions. In short, her psychological reaction to the circumstances was not disproportionate. Nor did Dr. Murray view Ms. Webster's symptoms of depressed mood and diminished interest as sufficiently pervasive or prolonged to qualify as a psychiatric injury.

166. With respect for the contrary view of Prof. Gournay, I agree. Ms. Webster has had to tolerate an extremely difficult situation for the past number of years. Overall, however I accept the evidence of Dr. Murray that her reaction to the WTN is not disproportionate to the circumstances that she is experiencing. As such, I also accept his view that Ms. Webster has not suffered from a recognisable psychiatric illness and does not currently so suffer.

Medical opinion in respect of Keith Rollo

167. When Prof. Gournay first examined Mr. Rollo in December 2020 he was extremely concerned for his mental well-being. Mr. Rollo's history was of expressed emotions of hopelessness and helplessness in the face of unremitting WTN and impulsive thoughts of suicide. These red flags for suicide, when juxtaposed with the fact that Mr. Rollo worked at heights, providing him with suicidal means and opportunity, prompted Prof. Gournay to take the extremely unusual step of intervening in the legal proceedings. He informed the plaintiff's solicitor of his concern and strongly suggested that the wind turbine was turned off at night so that Mr. Rollo's chronic sleep disturbance might be mitigated. As I note above, a request to this effect was refused by the defendant.

168. Prof. Gournay diagnosed Mr. Rollo as suffering from a major depressive disorder of at least moderate severity with low mood, sleep disturbance, irritability and anger. Dr. Murray did not substantially disagree.

169. There was some disagreement between Prof. Gournay and Dr. Murray in relation to Mr. Rollo's progress after diagnosis. On this, I find that Mr. Rollo's depression improved significantly after he moved away from the turbine in early 2021. However, in mid-2022, he experienced a recurrence of his symptoms. This recurrence was characterised by anxiety rather than depression and was in the mild to moderate range. Mr. Rollo attributed this recurrence to the upcoming court case which is an entirely reasonable explanation. I accept Dr. Murray's view that Mr. Rollo's depression has now substantially resolved, albeit that some residual

symptoms persist at a subclinical level. In addition, Mr. Rollo remains vulnerable to further episodes of depression and anxiety in the future.

170. In terms of causation, Dr. Murray opined that although the windfarm contributed to Mr. Rollo's depression, other potential risk factors mean that it is possible that he could have developed depression in any event. I find that this is improbable as most of the vulnerabilities described were longstanding and yet Mr. Rollo had never before suffered from depression. Mr. Rollo's past history appears to have been of a robust person. He had not previously experienced sleep disturbance or psychiatric symptoms save for a brief transient episode of anxiety.

171. Given the absence of any prior insomnia and the temporal relationship between the operation of the turbine and the onset of Mr. Rollo's sleep disturbance, I conclude that the WTN is the sole cause of this sleep disturbance. Further, in light of the well described relationship between sleep disturbance and depression, I accept Prof. Gournay's view that Mr. Rollo's depression was entirely reactive to the external stressor posed by the WTN and the resulting long term sleep disturbance.

172. Accordingly, I find on the balance of probabilities that the cause of Mr. Rollo's depression was the WTN and the sleeplessness associated therewith. I am fortified in this view by the fact that the medical records demonstrate significant improvement - no doubt assisted by modalities such as antidepressant medication and counselling - once Mr. Rollo moved away from the turbine.

173. I accept Prof. Gournay's view that the unremitting WTN, his lack of sleep and his depression ultimately affected Mr. Rollo's personality and outlook. I further accept that for a period of time, probably commencing in mid to late 2020 and perhaps continuing for a couple of months after he moved out of HH, this impacted upon Mr. Rollo's overall response to the WTN which was often characterised by obsessive ruminations. I also accept that this personality change was a manifestation of Mr. Rollo's illness and was also therefore precipitated by the WTN.

Planning Guidance in relation to Wind Energy Developments

174. The defendant's primary defence is that it is not open to this Honourable Court to find that the threshold for nuisance impact should be set at a specific level other than the noise limit set out in the planning permission and that because the WTN complies with this noise limit, nuisance is not established. I should consider this argument at the outset because, if accepted, it would be dispositive of the case.

175. Before embarking on this exercise, however, it is necessary to refer to planning guidance on wind turbine developments at the time of the grant of the Ballyduff planning permission. This is important to the interpretation of the Ballyduff planning permission (which, as we shall see is a matter of dispute between the parties). An understanding of the planning framework is also required to assess another aspect of this argument; namely the defendant contends that both the noise limits set in the Ballyduff permission and the WTN which it produces comply with all appropriate planning guidance on WTN at the time of the grant of permission. In addition, an appreciation of more recent planning guidance on wind turbine developments is similarly of relevance as the defendant also argues that both the noise limits set in the Ballyduff permission and the WTN is in compliance with current expertise on WTN[29]. Therefore, in addition to summarising planning guidance at the time of the grant of permission and to date, I will where relevant, highlight how same might be applied to the Ballyduff permission or to the WTN itself. At a later section of this judgment, I deal separately with the Defra Guidance (which is not planning guidance but rather guidance on the assessment of statutory nuisance complaints concerning WTN).

Guidance pre-dating the planning permission

176. The parties opened two key pieces of guidance pre-dating the permission: first, the ETSU-R-97 guidelines, *The Assessment and Rating of Noise from Wind Farms* published by the Department of Trade and Industry in 1996 ("ETSU") and second, WEDG 1996.

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[29] Thus, the defendant argues that "*the permission limits continue to reflect the current combined wisdom and expertise of appropriately qualified experts as to what levels of WTN*" [are reasonable]. It further contends that because the WTN complies with those permission limits, it reflects that current wisdom and expertise and is by definition not unreasonable.

ETSU

177. ETSU sets out a framework for noise levels thought to offer a reasonable degree of protection to windfarm neighbours without placing unreasonable restrictions on windfarm developments. Since its adoption, ETSU has been the primary framework by which planning conditions pertaining to wind farms are set in the United Kingdom. It is also the primary methodology by which planning compliance continues to be assessed in both the United Kingdom and Ireland.

178. ETSU assumes that WTN relative to background noise is likely to be greatest at low windspeeds. However, it acknowledges that assumption does not always hold true for turbines on hillier sites which may experience high winds, whilst the sheltered receptor will experience low levels of wind generated noise.

179. ETSU recommends that noise limits should be set relative to existing background noise at the nearest noise sensitive properties and that the limit should reflect the variation in both the WTN and background noise with windspeed.

180. Ultimately, a combined relative and fixed limit was recommended. In general, WTN would be limited to 5 dBA L90 above the background sound levels (the relative limit) or a value in the range of 35 to 40 dBA L90 (the fixed limit), whichever is greater. In low noise environments, the day-time level of the L90 of the wind farm noise should be limited to an absolute level within the range of 35-40 dBA L90.

181. An absolute night-time limit of 43 dBA L90 was recommended as appropriate to protect sleep. This limit was not felt to offer sufficient protection to external amenity in quiet areas during the day.

182. The ETSU approach applies the noise limit only to WTN and not to total operational noise, which is a combination of WTN and background noise. As it will often be difficult to isolate one from the other, ETSU assumes that if total operational noise is below the relevant noise limit, then no further action is necessary. Conversely, if total operational noise is above the relevant noise limit, then a correction for the influence of the existing background noise should be performed. In such circumstances, compliance cannot be demonstrated without ascertaining background noise.

183. In 2013, the Institute of Acoustics (IOA) released a *Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* ("GPG") which addressed many technical aspects of ETSU. In 2014, the IOA published six Supplementary Guidance Notes to the GPG, which provided further information on specific aspects of the assessment procedures. For present purposes the most important of these is Supplementary Guidance Note 5 on Post Completion Measures ("Supplementary Guidance Note 5") which governs the technical aspects of ETSU planning compliance assessments.

WEDG 1996

184. WEDG 1996 were the relevant planning guidelines at the time of the grant of planning permission in this case. These provided that noise levels measured externally at any dwelling house should not exceed 40 dBA Leq and that tonal or impulsive qualities in the noise should be avoided. I pause to note that although I find that the noise limits set in the Ballyduff permission are generally in accordance with WEDG 1996, total operational noise is frequently above 40 dBA Leq.

Guidance post-dating the planning permission

WEDG 2006

185. The current assessment framework applying to the grant of planning permission for wind farms is set out in the planning guidelines issued by the Department of the Environment, Heritage and Local Government in December, 2006, WEDG 2006.

186. WEDG 2006 characterises aerodynamic noise from wind turbines as general broadband noise which can display some "character" ("swish"). The possibility of thump AM is not mentioned. Noise limits should be applied to external locations. The chosen measurement index is L90 which is intended to allow reliable measurement without corruption from relatively loud transitory noise events from other sources.

187. In general, significant noise problems are unlikely where the distance from the nearest turbine to any noise sensitive property is more than 500 metres. I pause to note that T2 is of course 359/369 metres from the plaintiffs' dwellings.

188. During the day, WEDG employs a combination of relative and fixed noise limits. The language here is somewhat ambiguous. The guidelines provide for "*a lower fixed limit of 45 dBA or a maximum increase of 5 dBA background noise*" without specifying whether it is intended that the lower or greater of these two limits apply. I accept the defendant's argument that planning authorities are free to choose whichever of these limits is greater. Therefore, save in low noise environments, WEDG 2006 deems it acceptable to set a limit of 45 dBA L90 irrespective of background noise levels.

189. WEDG 2006 notes that during the night the protection of external amenity becomes less important, and the emphasis should be on preventing sleep disturbance. It provides that a fixed limit of 43 dBA will protect sleep inside properties during the night.

190. The defendant argues that the Ballyduff permission complies with the recommendations in WEDG and that the WTN experienced at the plaintiffs' homes also so complies. Strictly speaking, confirming compliance with WEDG requires an assessment of whether or not this is a low noise environment. There is presently no compelling evidence either way on this issue[30]. I will therefore give the defendant the benefit of the doubt and assume that the above noise limits apply.

191. As such, the two noise limits set out in the Ballyduff permission (40 dBA leq and 45 dBA leq), which are either below or equal to the WEDG noise limits (45 L90during the day and 43 L90 during the night) therefore comply with WEDG 2006.

192. The defendant consequently argues that because the Ballyduff WTN complies with the noise limits in the permission, this means *a fortiori*, that the WTN also complies with WEDG 2006.[31] I will accept, for the sake of argument, that this is so.

193. The key point however is that the issue of compliance or otherwise with the WEDG 2006 limits is largely beside the point. This is because, for reasons I will explain in due course,

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[30] See para 512 below for an analysis of the parties' respective evidence on background noise levels.
[31] For reasons I will detail below, I am of the view that the Ballyduff WTN is not in fact in compliance with the permission because the defendant has misinterpreted the permission limits. That however is not of immediate relevance because, as at this point of my discussion, I am considering whether the defendant is correct in submitting that the Ballyduff WTN complies with the *WEDG* noise limits.

I do not view WEDG 2006 as delineating the parameters of WTN nuisance in this particular case.

Developing understanding of AM and the Institute of Acoustics (IOA) Reference Method (IOA RM)

194. Whilst ETSU and WEDG 2006 continue to be applied in the UK and Ireland respectively, it is now recognised that there is a need to address noise impacts in a more nuanced way.

195. Although the ETSU methodology is intended to absorb any additional impact due to AM into the noise limits it recommends, it does not fully address the potential impact of AM in WTN in at least three respects. First, ETSU understood AM as overwhelmingly of the "swish" variety and no real account is taken of the possibility of AM of a lower frequency character, "thump AM". Second, ETSU primarily contemplates AM values of *"up to"* 3 dBA. Indeed, the ETSU Review[32] points out that on the basis of the comments in ETSU, the value of 3 dBA is sometimes referred to as the 'expected level' of AM. However, it is now apparent that AM can display AM values much greater than this. Third, ETSU assumes that as distance from the turbine increases beyond 50 metres, the rhythmic swishing would become less pronounced, reducing audibility. It is now clear that "thump AM" - compared with "swish AM"- can be discerned at longer ranges and over different wind directions.

196. Concerns about AM, particularly lower frequency "thump" AM, led to the commissioning of several UK government funded surveys. Ultimately, in 2016, the findings of two parallel AM studies were reported. The first was the IOA led investigation ("the IOA AM report") which states:

> *It is now generally accepted that there are two manifestations of wind turbine AM. An observer close to a wind turbine will experience 'blade swish' because of the directional characteristics of the noise radiated from the trailing edge of the blades as it rotates towards and then away from them. This effect is ... not generally expected to be significant at typical separation distances, at least on relatively level sites. The Renewable AM project... has coined the term 'normal' AM (NAM) for this inherent characteristic of WTN, which has long been recognised and was discussed in ETSU-R-97 in 1996 (ETSU, 1996)*

[32] As to which see further para 216 below.

> *In some cases, a form of AM is observed at residential distances from a wind turbine (or turbines). The sound is generally heard as a periodic 'thumping' or 'whoomphing' noise containing relatively low frequencies... The prevalence of this type of modulation is subject to debate. On sites where it has been reported, occurrences appear to be occasional, although they can persist for several hours under some conditions, dependent on atmospheric factors, including windspeed and direction....The Renewable UK AM report adopted the term 'Other AM' (OAM) for this characteristic. Elsewhere it might be reported as Excessive Amplitude Modulation (EAM).*

197. The purpose of the IOA AM report was to devise a method for measuring and rating AM in WTN. The primary goal was to develop a methodology to be used within the planning regime. I will consider in due course[33] the relevance of the methodology ultimately developed by the IOA for rating AM ("the IOA RM") to the exercise currently being conducted by this court.

198. The second 2016 study, the Phase 2 report, concluded that AM controls were needed at development planning stage and that this was best achieved by means of a suitable penalty scheme whereby, increasing levels of AM would attract a decibel penalty which would be added to the relevant sound power levels for the purposes of fixing decibel limits.

199. In simple terms the combined effect of the IOA RM and the Phase 2 Report is as follows: first, pursuant to the IOA reference, turbine related AM is calculated over ten seconds blocks. This is measured by deducting the L95 (the sound power level exceeded for 95% of the time) from L5 (the sound power level exceeded for 5% of the time). Provided that at least 50% of the ten second blocks contain detectable AM, average AM is logged for that 10 minute period. Thereafter, the AM value for each ten minute period is to be converted to a penalty which is then correlated with the relevant windspeed and incorporated into the decibel limit at the windspeed in question.

<u>Proposed revisions to WEDG 2006</u>

200. In Ireland, the Department of the Environment, Community and Local Government has produced three different draft guidance documents proposing various revisions to WEDG 2006.

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[33] See para 421 *et seq.*

Proposed revision to Wind Energy Development Guidelines 2006 – targeted review in relation to noise, proximity and shadow flicker, December 11th, 2013.

201. On 11th December, 2013, the Department published proposed revisions to WEDG 2006 on which it invited submissions ("the 2013 draft revision"). The 2013 draft revision recognised that distinctive special audible characteristics of WTN including impulsiveness, AM and low frequency presented a challenge. WTN can be influenced by a variety of factors not directly related to distance such as topography, ground cover, windspeed and direction.

202. The 2013 draft revision recommended 40 dBA L90 as an outdoor limit which would apply irrespective of day or night. Exceptions were possible in the case of consent of the windfarm neighbour impacted. I note that total operational noise at NF is in excess of 40 dBA L90 at windspeeds above approximately 8 m/s. Total operational noise at HH is in excess of 40 dBA L90 at windspeeds above approximately 6 m/s.

2017 Preferred draft Approach.

203. In 2017, a preferred draft approach was circulated. The preferred draft approach proposed a relative noise limit of 5 dBA above existing background noise within the range of 35 to 43 dBA L90 with 43 dBA L90 being the maximum noise limit permitted day or night. The noise limit would be further reduced to take account of AM and low frequency noise. I note that total operational noise at NF is in excess of 43 dBA L90 at windspeeds of 9.5 m/s and above.

204. The preferred draft approach provided that shadow flicker would be eradicated in full by technology and appropriate modelling at design stage. It was expected that strategic environmental assessment would be undertaken and that guidelines would be finalised and issued by the first quarter of 2018.

Draft revised Wind Energy Development Guidelines December 2019 ("draft WEDG 2019").

205. Draft WEDG 2019 was issued for public consultation in December 2019 ("draft WEDG 2019"). Their aim was "*to strike a better balance between addressing the concerns of the local communities in relation to wind farm proposals, whilst maintaining Ireland's ability to deliver on its binding energy policy obligations, and ensuring that there is greater, and earlier, community engagement by windfarm developers*".

206. The noise limits in the draft WEDG 2019 were undoubtedly more onerous than the WEDG 2006 and afford a higher level of protection to people who live in the vicinity of any future wind farm developments. The defendant in the present case submits that the WTN complies with draft WEDG 2019. Although I emphasise that WEDG 2019 is draft guidance only and further that it has now been withdrawn, I will nonetheless consider whether the defendant is correct in this argument.

207. Draft WEDG 2019 notes that the principle of a 5 dBA increase above background levels has been regarded as good practice for many years and proposed the adoption of this basic structure subject to a lower limit value of 35 dBA L90 and an upper limit value of 43 dBA L90. Effectively, this imposed a limit of 35 dBA L90 as a default until the 5 dBA above background levels exceeds this and 43 dBA L90 is the maximum noise permitted day or night, regardless of background noise level. Therefore, although the defendant contends that the Ballyduff WTN complies with draft WEDG 2019, compliance cannot be assessed, still less confirmed, absent a background noise study at this site.

208. Draft WEDG 2019 also recognised the particular challenges posed by thump AM. It notes that although the characteristic sound close to a wind turbine could be described by the listener as a regular 'swish' which decreases rapidly with distance, under adverse conditions at a distance of several hundred metres from the turbine, whoomphing or thumping type noise can dominate and cause annoyance at lower levels than noises without such characteristics. While such AM can occur over extended periods it tends to vary in intensity, adding to the annoyance.

209. Draft WEDG 2019 proposed a rating penalty for certain special audible characteristics (tonal noise and AM) in addition to a fixed threshold for low frequency noise. It was felt that subjective listening tests and direct measurements did not provide a reliable method of quantifying AM for the purposes of applying the penalty scheme. Accordingly, draft WEDG 2019 recommended the application of the IOA RM as an objective and reliable methodology for quantifying AM.

210. Draft WEDG 2019 acknowledged that the setting of a threshold for excessive AM is not straightforward. It notes that available research at that time did not identify a clear level at which the impact of WTN AM becomes "significant" "excessive" or "unacceptable". However,

research suggested an onset of perception at an AM value of about 2 dB and above this, rising annoyance with increasing AM values is expected. Moreover, the research highlighted a very strong relationship between annoyance and the overall sound power level - i.e., overall loudness- of the WTN.

211. The penalty scheme proposed in draft WEDG 2019 operates by penalising higher AM values as follows:

- AM with an AM value of less than 3 dB - no penalty
- AM with an AM value of 3dB to 10 dB - sliding scale of penalties ranging from 3 to 5 dB
- AM with an AM value of more than 10 dB - 5 dB penalty.

212. Draft WEDG 2019 recommended using only night-time measurements to isolate WTN from other potential noise sources. Draft WEDG 2019 noted that AM has been shown to occur in both downwind and crosswind conditions and that where a complaint relates to AM noise all wind directions associated with AM should be included in determining the rated noise level. I pause here to note that the defendant's compliance data only relates to one wind direction: directly downwind.

213. In any event, total operational noise at NF is in excess of 43 dBA L90 at windspeeds above 9.5 m/s. If therefore the Ballyduff WTN attracts <u>any</u> AM penalty, then total operational noise would exceed the recommended maximum noise limit in draft WEDG 2019. The plaintiffs' experts have purported to perform an IOA RM analysis which is said to suggest an AM penalty of 5 dB. For various reasons, I accept the defendant's argument[34] that the plaintiffs' IOA RM cannot be relied upon to calculate likely penalties under draft WEDG 2019.

214. I deal separately at para 471 below with the defendant's expert's contention that the WTN would comply with the recommended limits in draft WEDG 2019 regardless of any character penalty that could be applied. Suffice it to say for the moment that, as the defendant has not even attempted to estimate background noise or to calculate what penalties might apply, I am at a loss to see how it can confidently contend that the WTN complies with draft WEDG 2019.

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[34] The defendant's argument is set out at para 143 above.

215. Draft WEDG 2019 also recommended that shadow flicker would not to be tolerated at all. It notes that shadow flicker can easily be prevented through the installation of sensor-based switches / control mechanisms.

ETSU Review

216. The Department of Business, Energy and Industrial Strategy in the UK commissioned a review of ETSU, which was completed in October 2022 and published in February of 2023 ("the ETSU Review"). The primary aim of the ETSU Review was to make a recommendation on whether, in view of United Kingdom government policies on noise and Net Zero, and available evidence, ETSU required updating. The ETSU Review concludes that current regulation in relation to the potential impact of AM in particular should be reviewed and updated. Although, unsurprisingly, its recommendations have not yet been actioned, the ETSU Review provides a helpful objective overview of how the science has moved on since ETSU.

217. The ETSU Review observes that the need for official guidance on the control of AM in wind turbine sound was the single most common theme arising in its review. AM annoyance is influenced by both the AM values and the spectral frequency of the WTN. Increased annoyance is associated with thump AM, which propagates further, and is more effective at transmitting through structures. The ETSU Review notes that AM values for thump AM can be greater than for swish AM. It also notes that there is strong evidence demonstrating that thump AM is more prevalent at night, due to atmospheric conditions. Although thump AM is difficult to predict, it can potentially be mitigated by control of the blade pitch angle.

218. The ETSU Review concluded that AM is secondary to the overall sound level in determining subjective responses, and that the added impact of AM can be quantified as a change in the equivalent sound level. For planning purposes, the ETSU Review therefore favours a methodology similar to that recommended by draft WEDG 2019 - i.e., the use of IoA RM to rate AM combined with a decibel penalty system for AM.

219. In summary, in so far as relevant, my view in respect of the application of all the above planning guidelines to the Ballyduff windfarm is as follows:

220. I am satisfied that, as correctly interpreted, the noise limits set in the Ballyduff planning permission comply broadly with WEDG 1996. These noise limits also broadly comply with WEDG 2006. However, as the permission does not purport to relate the noise limits to background noise or to regulate AM, the permission does not "comply" with draft WEDG 2019. In other words, the permission does not reflect draft WEDG 2019.

221. I am not satisfied on the balance of probabilities that the WTN on site complies with WEDG 1996. I accept for the sake of argument that the WTN complies with WEDG 2006. Although the defendant maintains that the WTN also complied with the recommendations in draft WEDG 2019, this has not been demonstrated. Clearly, in the absence of a background noise assessment and a fully compliant IOA RM assessment of possible AM penalties, one cannot be satisfied one way or the other on whether the WTN complies with draft WEDG 2019. In any event, as draft WEDG 2019 has now been withdrawn this is not in my view an issue which I have to determine.

Relevance of planning permission-two potential zones of relevance of the permission

222. The grant of planning permission for a particular use is of potential relevance to a nuisance claim in two distinct ways.

223. First, the grant of planning permission (and its terms and conditions) may permit the very intrusion (for example, noise) which is alleged by the plaintiff to constitute a nuisance. In the present case, the question is the extent, if any, to which the planning permission (or the noise condition specified therein) can be relied on as a defence to this nuisance claim.

224. Second, as stated at para 30 above, nuisance is always assessed by reference to the character of the particular locality. The grant of permission for the development impugned may authorise the use of the defendant's property for certain purposes potentially changing the character of the locality. In the present case, the question is whether the plaintiffs' locality should be seen as including the defendant's windfarm at Ballyduff.

Issue 1: is the court bound by the noise condition in the planning permission in assessing what is objectively reasonable for the purposes of determining a claim for nuisance? Is the noise condition in the planning permission a wholly reliable indicator of what WTN is reasonable for the purposes of determining a claim for nuisance?

The defendant's argument

225. In *Cork County Council v. Slattery Pre Cast Concrete Ltd* [2008] IEHC 291, Clarke J. observed:

> *"It is, of course, the case that the mere fact that a party operates in accordance with a valid planning permission does not give that party the right to commit a civil wrong to neighbouring properties. Therefore, the mere fact that [the defendant] might operate in accordance with a valid planning permission does not, of itself, preclude the possibility that there might nonetheless be a nuisance actionable at the suit of neighbouring property owners."*

226. The defendant does not dispute that as a matter of common law and statute,[35]planning permission cannot deprive a property owner of a right to object to what would otherwise be a nuisance. The grant of planning permission for a particular development does not mean that the development is lawful, but that a bar to the use imposed by the planning law in the public interest has been removed.

227. Notwithstanding this, the defendant nonetheless argues that the court is *"bound"* by the terms and conditions of the planning permission in assessing what is objectively reasonable for the purposes of this nuisance claim. This argument was advanced in a number of different ways which I will consider below.

228. In its oral submissions the defendant argued that the court was bound to accept and apply the noise limits in the planning permission as a wholly reliable indicator of what the ordinary person would expect in terms of noise control. Although purporting to accept that planning permission cannot *per se* provide a defence to nuisance, it was argued that *as a matter of law*, a permission which specifically regulates the matter complained of – in this instance,

[35] Section 34 (13) of the Planning and Development Act 2000 provides that a person shall not be entitled solely by reason of a planning permission to carry out any development.

noise – prevents the court from concluding that operation in accordance therewith constituted a nuisance. That, it was said[36] was "*the end of the matter*".

229. The defendants' closing written submissions were more nuanced and argued that the planning permission is "*a key item of evidence*" establishing that the expectations of an objectively reasonable person had not been "*exceeded*" in this instance. The permission noise limits therefore comprise evidence of a "*reasonable objective standard*".

230. Finally, the defendant argues that the noise limits in the permission ought to benefit from curial deference.

231. The defendant maintains that *Smyth v. Railway Procurement Agency* is binding authority in support of these arguments. It is therefore necessary to consider *Smyth v. RPA* in considerable detail.

Smyth v. RPA

232. The plaintiffs' ("the Smyths") case was that the newly established Green Line LUAS light railway system operated by the defendant ("RPA") caused them a noise nuisance. They sought an order directing the RPA to erect an appropriate acoustic barrier together with damages for nuisance, negligence and breach of statutory duty.

233. Supported by several of their neighbours, the Smyths maintained that the noise of the trams had an adverse impact on the amenity of their back gardens (which backed on to the LUAS tracks); that it was difficult to hold a normal conversation in the garden; that the noise of the trams was very intrusive in the kitchen, dining area and living areas of their house and that the noise impact in the bedrooms at the rear of the house (which were roughly level with the tracks) was such as to cause serious sleep disturbance which was their single greatest complaint. The Smyths experienced difficulty getting to sleep and were obliged to close their bedroom windows and ultimately to move out of their master bedroom at the back of the house.

234. An understanding of the statutory context and process underlying the development of the Green Line, a major public infrastructural project, is crucial to appreciating the approach

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[36] Quoting from para 34.9 of *Smyth v RPA*, as to which see para 252 below.

taken by Laffoy J. in *Smyth v RPA to* (1) the legal effect of the Line B Order pursuant to which the LUAS was established; and (2) the consequent ascertainment of the appropriate objective standard to apply to the Smyths' nuisance complaint.

235. The Transport (Dublin Light Rail) Act 1996 ("the 1996 Act") enabled the Minister for Public Enterprise ("the Minister") by order to authorise the construction and operation of the light rail. The statutory process required that the application to the Minister was accompanied by an Environmental Impact Statement ("EIS") including detailed forecasting on noise emissions. The EIS included detailed analysis of the likely noise impacts on an area by area basis. The likely exceedance of the noise of the trams over the background noise was rated into three categories: *"slight"*, *"moderate"* and *"significant"*. Where necessary, mitigation measures in the form of acoustic screening were proposed for certain areas.

236. The application was published and any persons likely to be affected had a statutory entitlement to make submissions to the Minister. The Minister was mandated to appoint an inspector to conduct a public inquiry and submit a report of the resulting findings and recommendations. All affected landowners and occupiers and other interested parties were entitled to appear at the inquiry.

237. Judge Sean O'Leary ("the inspector") was appointed as inspector to conduct the inquiry which proceeded in three stages considering first, the *prima facie* need for the light rail, secondly whether the scheme was practicable, viable and safe and thirdly the impact of the Green Line on local communities. The issue of noise and vibration was a key issue to the third stage. The inspector heard evidence from an acoustic engineering consultant who had contributed to the sections of the EIS on noise. The inspector considered the area by area analysis conducted by this expert, commended the objectivity of his evidence and ultimately concluded that if operated in accordance with the noise conditions set out in the EIS, the noise and vibration impacts of the LUAS would be "*slight*". The inspector recommended the inclusion of detailed noise conditions in the Line B order together with general conditions in relation to monitoring noise emissions.

238. S.I. No. 280/1999- Transport (Dublin Light Rail) Act, 1996 (Line B – St. Stephen's Green to Sandyford Industrial Estate Light Railway) Order, 1999 ("the Line B Order") promulgated in September 1999- expressly authorised the construction and operation of the

Green Line and as recommended by the inspector, included a condition (condition 28) obliging RPA's predecessor ("NPS") to agree daytime and night-time limits at each relevant location with the appropriate local authority. Condition 28 further required that; in default of agreement, such matters would be determined by the Minister.

239. Two particular findings assist in understanding the significance of *Smyth v. RPA* to the issues at hand. First, Laffoy J. found that - as NPS had not in fact sought to agree or have such limits determined, condition 28 had not been complied with. Second, the court found, as a fact, that the LUAS operated in accordance with the conditions set out in the EIS and also within the more exacting limits published by the National Roads Authority in October 2004.

240. The courts' reasoning in *Smyth v. RPA* has two primary components.

First component of court's reasoning in *Smyth v RPA* - possible application of the defence of statutory authority

241. First, Laffoy J. determined that if the Green Line had been operated in strict accordance with the Line B Order, then that would be a complete answer to the claim in nuisance. In such circumstances the defendants would be operating the Green Line in accordance with the law and there could be no question of the perpetration of a civil wrong. Thus, at para. 3.7, Laffoy J. states:

> *"The real issue, the liability of the defendants for noise generated by the operation of the Green Line, is primarily determined by what the Acts of the Oireachtas and the secondary legislation under which the defendants operate the Green Line authorise them to do."*

242. Paragraph 32.10 is to broadly similar effect:

> *"The defendant is a statutory body, which by virtue of (the 1996 Act) has power to operate the Green Line in accordance with the terms of the Line B Order. If, as a matter of the proper construction of the Line B Order, the defendants are entitled to operate the Green Line at the rear line of No. 3 in the manner in which they are operating it, they are operating it in accordance with law, that is to say, in accordance with an Act of the Oireachtas and the secondary legislation made under it, both of which enjoy the presumption of constitutionality and that is a complete answer to the plaintiffs' claim. Alternatively, if the defendants are not operating the Green Line at that location in accordance with the terms of the Line B Order, the ordinary principles of common law apply in the defence to the plaintiffs' claim for nuisance."* (Emphasis added)

243. Counsel for the defendant invoked the language of para 32.10 and submitted that, *"at a high level"* its logic provided a *"complete answer"* to the plaintiff's claim in the present case. This aspect of the defendant's approach is somewhat contradictory. On the one hand it accepts that these passages in *Smyth v. RPA* concern the defence of statutory authorisation and cannot be read across to a grant of planning permission. On the other hand, it relies upon para 32.10 (and similar passages) to argue that because the planning permission for the Ballyduff turbines sets specific noise limits (with which it is asserted it complies), this provides a complete defence to a claim in nuisance in a manner equivalent to that provided by the Line B Order.

244. This cannot be correct. This component of Laffoy J.'s reasoning concerns an argument based on the defence of statutory authority. *Smyth v. RPA* does not support an argument that compliance with specific noise limits in a planning permission is necessarily a complete answer to a claim for noise nuisance. There is a difference between development specifically authorised by legislation and development on foot of a decision made by a planning authority in the form of a single planning permission. Indeed, it is relevant to note that although she reviews Irish and England & Wales authorities in relation to the impact of planning decisions on nuisance, Laffoy J. ultimately considered these authorities to be of *"little relevance"* to the case before her.

Second component of court's reasoning in *Smyth v. RPA*-*"wholly reliable indicator"*

245. The second component of Laffoy J.'s reasoning – pithily framed in the concluding sentence of para 32.10 (see above) - was that because the Line B Order had not in fact been strictly complied with (due to non-compliance with condition 28), the ordinary principles of common law applied in assessing the claim to nuisance. As the present case does not concern the defence of statutory authority, it is this second component which is of direct relevance.

246. Laffoy J. observed that the kernel of the plaintiffs' case was that the Green Line subjected them to serious noise nuisance, including sleep disturbance. Laffoy J. accepted the *bona fides* of the Smyths and concluded that there was no doubt on the evidence that they subjectively perceived that the operation of the Green Line interfered with the ordinary comfort and enjoyment of their home. However, the existence of nuisance is established by applying an objective standard. The defendant emphasises to this court that, in determining what that objective standard was, Laffoy J. adopted the noise conditions set out in the Line B Order itself.

247. The crucial passage of the judgment upon which the defendant places most reliance appears at para. 34.2:

> *"Even though the Line B Order has not been strictly complied with in the operation of the Green Line by the defendants since 2004, because of non-compliance with condition 28, the process which led to the making of the Line B Order in accordance with the Act of 1996, and its outcome, in my view, is a wholly reliable indicator as to what the ordinary person whose requirements are objectively reasonable would expect in terms of noise control and noise mitigation in the operation of the Green Line.*
>
> *"Every person who was likely to be affected by the operation of the Green Line had a statutory entitlement to make submissions to the Minister and to attend at the public inquiry conducted pursuant to the Act of 1996 and to make submissions,* inter alia, *on the proposals in the EIS in relation to noise and to noise mitigation. The question of noise was addressed at the public hearings and in the Inspector's report. He took cognisance of the views of the members of the public who appeared and made representations. On the basis that the projected noise levels identified in the EIS would be observed, and subject to compliance with conditions in relation to specific areas, and the general condition in relation to monitoring and fixing day-time and night-time limits, the Inspector found that the noise aspects of the project appeared to be satisfactory. There has been no challenge to that finding.*
>
> *...Therefore, I consider that I am entitled to treat the inspector's finding* [that the noise aspects of the project as set out in the EIS was satisfactory] *as the starting point of identifying the yardstick in applying the objective test. But for the fact that it has not been fully implemented, as conditioned into the Line B Order by (the NPS), it would be conclusive."*(Emphasis added)

248. Here, Laffoy J. is not solely concerned with the defence of statutory authority but with the common law principles governing the tort of private nuisance. The learned judge considered that the noise conditions in the EIS and the Line B Order were a proxy for the objective test of what is reasonable. She was satisfied that the inspector's finding in relation to the noise levels predicted in the EIS were a "*wholly reliable indicator*" as to what the ordinary person whose requirements are objectively reasonable would expect in terms of noise control. Therefore, operation of the Green Line within the noise levels predicted in the EIS – which were conditioned in the Line B Order - did not infringe the comfortable and healthy enjoyment expected by an ordinary person whose requirements are objectively reasonable in the particular circumstances. Laffoy J. therefore held that the Smyths had not established nuisance.

The proposition of law contended for by this defendant

249. This defendant effectively seeks to substitute the words "*the 2004 planning permission*" for the words *"the process which led to the making of the Line B Order in accordance with the*

Act of 1996" in para. 34.2 of Laffoy J.'s judgment. Counsel opened this particular passage to the court and stated, *"we say exactly the same thing pertains here."*- in other words that the limits in the permission are, as a matter of law, a wholly reliable indicator of what is objectively reasonable in terms of noise.

250. However, this aspect of Laffoy J.'s finding in *Smyth v. RPA* was based on the evidence before her. Weight is placed on the statutory genesis of the process culminating in the Line B Order. Weight is also placed on the robustness of the process, the evident depth of the consideration of the noise impacts complained of and the need for acoustic barriers. All this provides the context for Laffoy J.'s finding that the noise limits were *"a wholly reliable indicator"*.

251. This is evident from the very passage relied upon by this defendant (para. 34.2) in which Laffoy J. highlighted the following pertinent aspects of the statutory process and the resulting noise conditions: (a) every person who was likely to be affected by the operation of the Green Line had a statutory entitlement to make submissions; (b) such a person had a statutory entitlement to attend at the public inquiry and to make submissions *inter alia* on the proposals in the EIS in relation to noise limits and mitigation; (c) the question of noise was addressed at the public hearings and in the inspector's report; (d) the inspector took cognisance of the views of the members of the public who made representations; (e) the inspector determined that on the basis of the projected noise levels and mitigation measures identified in the EIS the noise impact of the project would be satisfactory and (f) there had been no challenge to that finding. These factors permitted the court to treat the inspector's finding as the yardstick to be applied in determining the objective test.

252. It cannot be gainsaid that the process under consideration in *Smyth v. RPA* was not only of statutory origin; it also incorporated a searching and comprehensive investigation, analysis and assessment of all noise aspects of the project. The relevance of these considerations to Laffoy J.'s finding is further evident at para. 34.9. Laffoy J. stated that if the NPS had complied with condition 28 and if the daytime and night-time limits set had accommodated the level of noise complained of by the Smyths then "*... that would have been the end of the matter.*" She continued:

> *"The defendants would be operating the Green Line in accordance with the law and there could be no question of the perpetration of a civil wrong on the plaintiffs. Where, in pursuance of a statutory process*

of the type formerly provided for in the Act of 1996, and now provided for in the Act of 2001, standards are established for permitted environmental effects and impacts of the construction and operation of a major public infrastructure, such as a public transport system, those are the standards by reference to which the statutory undertaker is authorised and required to act. In such circumstances, it is not open to an occupier of property in the vicinity of the infrastructure to contend that some other standard should be applied. In this case, in my view, as a matter of law, it was not open to the plaintiffs to contend that the Green Line must be operated in accordance with the WHO guidelines or the BS Code requirements so as to avoid committing a nuisance."(Emphasis added)

253. This finding of the court was on the evidence before it. The statement of principle expressed in this passage may not simply be applied to a totally distinguishable process such as a grant of planning permission for a single windfarm, particularly where (as will be further discussed below) that process does not reveal detailed consideration of the impact of WTN. In short, the above passage does not support the proposition of law advanced by this defendant.

Key item of evidence/ wholly reliable indicator of what noise is reasonable?

254. The defendant also relies upon *Smyth v. RPA* to argue that the planning permission is "*a key item of evidence*" establishing that the expectations of an objectively reasonable person *"have not been exceeded"*.

255. However, there is no comparison between the statutory process culminating in the Line B Order and that culminating in the granting of Ballyduff planning permission and, in particular, the adoption therein of the condition 15 noise limits.

256. The process leading to the grant of permission in this case was as follows. On 25th November 2003, the defendant applied to Wexford County Council ("the planning authority") for planning permission. The application includes no specific information on expected noise emissions. In contrast to the large number of submissions considered by the inspector prior to the making of the Line B Order, although duly advertised, no submissions were made by any effected landowners in relation to the Ballyduff application generally or in relation to the anticipated noise aspects specifically.

257. The report prepared by the planning authority's planner ("the planners report") of 22nd January, 2004 noted that the proposed site was in an elevated rural area which might prove suitable for a windfarm. Whilst the planning authority had not yet formally adopted a wind

strategy for the locality, the draft strategy identified certain areas in north Wexford where windfarms could be encouraged and the proposed Ballyduff turbines were in one such designated area. In contrast to the inspector's highly specific, area by area consideration of the likely noise impacts of the Green Line, the planner's report contains no assessment – formal or otherwise - of the likely levels of background noise or of the potential impacts of WTN (or shadow flicker) on residential amenity.

258. On 16th April, 2004, the planning authority granted permission for a period of 20 years duration. Condition 15 provided that noise levels from the proposed development when measured at the nearest inhabited house shall not exceed 40 dBA leq and 45 dBA leq at windspeeds of 5m/s and in excess of 10 m/s respectively. Beyond stating that the noise limits set out in condition 15 were "*In the interests of residential amenity and the proper planning and development*", the rationale for the selected noise limits is not elucidated. Although I believe the noise limits broadly reflect the limit of 40 dBA leq generally recommended in WEDG 1996, there is no express reference to that guidance.

259. As the grant of permission was not appealed, there was no consideration by An Bord Pleanála – or its inspectors – of the anticipated noise impacts.

260. Therefore, whilst it goes without saying that the permission is a "*planning consent ... given after due process for a development*" (in the words of Charleton J. in *Lanigan v Barry*,), the process is not comparable to the process held by Laffoy J. in *Smyth v. RPA* to establish a wholly reliable indicator of what is reasonable in terms of noise impacts.

<u>Planning permission does not fully regulate the matter complained of</u>

261. In any event, even if the specific noise limits set out in the planning permission were a wholly reliable indicator of what is objectively reasonable in this locality in terms of absolute noise levels, this would not assist the defendant for two important reasons.

262. First, the Ballyduff permission essentially regulates WTN decibel levels only. Although the ETSU approach takes into account blade swish and absorbs a certain level of AM into the recommended noise limits, AM values were then anticipated to be in the order of 3 dBA and of the swish variety. The ETSU methodology - upon which both the Ballyduff planning permission and WEDG 2006 is based - cannot therefore establish a yardstick for the particular

aspects of the WTN complained of by the plaintiffs in this case, high AM values, thump AM and the intrusion and dominance that accompanies those features. Neither the Ballyduff permission nor the planning file as a whole reveal any consideration, assessment or regulation of these features of WTN. How then can the permission comprise a wholly reliable indicator of whether the noise characteristics complained of here - high AM values and thump AM etc - are objectively reasonable?

263. Second, for reasons which I will explain below, compliance with the noise limits in the Ballyduff planning permission is not in any event demonstrated. Therefore, even if a grant of planning permission were to provide an absolute defence to a private nuisance action or to provide a wholly reliable indicator of what WTN must be considered reasonable at this location, it could not on the facts provide a defence in this case.

264. In short, I find that neither as a matter of law nor fact is the permission a wholly reliable indicator of what is objectively reasonable at this locality in terms of WTN.

The condition 28 argument

265. The defendant makes a related argument that if a development benefits from planning permission, but that permission does not fully regulate aspects of the noise complained of (AM, particularly, thump AM), then the court must (a) attempt to ascertain whether, and if so, how the planning authority might have regulated this impact had it directed its mind to it and (b) proceed accordingly.

266. This argument is based on a specific aspect of *Smyth v. RPA*. At 34.2, Laffoy J. stated:

> *"However, in light of what I consider to be the proper construction of the Line B Order and in particular, condition 28, it is necessary to consider what day-time and night-time limits would have been agreed to, or determined, if the (NPA) had complied with condition 28 prior to the commencement of operation of the Green Line in 2004 and to consider whether the operation of the Green Line at the rear of No. 3 would have come within those limits"*

267. In other words, having determined that the RPA had not complied fully with the terms of the Line B Order by failing to set specific daytime and night-time limits, Laffoy J. turned to consider as a matter of probability what daytime and night-time limits might have been agreed or determined had condition 28 been complied with.

268. The defendant gears off this logic to argue that as a matter of law this court is confined to considering "*what*...[AM] *limits*...*would have been* ... *determined*", by the planning authority at the time of the grant of permission in 2004.

269. However, this misses the rationale for Laffoy J.'s approach to the condition 28 issue. Consideration of what daytime and night-time limits might have been set under the Line B Order was relevant for two reasons. First, because, correctly construed, this is what condition 28 required. The exercise was therefore performed to simulate what would have occurred had the statutory process been correctly complied with. Second, such consideration was relevant in light of the court's finding that, for reasons I have already explored, the noise limits which would have been set in accordance with the statutory process (and all it entailed) were themselves a wholly reliable indicator - a conclusive yardstick - for what was objectively reasonable. This aspect of the *Smyth* case is in my view *sui generis.*

270. I therefore cannot accept the defendant's submission. The court is not bound by the approach that the planning authority might have taken in relation to AM in 2004. At that time, this feature of WTN was, to put the matter neutrally, incompletely understood.

Curial deference

271. In *Kelly v Simpson* [2008] IEHC 374, Charleton J. noted that:

> *"The effect of a planning decision can be that what would have been a nuisance because of the intrusion on the quiet, comfort and enjoyment of those occupying the area, as it was prior to the lawful grant of a development through planning permission, may be changed into something which those living in the area will simply have to tolerate ... Those who are elected to fulfil the role of the local planning authority can be hoped to take a longer term view as to how the development of their area could best be effected through fitting in housing and industry within an appropriate setting and without ruining the economic draw of an area."*

272. The defendant in the case before me accepts that the granting of planning permission does not create an immunity from being sued for nuisance. It nonetheless contends that very significant weight must be attached to the views of the planning authority. When asked to identify an authority in support of this proposition, the defendant points to a passage from *Lawrence & Anor v Fen Tigers Ltd & Ors* [2014] 2 All ER 622, in which the Supreme Court accepted that there are circumstances in which the terms of a planning permission will be relevant in a nuisance case, with Lord Neuberger stating as follows at paragraph 96:

"However, there will be occasions when the terms of a planning permission could be of some relevance in a nuisance case. Thus, the fact that the planning authority takes the view that noisy activity is acceptable after 8.30 am, or if it is limited to a certain decibel level, in a particular locality, may be of real value, at least as a starting point as Lord Carnwath says in para 218 below, in a case where the claimant is contending that the activity gives rise to a nuisance if it starts before 9.30 am, or is at or below the permitted decibel level. While the decision whether the activity causes a nuisance to the claimant is not for the planning authority but for the court, the existence and terms of the permission are not irrelevant as a matter of law, but in many cases they will be of little, or even no, evidential value, and in other cases rather more."

273. This passage is hardly a ringing endorsement of the proposition for which the defendant contends - i.e., that the court is bound to accept the planning conditions as a wholly reliable indicator of what is reasonable in terms of noise impact.

274. In a slightly different argument, the defendant contends that the planning permission is a *"pre-baked"* determination of what is reasonable. It is argued that an assessment of what WTN a reasonable person would be prepared to put up with at this location is "*hardwired into the process*" leading to the grant of permission.

275. This, the defendant asserts is evidenced by the fact that the noise limits in the Ballyduff permission reflect and incorporate (a) planning guidance at the time of the grant of permission, (b) the practice of planning authorities and An Bord Pleanála at the time of the grant of permission (c) current planning guidelines, i.e., WEDG 2006 and (d) current expert scientific knowledge both nationally and internationally in relation to the regulation of windfarm noise.

276. I cannot agree.

(a) Planning guidance at the time of the grant of permission

As I explain below at para 285 *et seq*, as the defendant interprets the Ballyduff permission, the noise limits do not in fact reflect or comply with WEDG 1996 which was the applicable planning guidance at the time of the grant of permission[37]. Conversely, as I will also explain at para 301 *et seq* below, if the Ballyduff permission is interpreted in accordance with the

[37] WEDG 1996 provides that noise levels measured externally at any dwelling house should not exceed 40 dBA Leq and yet the defendant argues that the planning permission permits noise levels of 45 dBA Leq for all windspeeds over 5 m/s.

applicable noise limits in WEDG 1996, then total operation noise exceeds the condition 15 noise limits.

(b) the practice of planning authorities and An Bord Pleanála at the time of the grant of permission

Planning practice at the time of the grant of permission was by no means homogenous. Mr. Lawlor furnished the court with 28 different planning decisions taken by a range of planning authorities and by An Bord Pleanála as representing planning practice roughly contemporaneous with the grant of the Ballyduff permission. Approximately half of these planning permissions applied a 5 dB penalty to WTN if the noise contained *inter alia* distinct impulses such as bangs, clicks, clatters or thumps or if the noise was irregular enough in character to attract attention. Clearly therefore, even at the time of the grant of permission, certain planning authorities and An Bord Pleanála were attempting to regulate and limit precisely the kind of characteristics of which the plaintiffs here complain. In light of this I find it difficult to see how the defendant can maintain that a planning permission which sets only an absolute decibel limit and effectively ignores AM reflects planning practice at the time of the grant of permission.

(c) Current planning guidelines, i.e., WEDG 2006

and

(d) current expert scientific knowledge both nationally and internationally in relation to the regulation of windfarm noise

Although I accept for the sake of argument that the noise limits in the Ballyduff permission and indeed the WTN itself comply with WEDG 2006, I cannot accept the defendant's submission that *"the permission limits continue to reflect the current combined wisdom and expertise of appropriately qualified experts as to what levels of WTN would and would not be objectively reasonable"*. Although the defendant contends that the permission complies with draft WEDG 2019, a comparison would not support this proposition. The essential methodology of draft WEDG 2019 sets maximum decibel limits by reference to background noise and penalises "excessive" AM. Demonstrably a permission which permits noise emissions up to 43 dBA L90 without regard to either background noise or possible AM impact does not reflect draft WEDG 2019.

Conclusion on issue 1

277. Depending upon the evidence, the court may in a nuisance action place considerable weight on the terms of a planning permission. The fact that the planning authority takes the view that a particular noise is acceptable at a particular locality, may be highly relevant. However, there is a spectrum of relevance depending upon the circumstances. At one end of the spectrum are cases where there is no assessment at all of the matter complained of. Such planning permissions are likely to be of no relevance in a nuisance case. At the other end of the spectrum are cases where the particular aspect of the development complained of is the subject of detailed conditions reflecting modern guidance and best practice. Such permissions (and the planning guidance on which they are based) are likely to constitute a strong indicator of what is objectively reasonable. At the mid-point will be cases where, for example the planning permission is opaque in its rationale, where the science in the area has moved on since the grant of permission or where the particular matter complained is incompletely regulated by the permission. Such permission is certainly not irrelevant to the nuisance assessment; but, in a WTN case, it can only assist on those aspects of the WTN which it purports to regulate.

278. I find that, at best, the Ballyduff planning permission is at this mid spectrum point. The permission regulates only one aspect of the WTN, the absolute decibel limit. The basis for the decibel limit chosen is unclear. Scientific knowledge and best practice now establish that significant elements of the noise impact are not regulated by the permission.

279. Indeed, the defendant's argument that the noise limits set out in the permission are paramount is particularly weak here. Although the planning permission was granted in 2004, it was not implemented until 2017 due to grid connection difficulties. If the permission had been implemented in April 2004, the turbines would be de-commissioned in the next few months. When such a long hiatus ensues between grant and implementation of a permission, there will always be a risk that evolution in scientific knowledge and amenity standards will bear down on the operation of the development.

Issue 2: Is compliance with the planning permission demonstrated?

Issue 2 (a): For the purposes of the nuisance case, which party bears the onus of demonstrating compliance or non-compliance (as the case may be) with the noise limits in the planning permission?

280. An unusual feature of this case is that, although the planning permission is a key piece of evidence, neither party had apparently adverted to an obvious ambiguity in the noise condition in the planning permission.

281. Condition 15 states:

> *"15. Noise levels from the proposed development when measured at the nearest inhabited house shall not exceed 40dBA (15 minute leq)[38] at a windspeed of 5 metres per second and 45dBA (15 minute leq)[39] at a windspeed in excess of 10 metres per second. Measures shall be made in accordance with I.S.O. Recommendations R1996/1 'Acoustics – Description and Measurement of Environmental Noise. Part 1 : Basic qualities and procedures...'*

282. It is clear that at a windspeed of 5 m/s, WTN may not exceed 40 dBA leq. It is also clear that at windspeeds in excess of 10 m/s, WTN may not exceed 45 dBA leq. However, the permission does not specify the applicable limit at windspeeds between 5 m/s and 10 m/s. There is therefore an ambiguity in the permission. Moreover, the resolution of this ambiguity impacts on whether or not the defendant has demonstrated that the WTN complies with condition 15.

283. The defendant suggests that the resolution of this ambiguity is not a justiciable issue in the context of the nuisance case because the plaintiffs have not pleaded any specific breach of the condition at windspeeds between 5 m/s and 10 m/s. I am satisfied that in the nuisance action, the defendant bears the onus of proving the defence advanced; namely that the WTN complies with the permission, correctly interpreted.

284. As it was therefore apparent that this ambiguity in the permission had to be resolved, I re-listed the matter and heard legal submissions from both parties on the interpretation of the permission. Although I take the view that the interpretation of a planning permission is primarily a legal matter for the court and does not turn on factual or expert evidence, I also afforded the parties an opportunity to call such further evidence as they deemed necessary

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[38] For brevity, 40dBA leq
[39] For brevity, 45dBA leq

either relating to or arising from this issue. The defendant re-called its acoustician, Mr. Carr, and its planning expert, Mr. Lawlor, who both gave evidence on the interpretation of condition 15. The defendant did not call further evidence to demonstrate that the WTN complied with the permission as interpreted by its counsel in argument or as interpreted by the testimony of its experts (which were quite different). Nor did the defendant call evidence on whether the WTN complied with the permission limits as interpreted by the plaintiffs. The plaintiffs did not consider it necessary to call any further evidence concerning the interpretation of the permission or relating to whether the WTN complied with the permission limits.

Issue 2(b): What is the correct interpretation of the noise limits in the permission?

285. As noted in Simons on Planning Law, 3rd Ed'n (Browne) at 1-141: Planning permission enures for the benefit of the land, and all persons who may be interested. A planning permission is therefore to be construed objectively, with the words given their ordinary and natural meaning, as would be understood by members of the public without legal training, as well as by developers and their agents. It appears that there are four alternative constructions of condition 15.

I. The interpretation urged upon the court by the defendant's experts Mr. Carr and Mr. Lawlor is that condition 15 sets only two defined limits; namely a limit of 40 dBA leq at 5 m/s and a limit of 45dBA leq at 10 m/s. If the WTN complies with these two specific limits, then that is the end of the matter. The defendant's experts therefore maintain that there is no noise limit at windspeeds between 5 m/s and 10 m/s. I pause to note that this was not the interpretation urged by counsel for the defendant in legal submissions to the court.[40]

   Mr. Carr argued that this interpretation is in compliance with WEDG 2006 which permits WTN of up to 45 dBA L90 without apparent reference to windspeed. However, any suggestion that one should interpret the permission by reference to WEDG 2006 is entirely incorrect. No evidence has been given that these guidelines were available, even in draft form at the time of the grant of this permission in April 2004. Indeed, even if they had been published in draft form, they could not inform the interpretation of the permission until formally adopted.

   By contrast, whilst extrinsic evidence may not generally be admitted in the interpretation of a planning permission, as the present permission is ambiguous, regard

[40] See part III below.

may be had to WEDG 1996 which provides the policy context referable to the determination of the planning permission. WEDG 1996 proceed on the assumption that WTN is most perceptible at lower windspeeds because of lower background noise. As such, it is all the more difficult to discern a valid rationale for apparently imposing a noise limit at 5 m/s and at 10 m/s but imposing no limit between 5 m/s and 10 m/s. Where appropriate, a planning permission is to be given a purposive interpretation to achieve its objective. The interpretation contended for by the defendant's experts would rob condition 15 of much of its utility. The turbine reaches maximum power output at approximately 9 m/s and, on the interpretation contended for, would at that point be subject to no noise limit.

As WEDG 1996 viewed WTN as being most impactful at lower windspeeds, this suggests that the intent of condition 15 was to control noise levels at low as well as at high windspeeds. Members of the public will give a planning permission a common sense interpretation, not a technical interpretation. It is in my view most unlikely that ordinary and reasonably informed members of the public without legal training would favour an interpretation which would permit the turbine to reach its natural maximum power out-put with no applicable noise limit.

The defendant's experts stated that as wind rises, so too does speed of rotation and consequently WTN. They therefore argue that, by definition, if WTN is no greater than 45 dBA leq at windspeeds of, or in excess of, 10 m/s, then compliance with that limit at lower windspeeds can be assumed. Conversely, if WTN were to rise to e.g., 50 dBA leq at a windspeed of 7 m/s, then it would necessarily also be significantly higher than 45 dBA leq at a windspeed of 10 m/s. Hence, they argue, it is necessary only to measure compliance at these two specified levels.

This ignores the fact that the turbine might require to be de-rated and operated in a constrained mode in order to secure compliance with the permission noise limits Indeed, it is common case that noise emissions for this model of turbine are predicted to climb by 14 dBA leq between cut in speed (which is slightly below 5m/s) and maximum power output (at approximately 9 m/s). If WTN is already or close to 40 dBA leq at comparatively low windspeeds (between 5 m/s and 10 m/s) then an increase of 14 dBA leq would bring WTN at maximum power output at 9m/s to a level substantially in excess of the 45 dBA leq permission limit. In short, even if compliant at 5m/s and/or 10 m/s, unconstrained, WTN might considerably exceed the condition 15 limits at windspeeds of 6m/s, 7m/s, 8m/s and 9m/s.

Therefore, one cannot comfortably assume that simply measuring noise emissions at 5 and 10m/s will necessarily protect residential amenity from WTN at these intermediate windspeeds. On the contrary, ensuring compliance at all windspeeds might require operational constraints and such operational constraint must be benchmarked against some noise limit. I therefore take the view that there must therefore be some noise limit between 5 m/s and 10 m/s. The question is: what is that nose limit? There are three candidates.

II. One might conceivably interpret the permission as providing that WTN may not exceed 40 dBA leq at 5 m/s and 45 dBA leq for all windspeeds above that. In a moment of refreshing harmony, neither party contended that this was the correct interpretation. I agree. This is a most unlikely interpretation as the permission specifically uses the words *"in excess of 10 metres per second"*, in permitting noise of 45 dBA leq. To interpret the permission as permitting noise of 45 dBA leq at windspeeds between 5 m/s and 10m/s would be to wholly ignore the words *"in excess of 10 metres per second"*.

III. The interpretation urged upon the court in the defendant's legal submissions[41] is that the noise limit permits WTN to increase incrementally between 5 m/s and 10 m/s, such that the noise is limited to 40 dBA leq between 5 m/s and 6 m/s, 41 dBA leq between 6 and 7 m/s, 42 dBA leq 15 between 7 and 8 m/s, 43 dBA leq 15 between 8 and 9m/s, and 44 dBA leq 15 between 9 and 10 m/s. This interpretation would require the court to insert detailed text into the condition to govern these intermediate windspeeds. If such a sliding scale of noise limits was the intended meaning, one would expect the permission to specify the interval windspeeds and corresponding noise limits. One would at the very least expect the condition to reference the principle of a sliding scale.

IV. The interpretation for which the plaintiff contends is that noise levels may not exceed 40 dBA leq at windspeeds of between 5 m/s and 10m/s and that the higher limit of 45 dBA leq only applies for windspeeds in excess of 10 m/s.
WEDG 1996 provides that generally noise levels measured externally at any dwelling house should not exceed 40 dBA leq. As the condition 15 limit of 45dBA leq is

[41] Albeit not supported by the defendant's experts.

considerably in excess of this generally applicable limit, there is little reason to assume it should be engaged at lower windspeeds.

Rather, it is reasonable to interpret the condition as reflecting the assumption that because background noise is lower at low windspeeds, this is when the impact of WTN is greatest. It is reasonable to assume that the permission means just what it says and is intended to restrict noise levels to the generally recommended limit of 40 dBA leq until windspeeds were comparatively high - in excess of 10m/s - at which point an uplifted limit of 45 dBA leq was judged acceptable.

I note that Mr. Carr indicated that he would not expect WTN to be as high as 40 dBA leq at the cut in speed of 4 m/s or 5 m/s. This is consistent with an interpretation pursuant to which the noise levels are permitted to gradually rise from a low base at cut in speed to 40 dBA leq at 10 m/s, but not beyond that until windspeeds exceed 10 m/s. A natural gradual ramp up of WTN with windspeed to 40 dBA leq is thus catered for.

286. In short, it is my view that, logically, some noise limit must apply at windspeeds between 5 m/s and 10m/s. Both the specific wording of the condition and the policy context drive me to the conclusion that the relevant permission limit between 5 m/s and 10 m/s is 40 dBA leq.

287. I emphasise that I do not purport to interpret any planning permission other than the one now before me. In particular, if similar wording were to appear in a windfarm permission granted after WEDG 2006, then this might affect matters. WEDG 2006 permits noise levels up to 43 dBA L90 (45 dBA leq) and 45 dBA L90 (47 dBA leq) for night-time and daytime, respectively. With reference to these guidelines, therefore, the argument that the permission is intended to limit WTN generally to 40 dBA leq would be significantly weaker.

Technical approach to assessment of compliance with planning compliance

ETSU approach

288. I accept the defendant's argument that although not expressed as such, condition 15 is an ETSU derived limit. The defendant's approach was therefore to assume that if the total operational noise is below the level set in condition 15, planning compliance may definitively be concluded. I accept that this approach complies with ETSU.

289. I also accept the defendant's contention that in accordance with standard practice, the GPG and Supplementary Guidance Note 5 govern the technical aspects of compliance (windspeed calculation, sound measurement, data collection, data filtering etc). [42]

290. Technical aspects of compliance are also referred to in condition 15 itself which states that measurements shall be made in accordance with ISO 1996-1, "*Description and measurement of environmental noise*" (ISO 1996). ISO 1996 comprises 3 parts. Part 1, which does not deal with measurements *per se* but rather with "*Basic quantities and procedures*", and cross - refers to Part 2; "*Acquisition of data pertinent to land use*" ("ISO 1996-2"). ISO 1996-2 which includes recommendations on measurement methodologies has been updated twice since 1996; in 2007 and 2017 ("ISO 1996-2, 2017") respectively. As the parties agree that it would not be standard practice to apply these later editions to a planning compliance assessment, I will apply the 1996 version.

291. The application of the following principles in assessing planning compliance are, to a greater or lesser extent in dispute. On each such contest, I prefer the defendant's approach.

L90

292. In measuring noise levels, the defendant's expert, Mr. O'Reilly used the L90 rather than the Leq metric specified in condition 15. The plaintiffs object on the basis that the L90 metric will have a smoothing effect on intermittent noise sources and will therefore fail to represent AM. Further, as L90, is a measure of the sound power level exceeded 90% of the time, it will of necessity be lower than the leq sound power level. Its use, however, is standard practice in the ETSU methodology which uses a conversion metric of plus 2 dBA as between L90 and Leq. The defendant's expert adopts this approach which I accept as an entirely legitimate approach.

[42] As we will see, the GPG/ Supplementary Guidance Note 5 are of particular relevance to the impact of wind direction on noise levels at the plaintiffs' houses in assessing planning compliance ("directionality").

10 or 15 minute leq?

293. Condition 15 sets the noise limits by reference to 15-minute leq intervals. However, I accept that, because the SCADA data is recorded in 10-minute intervals, it was appropriate to assess compliance by reference to 10 minute intervals.

Windspeed

294. Because windspeed varies with turbine hub height (which differs from turbine to turbine), setting noise limits by reference to hub height windspeed would result in inconsistency. A formula was therefore developed pursuant to which, irrespective of the hub height of the turbine, windspeed is extrapolated down to a 10 metre height using a standard wind shear profile. This enables sound emissions from turbines of different physical heights to be compared and regulated. The GPG states that unless otherwise stated, reference to windspeed is to the 10-metre standardised windspeed.

295. The defendant's planning compliance evidence and argument was presented as against both standardised 10 metre height windspeed and hub height windspeeds (without contending for either one or the other). As argued by the defendant I apply the GPG in other contexts. In the interests of consistency therefore, I will proceed on the assumption that compliance is also to be assessed as against standardised 10 metre height windspeed.

296. As I understand it, the standard practice for plotting windspeeds is that bins are centred on integer windspeeds with a width of 1 m/s. For example, the 5 m/s bin would include all data at windspeeds of 4.5 to 5.5 m/s etc. When applied to this permission, this would mean that condition 15 permits WTN of 40 dBA leq for windspeeds of 4.5 m/s to 9.5 m/s and 45 dBA leq for windspeeds in excess of 9.5 m/s.

Filtering

297. To minimise the effects of extraneous noise sources, ETSU recommends that measurements are taken during quiet waking hours (1800-2300 hours on all days plus 0700-1800 hours on Sundays and 1300-1800 hours on Saturdays) and night hours (2300 to 0700). The defendant's compliance data is therefore limited to these times.

298. I accept the view of both parties that planning compliance should be assessed primarily by reference to night-time data. Mr. O'Reilly has filtered out all night-time data between the hours of 4am to 7am to exclude elevated noise levels due to extraneous bird song during the dawn chorus. Mr. Stigwood is critical of this approach which excludes over a third of time data irrespective of the fact that the dawn chorus lasts for a comparatively short time.

299. Mr. Carr accepts that a more nuanced approach to filtering the dawn chorus might have been more appropriate, particularly because at higher windspeeds (i.e., at the right hand side of the graph) one would not expect the dawn chorus to have an appreciable impact on overall noise levels. However, having considered the GPG and Supplemental Guidance Note 5, I am satisfied that Mr. O'Reilly's approach is consistent with the ETSU methodology and I accept its validity.

300. Supplementary Guidance Note 5 provides that compliance measurements should be undertaken in downwind conditions unless there is a specific requirement to measure in other wind directions (such as complaints during cross wind conditions), and that all data except that corresponding to such conditions should be filtered out. Mr O'Reilly took this approach and filtered out all wind directions other than directly downwind of the turbine. Mr. Stigwood disputes the validity of this and maintains that the worst case noise prorogation conditions at this site actually occur in crosswind conditions. For reasons I will explain, I accept the validity of the defendant's approach as being more consistent with Supplementary Guidance Note 5.

Issue 2 (c): What does the compliance data show? - Evidence tendered on planning compliance

301. Mr. O'Reilly carried out noise monitoring at NF from 18th May 2017 to 15th June 2017. His evidence is that the noise monitoring equipment was placed on a terrace in the back garden approximately 17 m from the house at a height approximately level with the eves of the house. Mr. O'Reilly prepared two charts on foot of this monitoring and informed Mr. Brazil that the noise levels complied with the planning permission.

302. A month or so later Mr. O'Reilly was instructed to carry out monitoring at HH which he found strange. Mr. O'Reilly proceeded to conduct monitoring at HH between 6th August to 4th September, 2017. His evidence is that the noise monitoring equipment was placed on a bag

of sand in the patio at the back of the house 4.5 metres from the façade of HH, and 2.1 metres from the "end of" an adjacent garage door. Mr. O'Reilly informed Mr. Brazil that this monitoring also demonstrated planning compliance. He was, however instructed to hold off from writing a compliance report.

303. It was not until January 2021 that Mr. O'Reilly was instructed to write a compliance report. He was requested to present the HH data only. In the meantime, the NF noise monitoring data (referred to immediately above) appears to have gone missing and was only recovered from Mr. O'Reilly's computer in December 2022.

HH planning compliance data

304. The primary data advanced by the defendant was in the form of compliance graphs in respect of HH showing WTN in downwind conditions.

Incorrect measurement location

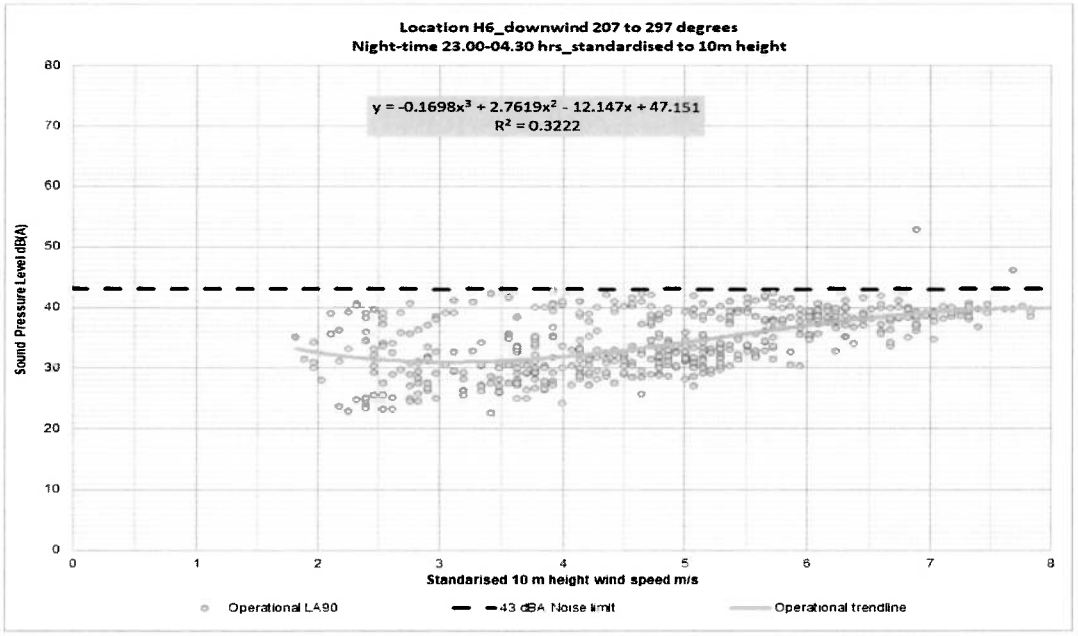
305. Condition 15 requires the measurement of noise levels at the nearest inhabited house. The nearest inhabited house is NF and not HH. Although as I say, Mr. O' Reilly took compliance measurements at NF in June 2017, for reasons which are not entirely clear to me, only the HH data was referenced in the defendant's experts' reports as the basis for the planning compliance assessment.

306. The defendant argues that as the two houses are only ten metres apart, it is unlikely that there is a substantial difference between their respective compliance levels. However, the data derived from HH and NF is quite different both as regards total operational noise and as regards the background sound levels they suggest.

307. As this was the approach taken by the defendant, I will consider the HH compliance data first. Having done so, I will turn to consider the NF compliance data.

Incorrect interpretation of condition 15

308. Mr. O'Reilly produced a number of graphs in which he presents total operational noise at HH during the period of his monitoring. The downwind HH night hours compliance graph (with the dawn chorus removed) is below.



309. Each data point represents a ten-minute period of noise measurements on the L90 metric. Each data point is therefore an average of the L90 noise levels (i.e., the noise level exceeded for 90% of the time during the 10-minute measurement period). In the graph below, these data points are then plotted as against windspeeds (standardised to 10 m), and a trend line is derived. This trend line represents an average of the data points which themselves represents the lowest 10% of the noise levels obtained. The trend line is then compared to the permission limits. In order to compare this data, which was on the LA 90 metric with the Leq metric used in the planning permission, Mr. O'Reilly applied a 2 dBA correction. He therefore assumed that the condition 15 limits of 40 dBA leq at a windspeed of 5 m/s and 43 dBA leq was 38 dBA L90 and the condition 15 limits at a windspeed in excess of 10 m/s was 43 dBA L90.

310. The above HH compliance graph demonstrates that the trend line is below 38 dBA L90 (40 Leq 10) at 5m/s and below 43 dBA L90 (45 Leq 10) at 8 m/s during quiet waking hours. Mr. O'Reilly therefore interpreted this graph as demonstrating compliance and the plaintiffs' expert did not demur in this particular respect.

311. However, neither expert had adverted to the ambiguity in condition 15. I have determined that, correctly interpreted, condition 15 limits WTN to 40 dBA leq between 5 m/s and 10 m/s. Although neither party's experts therefore tendered on this precise basis, the data

speaks for itself. It suggests that total operational noise at HH is in excess of 40 dBA leq for windspeeds in excess of 6 m/s.

312. Total operational noise above the permission limits does not of course establish planning non-compliance as the noise limit applies only to WTN and not to total operational noise. However, if total operational noise exceeds the noise limit, then the developer must ascertain and deduct background noise levels from total operational noise. The defendant has not carried out this exercise. Therefore, whilst non-compliance with the permission has not been conclusively demonstrated, nor has compliance been demonstrated[43].

Insufficient data

313. There is no data at moderate to high windspeeds on the HH night-time graph. Mr. O'Reilly stated that the NF data is far more complete, robust and overall "*better data*" than the HH data. Mr. O'Reilly had been happy with the NF data and expressed surprise that he had been asked to prepare a second set of readings. As such, it is hard to fathom the defendant's focus on the HH data to the complete exclusion of the NF data.

314. There is no noise data at HH during night hours at windspeeds above 8 m/s. It is not possible to reliably assess compliance at 8 m/s (which includes all data in 7.5 to 8.5 windspeed bin) as there are no data points between 8 and 8.5 m/s. Indeed, there are apparently only 5 valid data points between 7.5 m/s and 8 m/s. Compliance at night may therefore only be assessed up to 7 m/s (which includes all data in the 6.5 m/s to 7.5 m/s windspeed bin). For the same reason one cannot assess compliance at windspeeds of 9, 10, 11, 12 etc m/s.

315. Mr. Carr's response to this problem was to rely upon the data collected during quiet waking hours which shows that total operational noise increased from 39.5 dBA L90 at windspeeds of 7m/s to 42.4 dBA L90 at 9 m/s. Mr. Carr suggests that one could assume the same increase at night-time thereby combatting the paucity of data above 8m/s at night. With respect, this is to urge a rather *à la carte* approach to compliance assessment. I have been referred to no guidance which would permit of such an approach.

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[43] I deal separately below with whether a façade level deduction may be made in light of the measurement location.

316. On the contrary, the GPG requires that compliance data reflect either likely worst case noise conditions or the conditions complained of by the complainant (or both). Supplementary Guidance Note 5 provides that it will usually be necessary to carry out noise monitoring for around 1 month to obtain the necessary range of windspeeds and wind directions to ensure that noise limits are being met for worst case downwind propagation conditions.

317. As the plaintiffs' greatest complaints are at higher windspeeds, the absence of data at moderate to higher windspeeds, means that there is no assessment of the potential worst case WTN. Further, whilst they also complain of noise intrusion during the day, the plaintiff's primary complaint is of noise disturbing their sleep at night. Reliance on the quiet waking hours data at HH cannot fill the lacunae in the monitoring data.

318. This is no mere matter of detail. Although windspeeds during Mr. O'Reilly's monitoring were considerably lower, higher windspeeds are by no means unusual at this location. Mr. Carr prepared two tables of indicative windspeeds which show that windspeeds in excess of 7 m/s occurred 60% of the time during the MAS 2017 monitoring period and 35% of the time during the MAS 2021 monitoring period. Planning compliance clearly could not be established without including these windspeeds in the compliance data.

319. In addition, the inability to assess compliance at windspeeds in excess of 8 m/s means that even if I were to accept the defendant's expert's interpretation of the permission (which would require compliance testing at only 5 m/s and 10 m/s) compliance could still not be demonstrated. Nor, in the absence of data at the relevant windspeeds could compliance with the "sliding scale" interpretation contended for by counsel for the defendant be demonstrated.

Incorrect positioning for façade deduction

320. ETSU and Supplementary Guidance Note 5 require the placement of a microphone at a free field location, which as per ISO 1996-2 is at least 3.5 metres from the façade of a building. Mr. O'Reilly's report states that he positioned the microphone 4.5 metres from the façade of HH, and 2.1 metres from the *"end of"* an adjacent garage door. The measurements are neither free field measurements nor façade measurements, but a hybrid of both.

321. ISO 1996-2 states *"Note:-if measurements are made 1 to 2 m in front of the façade of a building...an approximation to the incident sound level may be obtained by subtracting 3dB from the measured value"*. Mr. O'Reilly relies on proximity to the garage door to make a deduction of *"at least 2 dBA"* from the measured values. There are two difficulties with this.

322. First, I am unconvinced of the robustness of these measurements insofar as concerns the location of his microphone. It was put to Mr. O'Reilly in cross-examination that his measurements were inaccurate, and that the monitoring equipment had in fact been placed 8.8 metres rather than 4.5 metres from the house façade. He freely conceded that this could be the case as he had only *"stepped out"* rather than measured distance to the house. This means that the reported measurements contains at least one significant inaccuracy, potentially almost doubling the distance from the house façade. It was also put to Mr. O'Reilly that he had also underestimated the distance from the microphone to the garage door. Mr. O'Reilly denied this and said that he had measured this distance with a tape measure. However, Mr. O'Reilly did not recall the site visits and did not take contemporaneous notes of same. As such, I must doubt the accuracy of a measurement first committed to paper several years after his site visit. This is not a reliable basis for claiming a 2 to 3 dB deduction in the measured sound levels.

323. Second, a façade deduction is dependent upon the angle of incidence as between the microphone and the façade. ISO 1996-2 applies this deduction to the measurements taken *"in front"* of the façade. In this case, the angle of incidence as between the microphone, the turbine and the contended for façade (the "garage door") is entirely unspecified. Mr. O'Reilly's report states that the microphone was positioned 2.1 metres from *"the end"* of the garage door, which does not suggest that it was perpendicular to the door. Indeed, nor do the photographs taken by Mr. O'Reilly of the monitoring equipment *in situ* so suggest.

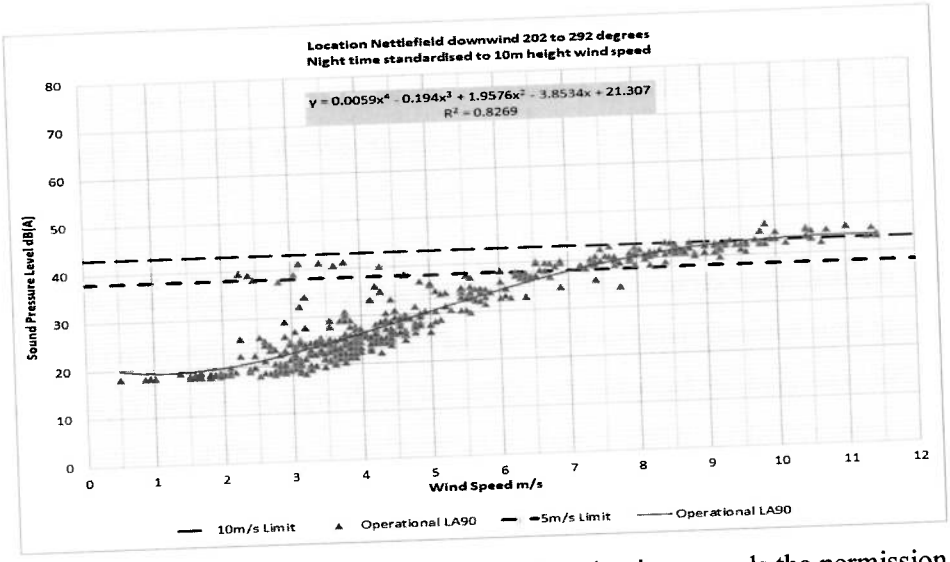
324. The onus is on the defendant to demonstrate planning compliance. In the absence of reliable measurements of both the distance to the façade and the angle of incidence, this is an exercise in conjecture. Whilst it is therefore perfectly possible (and indeed is likely) that some deduction should apply, one cannot without more know what that deduction should be.

325. In any event, this issue is largely academic as it appears unlikely that a 2-3dB reduction would bring total operational noise between 5 m/s and 10 m/s into compliance with the permission limit of 40 dBA leq.

NF planning compliance data.

326. On foot of his noise monitoring in May/June 2017, Mr. O'Reilly prepared downwind NF planning compliance graphs. However, these were not referenced in either Mr. O'Reilly's expert report or in Mr. Carr's reports. Further, no evidence was tendered in relation to the NF compliance data by the defendant's primary acoustics expert Mr. Carr over the course of his 7 days of evidence to the court. This data was only first introduced by Mr. O'Reilly on day 47 of the trial. In addition, notwithstanding repeated requests over a period of over five years the NF data was not at any stage furnished to the Carty-Shortens or to their solicitor. Furthermore, the NF data was not, (as the defendant accepts it ought to have been) included in the defendant's affidavit of discovery. In fact, the continued existence of the NF data only came to light in December 2022 during the course of the trial. It was first furnished to the plaintiffs on day 24 of the trial.

The downwind NF night hours compliance graph (with the dawn chorus removed) is below:



327. The NF graphs show that total operational noise exceeds the permission limit of 40 dBA leq at windspeeds between 7 m/s and 10 m/s. At a windspeed of 9m/s, it exceeds the limit by perhaps as much as 4 dB.

328. In addition, Mr. O'Reilly accepted that the NF graphs demonstrate that total operational noise at night exceeds even the 45 dBA leq limit in the permission from windspeeds of 9.5 m/s. As such, total operational noise exceeds the upper permission limit of 45 dBA leq even under the interpretation favoured by the defendant's experts whereby compliance is assessed only at 5 m/s and at 10 m/s.

329. For a number of reasons, the defendant argues that this exceedance is not attributable to WTN but to wind noise.

330. First, it emphasises that the turbine reaches maximum power levels at 9 m/s and that one would not therefore expect WTN levels to increase beyond 9 m/s. As such, it is argued that the exceedance of total operational noise over 45dBA leq at windspeeds in excess of 9 m/s cannot be WTN and must be background noise, specifically wind noise. Although I have been furnished with thousands of pages of guidance, not one document suggests that one could safely make this assumption.

331. Second, the defendant argues that these measurements were taken 17 m from NF and thus closer to the turbine. However, ETSU permits noise monitoring to be carried out some distance from a residence and states: *"In order to ensure that measurements of wind turbine noise are not influenced by reflections off buildings the microphone should be positioned at least 10m away from the façade"*. Indeed, Mr. Carr states that the GPG permits measurements between 3.5 and 20 m from a dwelling. Given the distance from the turbine to NF - 369 m - I fail to see how this additional distance could make an appreciable difference to the level of WTN.

332. Third, the defendant submits that the NF noise levels are elevated because they were taken at a height approximately level with the roof of NF. Yet, no effort has been made by the defendant to calculate what the impact of the additional height may be. Moreover, I have been referred to no guidance which would permit of an unspecified reduction in noise levels by reason of height.

333. Finally, the defendant suggests that because the monitoring equipment was placed 17 m back from the house and thus closer to the tree line, the increased noise levels can be explained by wind in the trees. Mr. Stigwood rejects the suggestion that such noise could have an appreciable impact on the noise levels recorded on Mr. O'Reilly's compliance graphs. His view is that although not as sheltered as the house, the monitoring location chosen is still sheltered. There is therefore a conflict of views on this issue upon which the court has entirely insufficient evidence to adjudicate.

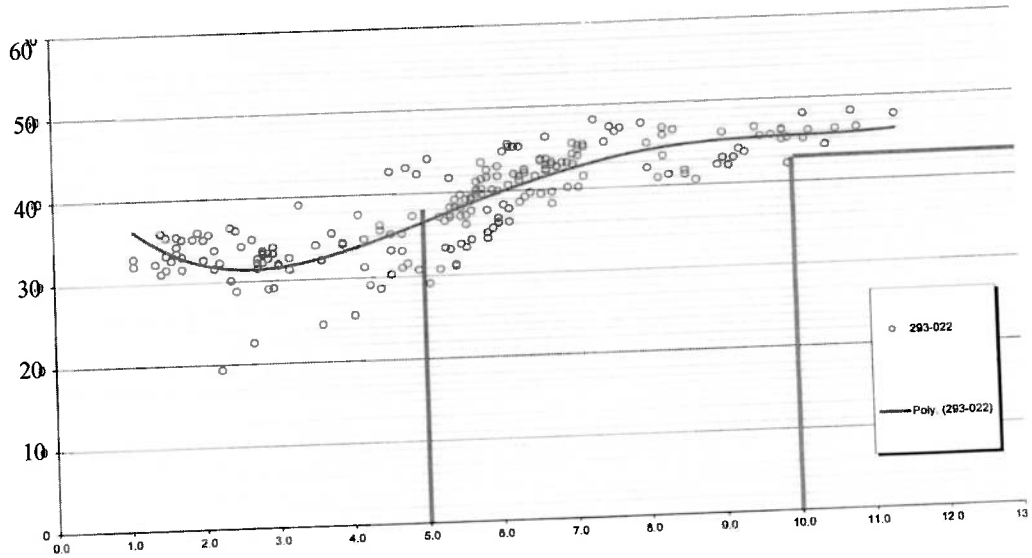
334. The point, however, is that I do not need to decide upon the merits of any of the defendant's above arguments. ETSU is crystal clear. If total operational noise is in excess of the relevant permission limit, then it is for the defendant to ascertain background noise levels at the relevant measurement location and deduct same from total operational noise. The defendant has made no effort to do this. Accordingly, whilst it may be that background noise levels are a substantial contributor to the noise levels appearing on Mr. O'Reilly's NF graphs, the present state of the evidence means that compliance is not demonstrated.

Wind Direction - the MAS NF crosswind planning compliance graph

335. The key to compliance monitoring is to ensure that the compliance testing is carried out under worst case conditions. According to the GPG, this is generally assumed to be downwind unless there are complaints in other wind directions. Mr. O'Reilly therefore presented compliance data only for downwind conditions and the other three quadrants were filtered out.

336. As referenced above, the defendant did not discover the NF monitoring data until mid-trial. When this data was finally made available, Mr. Stigwood interrogated it and formed the view that the worst case of WTN (in terms of absolute dBA or sound power level) apparently applied in crosswind and not downwind conditions.

The MAS NF crosswind planning compliance graph is below.



337. Mr Stigwood contends that this graph demonstrates that total operational noise exceeds the permission limits.

338. As the NF data was not made available until well into the trial, the purported non-compliance demonstrated in crosswind conditions could not have been pleaded. I will therefore admit this evidence and will, accordingly consider whether it impacts upon planning compliance.

339. The defendant contends, with some merit, that it would be extremely unusual if worst case noise propagation were to occur in crosswind conditions. It argues that the higher readings in crosswind conditions at NF are not attributable to WTN but to the fact that wind coming from this direction would be incident upon the treeline located to the west of the plaintiffs' house. This could be a perfectly coherent explanation for the elevated levels[44]. On the other hand, if the elevated levels were attributable to wind noise one would expect the noise to continue to climb as the wind increases. This however is not what the graph shows. Rather the noise increases up to 10 or 11m/s and then levels off. Mr Stigwood therefore argues that it is more likely that these elevated levels reflect WTN which levels off when maximum power output is reached at 9m/s approximately.

340. However, I accept the defendant's argument that compliance measurements need only be undertaken in downwind conditions unless there is a specific requirement to measure in other wind directions such as complaints during cross wind conditions. Overall, the evidence is not particularly consistent with complaints in cross wind conditions. As such, compliance monitoring in cross wind conditions was not required. I will therefore place no reliance upon the MAS NF crosswind planning compliance graph.

Summary and conclusions in relation to planning compliance.

341. In summary, it does not seem to me that the defendant's data demonstrates compliance with the planning permission for the following reasons:

a) Compliance cannot be demonstrated by reference to the HH compliance data because NF is the appropriate measurement location. Further, there is a paucity

[44] The Good Practice Guidelines acknowledge that in rural or semi-rural areas noise generated by wind in the trees is generally a dominant noise source at higher windspeeds and therefore proximity of the monitoring location to trees and vegetation and the type of such vegetation may be significant.

of night hours HH compliance data at all windspeeds above 8m/s. One cannot be confident that worst case WTN has been assessed.

b) Although this issue is largely academic due to point a) above, I am not satisfied on the balance of probabilities that Mr. O'Reilly correctly positioned the measuring equipment - either as regards distance from the façade or angle of incidence - to capture façade level measurements, I do not accept therefore that it is appropriate to deduct 3 dB from the HH measurements.

c) In any event, on the correct interpretation of condition 15, the HH night hours compliance graph shows that total operational noise exceeds the limits set out in the permission at windspeeds above 6 m/s.

d) Furthermore, the inability to assess night hours compliance at HH at windspeeds in excess of 8 m/s means that even if I were to accept the defendant's experts' interpretation of the permission (which would require compliance testing only at 5 m/s and 10 m/s) compliance could still not be demonstrated in the absence of data at 10 m/s.

e) Compliance at HH has therefore not been demonstrated.

f) NF is the closest inhabited house and the NF data is more complete and therefore robust. For that reason, compliance ought to have been adjudged by reference to the night hours NF compliance data.

g) The NF monitoring was not carried out at façade level and no façade deduction is indicated from the noise levels measured.

h) On the correct interpretation of condition 15 total operational noise as shown on the NF night hours compliance graph exceeds the limits set out in the permission at windspeeds above 7m/s.

i) Total night hours operational noise at NF also exceeds 45 dBA leq at windspeeds in excess of 9.5 m/s. Therefore, even if I were to accept the defendant's experts' interpretation of the permission (which would require compliance testing only at 5 m/s and 10m/s) compliance could still not be demonstrated.

j) Although the defendant argues that any exceedance of total operational noise over 45 dBA leq at NF is attributable to background noise/wind noise, the onus is on the defendant to so demonstrate by refence to background noise studies. No such evidence has been tendered to the court.

k) In addition, although the defendant contends that this exceedance may be due to monitoring height, it bears the onus of so demonstrating. No such robust evidence has been tendered to the court.

l) Compliance at NF has therefore not been demonstrated.

342. In the case of HH total operational noise exceeds 40 dBA leq between 6 m/s and 10 m/s by approximately 2 dBA. The exceedance at NF - which is the correct property for compliance testing - is greater, perhaps up to 4 or 5 dBA. An exceedance of this order is potentially a material deviation from the noise limits in condition 15.

343. I accept that on the defendant's experts' interpretation of the permission, the exceedance of total operational noise over 45 dBA leq at 9.5 m/s and above is marginal, perhaps no more than a decibel overall. However, this is largely beside the point as I do not accept that this is the correct interpretation of the planning permission. Moreover, the defendant's chosen defence to this action is to maintain that the planning permission is the appropriate metric for assessing nuisance. In contrast to the plaintiffs, who argue that the test for nuisance is both quantitative and qualitative, the defendant argues that the test is purely quantitative and that the WTN is "*meticulously compliant*"[45] with the permission limits. Whilst I reject the argument that the nuisance assessment is exclusively quantitative, it could only ever carry weight if meticulous compliance is in fact demonstrated. Mr. Carr's evidence was that he would regularly advise wind farm developers in adopting mitigatory strategies to bring down WTN by a decibel or two to ensure compliance. There is no suggestion therefore that relatively modest exceedance would not be viewed by the planning authority as non-compliance or would not require the adoption of mitigation measures. Therefore, even if the interpretation that the defendant's experts place on the planning permission is correct, I would not be disposed to hold that compliance is demonstrated.

344. In short, I do not accept the defendant's arguments on Issue 1 or Issue 2.

345. The defendant's arguments are not therefore dispositive of this case, and I will now turn to the key question of whether nuisance is established on the evidence.

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[45] In the words of the defendant's planning expert, Mr. Lawlor.

Issue 3: is the character of the locality to be assessed on a "windfarm" or "no windfarm" basis?

346. The character of locality is an important factor in any nuisance assessment. Here also a dispute arises as to the relevance of the planning permission.

347. The plaintiffs and their experts present the locality as a quiet rural location *simpliciter.* To assess nuisance, they therefore compare the current scenario to a "no turbine" scenario.

348. The defendant argues that the planning permission defines the character of the locality, which is therefore presented as a rural location with a windfarm at reasonably close proximity with all that that entails.

349. Should one assess the character of the locality with or without the Ballyduff windfarm?

350. In general, the Irish courts have tended to afford weight to the decisions of the planning authorities in determining the character and nature of the locality. In *Lanigan v. Barry*, Charleton J. considered the relevance of planning permission in determining whether an actionable nuisance had occurred. At para. 22 of the judgment, Charleton J. stated:-

> *"In considering the issue as to the amenity of an area, regard should be had to its immediate history and its character prior to the commencement of the activity complained off. The character of a neighbourhood may, however, change. This may be due to economic deprivation or to the development within the area of enterprises and structures which change its character. In that regard, the wider question as to how an area is to develop is to be determined in accordance with the Planning and Development Act, 2000. The legislation is an example of the application of democratic principle to the important question as to how the area in which a citizen lives, or carries on his or her business, may change. ... Were the legal mechanism of the scrutiny of planning permission not to exist and were it not the case that notice must now be given in a direct manner through what is in effect an advertisement as to what may happen at the site of a proposed development, then persons might feel aggrieved at being taken by surprise when a factory, set of apartments or some house extensions, suddenly spring up beside them. The legal mechanism is there, however, to allow participation in decisions which may affect the environment, the value of property and the nature of such quiet and comfort as may be the settled expectation of people in any particular area. Therefore, where planning consent is given after due process for a development, including a change of use, the issue as to what is a nuisance will be determined according to the character of that neighbourhood as authorised by relevant planning permissions and as declared by the development plan."* (Emphasis added).

351. In *Gillingham Borough Council v. Medway (Chatham) Dock Company Ltd* [1992] 3 All ER 923 at 934 Buckley J. had noted that Parliament had set up a statutory framework and delegated the task of balancing the interests of the community against those of individuals to the local planning authority. The right to object, the provision for appeals and enquiries and the added safeguard of judicial review applied but, ultimately, a planning authority could, through its development plans and decisions, alter the character of a neighbourhood rendering innocent activities which, prior to that change, would have been an actionable nuisance.

352. In *Lanigan v. Barry,* Charleton J. quoted these passages which in his view emphasised the primacy of the planning process in setting local standards of amenity.

> *"24. This does not mean that a nuisance is authorised by a planning permission granted in accordance with the development plan of a local authority. On the contrary, people retain their rights but according to the standard, judged against the nature of the locality, that the law sets.*
>
> *25. All of this emphasises the primacy of the planning process in setting local standards of amenity. That process can not be ignored or flaunted or undermined by deception. The standard of amenity that is reasonably to be expected by people living in an area can change as an area is lawfully developed. The nature of businesses suitable for an area can also change as an area is developed by lawful means. Unless the business activity be regarded as unduly sensitive, and therefore unsuitable for the character of an area in which it is situated, no one is entitled to use a planning permission to destroy the business of a neighbour"* (Emphasis added).

353. In *Smyth v. RPA*, Laffoy J. also referred to the then recent English authority in *Watson v. Croft* [2008] 3 All ER 1171 in which the Court of Appeal restated the basic principle that a grant of planning permission does not affect the property rights of third parties but that the implementation of that planning permission may so alter the nature and character of the locality as to shift the standard of reasonable user which governs the question of nuisance or not.

354. I accept the defendant's submission that, as a matter of law and fact, part of the character of the locality where the plaintiffs' homes are located is that there is planning permission for a windfarm. I also accept that this inevitably brings with it some degree of visual and aural intrusion - some degree of aerodynamic noise and some AM - which the plaintiffs would be expected to tolerate. However, in the words of Charleton J, "*this does not mean that a nuisance is authorised by [the] planning permission. On the contrary,* [the plaintiffs] *retain their rights but according to the standard, judged against the nature of the locality, as including a windfarm.*"

355. Here the plaintiffs do not base their claim to nuisance on the mere presence of the turbines in a quiet, rural area. Nor does their evidence suggest any objection to some aerodynamic noise or some swish AM of the kind one would usually expect.

356. On the other hand, no reasonable person could reasonably have expected that this permission had authorised WTN which regularly dominates the soundscape and exhibits AM and other characteristics rendering it unreasonably difficult to work, or uncomfortable to relax or sleep. Although the character of the locality includes a windfarm, it is still the case that depending upon the level of intrusion and on its duration and frequency, the WTN associated therewith might be such that ordinary people could not reasonably be expected to tolerate it without mitigation, without compensation, or possibly at all. Whilst the plaintiffs cannot expect their location to be as peaceful as if there was no windfarm, they can nonetheless expect that noise intrusion from the permitted windfarm will not be unreasonable.

357. The court's assessment here must be reasonably exacting. Because of the planning permission, the plaintiffs cannot fairly contend that audible WTN is by definition an unreasonable interference. On the other hand, the defendant cannot say that because (particularly in more recent times) WTN is known to occasionally demonstrate certain particularly intrusive characteristics - for example prominent or thump AM - the grant of planning permission means that the plaintiffs have no remedy if these characteristics present themselves in a manner that is unreasonable in all the circumstances. WTN of this latter nature could not have reasonably been anticipated on foot of the Ballyduff planning permission and is not therefore part and parcel of this locality.

Conclusion on issues 1, 2 and 3

358. In the circumstances of this case, the Ballyduff planning permission does not dictate the boundaries of actionable nuisance. While the decision of the planning authority grants planning permission at a general level for a windfarm at this location, it does not purport to address or regulate the key aspects of the WTN which are complained of here - AM with high AM values and low frequency characteristics.

359. Whilst a windfarm is part of this neighbourhood, this does not mean that the plaintiffs should be expected to tolerate any and all noise nuisance that goes with that use. All that the

planning permission can be said to authorise is WTN of a particular decibel level whereas this case is not about the decibel level of the noise but rather its character. It cannot be therefore said that the characteristics complained of are authorised by the planning permission and must be seen as part of the locality.

360. Furthermore, it has not been demonstrated that the WTN is within the noise limits specified in the permission in any event. Therefore, even if this case revolved around decibel levels only, I could not be satisfied that the permission authorises WTN at the level that presently pertains or that WTN at these levels is part of the character of the locality.

Issue 4: What criteria ought the court consider in the assessment of nuisance?

Defendant's argument-the line in the sand

361. The defendant correctly submits that the question of whether the WTN is an objectively unreasonable interference with the plaintiffs' amenity cannot be determined by reference to the plaintiffs' subjective evidence. It further argues that the plaintiffs have made no attempt to establish what their requirements are or, how they can be regarded as objectively reasonable.

362. Thus, the plaintiffs have failed to:

- identify by way of the ETSU methodology the decibel level beyond which noise becomes objectively unreasonable and poses a nuisance or;
- identify, in a manner analogous to the draft WEDG 2019 methodology, the precise parameters pursuant to which noise of a particular decibel level combined with a particular level of AM becomes objectively unreasonable and poses a nuisance.

363. In short, the plaintiffs have not identified a line in the sand, a line of acceptability. Unless and until such a line is identified and applied, it is said that the court cannot assess the matter. Irrespective of how the WTN is experienced by the plaintiffs, this line must determine

the outcome of the case. However, the defendant's attempt to identify what the line should be are in my view unconvincing.[46]

364. The primary "line" identified by the defendant and its experts is of course the planning permission. For all the reasons explained above, I find that the line cannot be supplied by condition 15 (with which in any event compliance has not been demonstrated) as it does not regulate what is said to be the most intrusive aspects of the Ballyduff WTN, namely AM, particularly thump AM.

365. Nor, for the same reason, can the line be supplied by WEDG 2006 (with which, for the sake of argument, I accept the WTN complies). WEDG 2006 does not provide the court with any yardstick - objective or otherwise - against which to assess what AM values or what degree of thump AM is objectively reasonable.

366. Similarly, although the defendant places huge reliance on IOA RM, that methodology is not intended to capture the subjective annoyance response and does not purport to be a yardstick for nuisance. The IOA RM cannot tell one what the noise sounds like. Crucially, the defendant's experts do not contend that the IOA RM differentiates between swish and thump AM. Despite Mr Carr's very heavy reliance upon it, the IOA RM is not a "recognised standard"" capable of assessing the <u>impact</u> of AM, and thump AM in particular. The only yardstick of which I have been informed for identifying and assessing the impact of thump AM is the qualitative yardstick advanced by the plaintiffs' expert; to record, listen and analyse the WTN and to correlate same with spectral frequencies by means of a spectrogram.

367. Even leaving these difficulties aside, the IOA RM is not in any case "self-executing". The IOA RM only assists in establishing a "line" if it is used to rate AM values per windspeed on foot of which one then calculates a penalty and then incorporates that penalty into a defined decibel limit. In other words, the IOA RM could only even provide a yardstick for objectively reasonable noise if deployed in a manner analogous to the draft WEDG 2019 methodology.

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[46]As I note above in my summary of the expert's evidence, Mr Carr's opinion was that nuisance must be assessed in accordance with "*some recognised standards or guidance*". In this respect, Mr. Carr relied primarily on the planning permission and WEDG 2006, but also mentioned draft WEDG 2019 with which he asserted the WTN complied. He also relied heavily on the IOA RM.

368. Yet the defendant and its experts do not see this logic through. Although it maintains that it complies with draft WEDG 2019, the defendant also distances itself from that guidance. The defendant emphasises that although consideration was being given in draft WEDG 2019 to changing the basis of regulation from that set out in WEDG 2006 – principally to bring down maximum noise limits from 45 dBA L90 to the 43 dBA L90 or 5 dBA over background and to reflect a penalty for AM - this draft guidance has not been brought forward. The defendant's uncontradicted evidence is that the present practice of planning authorities is to fix permission noise limits for wind farms in accordance with WEDG 2006 - i.e., by reference to fixed decibel limits only with no penalty for AM.

369. The defendant therefore argues that because this is the present practice of local authorities, the court ought to adopt a similar approach in its assessment of nuisance in this case. I do not agree. The issue is not whether or not WEDG 2006 remains the current regulatory framework for windfarms in this country or indeed whether the Ballyduff WTN complies therewith. Neither WEDG nor present planning practice can determine the matter at hand because they do not reflect current expert scientific knowledge on WTN. Current expert scientific knowledge at least informs more recent publications such as draft WEDG 2019 and the ETSU Review (although of course the first of these has been withdrawn and the second has yet to be formally adopted). Unlike these more recent publications, WEDG 2006 does not even consider the extent to which those aspects of the WTN which are the source of complaint in this case may be said to be objectively reasonable.

370. The fact that AM and thump AM remain to be regulated does not mean that the court should ignore these characteristics. I fail to see how it can credibly be said that merely because an acknowledged problem has not been regulated in the planning sphere the court should now ignore the problem in the context of a nuisance action.

371. This review of WEDG 2006 is clearly a difficult and long-drawn-out process and the same is evidently the position in the UK. In and of itself this demonstrates just how complex and multifactorial the impact of WTN can be.

372. This ongoing evolution reveals the fallacy of a related argument advanced by the defendant; namely that the plaintiffs must demonstrate non-compliance with WEDG 2006 and that the failure to do so effectively means that nuisance is not established. The plaintiffs do not

rely upon non-compliance with current planning guidance as establishing nuisance. They argue - correctly in my view - that existing planning guidance effectively (WEDG 2006) is not responsive to the issues complained of - AM, thump AM etc.

373. I think it is fair to conclude that the current direction of travel in wind energy planning guidance is towards setting decibel limits combined with a penalty for character such as AM together with limits on low frequency noise. However, the recommended decibel levels in draft WEDG 2019 might go up or they might go down. The suggested penalties for AM might also go up or they might go down. The permitted exceedance over background noise might go up or it might go down. Likewise, the current low frequency curve may be adjusted.

374. Draft WEDG 2019 is perhaps a reasonably up to date indicator (2019) of what might have been considered appropriate in terms of WTN, AM, low frequency noise etc. However, it is no more than that. Draft WEDG 2019 has since been withdrawn. I therefore criticise neither party for failing to carry out a formal assessment of the Ballyduff WTN as against these draft guidelines. I do, however criticise the defendant's casual assertion that it complies with draft WEDG 2019 (indeed with "*headroom*") when there is little credible basis for this view.[47]

375. I should say that this court would place very considerable weight upon up-to-date, scientifically robust planning guidelines on wind energy developments which advised on the particular decibel level at which WTN, when combined with AM of a particular nature, is considered an acceptable interference with amenity. If responsive to the particular aspect of the noise complained of, such guidance would be highly persuasive in a nuisance action. A plaintiff who sought to argue that such guidance did not represent a reliable – if not a wholly reliable – indicator of what is objectively reasonable would, in my view, bear a heavy onus. However, no such guidance currently exists; planning guidance in this jurisdiction (and elsewhere) can fairly be described as flux and cannot identify the line of acceptability.

376. This raises a further principled objection to the notion that the plaintiffs must identify a line in the sand upon which this court must rule. Although the defendant does not overtly request a line to be drawn for every windfarm, this would seem to be the terminus of its argument.

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[47] I explain this further at para 206 *et seq* above and 471 below.

377. Yet, there is currently a government policy in evolution in relation to the wind energy development which one would expect to consider at least some of the crucial components of this line in the sand. WEDG 2006 is in the course of review. It would in my view represent a wholly unwarranted intrusion on the executive function for the court to attempt to draw the line of acceptability for windfarm noise. Not only does the court have no jurisdiction to do this, but it also lacks the expertise to even attempt this task.

378. In short, neither the parties' experts nor the court can or should attempt to set a line of acceptability for the community as to what constitutes unacceptable windfarm noise. That is not the purpose of this litigation.

The Defra criteria

379. Ms. Large and Mr. Stigwood identified BS 4214, *Methods for rating and assessing industrial and commercial sound* and the Defra Guidance as the methodologies of most assistance to the court in the assessment of WTN nuisance.

380. I accept the defendant's contention that BS 4142 applies to the assessment of industrial and commercial sound generally and that it is not appropriate to apply it when there is other more specific guidance on windfarms, such as the Defra Guidance.

381. I accept that the Defra Guidance is of considerable assistance. Although the Defra Guidance relates to complaints of (United Kingdom) statutory noise nuisance and not to private nuisance, it is a *"recognised standard or guidance"* on the assessment of WTN nuisance. The Defra Guidance provides a helpful framework under which to analyse the various elements of a WTN nuisance complaint.

382. Whilst not necessarily subscribing to the Defra Guidance to the same extent as the plaintiffs' experts, Mr. Carr referred to it in his direct evidence. In particular he referred on several occasions to the following passage:

> *"Because there are no fixed decibel levels and noise index based standards that act as thresholds for the onset or as a definitive test for Statutory Nuisance, the primary uses of noise measurement will be establishing the intensity of the noise complained of and whether an established threshold of impact is being exceeded as an indicator of impact; and to assist in deciding if the complainant is being more than*

ordinarily sensitive. Consequently, the choice of noise index will depend on what guideline, standard or limit value is used to assist in making this judgment or articulating the reasons for a decision".

383. Mr. Carr argues that this means that the plaintiffs must demonstrate that a threshold of impact or "*threshold of significance*" has been exceeded before they can establish nuisance. At a broad level, I accept that this is so. The courts will not entertain claims for minor annoyances and the interference with the use of the plaintiffs' land must exceed a minimum level of seriousness to justify the law's intervention.

384. However, I do not accept that this "*threshold of significance*" is determined by decibel level alone, by the noise limits in condition 15 or indeed by WEDG 2006. Sound levels which can be measured by a sound level metre or other measuring system describe only the amount of energy in a sound but do not provide any other information about its qualities. Therefore, as the Defra Guidance makes clear, noise measurement are helpful but not determinative. The Defra Guidance states that the assessment must be made *"in the context of the specific complaints made and the circumstances of each case, there is no one size fits all approach that can be applied in all situations; instead, a bespoke investigation is required in each case".* Ironically, one of the criticisms Mr. Carr levels at the MAS assessment methodology is just that - that it is, in his words, *"bespoke".*

385. The criteria identified by the Defra Guidance as relevant to the "*bespoke investigation*" - together with certain other pertinent considerations identified by the plaintiffs' experts - which purely for the sake of brevity I will refer to collectively as "the Defra criteria"- are as follows:

- sensitivity of the complainant.
- the level of WTN;
- the type of noise – e.g., the prevailing AM value and the variability, regularity and predictability of the noise;
- whether any aggravating characteristics are present in the WTN - the spectral content of the WTN and whether thump AM is present;
- the characteristics of the neighbourhood where the WTN occurs;
- the exceedance of WTN over background noise;
- the impact of the WTN on basic needs such as sleep;
- how easily the WTN can be avoided and what measures could reduce or modify the WTN;

- the time of day or night when the WTN occurs;
- the duration and how often the WTN occurs.

386. The above factors reflect the fact that human hearing is obligatory in the sense that our brains are constantly analysing and interpreting sound. Human responses to sound therefore combine both physiological and psychological responses. Noise is related to human response and is routinely described as unwanted sound or sound that is considered undesirable or disruptive. The difference between a sound and a noise is dependent on a number of objective and subjective variables. This all means that the characteristics of a given sound can have a considerable influence on our reactions. I accept Ms. Large's evidence that constant sound with minor change to volume, frequency or character can be easily accustomed to. By contrast, sound characteristics that attract attention and render the sound more discernible are generally considered to increase annoyance. Negative responses are therefore associated with variable, unpredictable sounds and with unexpected changes in loudness such as impulsivity, erraticism and intermittency. Assessment of noise nuisance must consider all of these variables.

387. I also note that the Defra criteria are quite similar to those listed by the EPA in *EPA NG4: Environmental Protection Agency Office of Environmental Enforcement (OEE) Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities* ("EPA NG4") [48]. Although this guidance, unlike the Defra Guidance, is not windfarm specific, it can only be seen as an endorsement of the view that both quantitative and qualitative factors must be weighed and assessed with care and professionalism in each case.

388. It is my view, that a robust assessment of a windfarm noise private nuisance complaint cannot be conducted without reference to factors such as the Defra criteria.

Issue 5: Do the criticisms advanced by the defendant undermine the reliability of the plaintiffs' experts' evidence - and the data on which it is based - on nuisance?

389. Before assessing the evidence presented in this case as against the Defra criteria, it is first necessary to consider the reliability of the audio recordings (and the associated graphs)

[48] This notes that the potential impact of noise is dependent on a wide range of factors such as:
• *The subjective loudness/the measured sound pressure level;*

which the plaintiffs' experts placed before the court. In particular, it is necessary to determine whether the various criticisms levelled at this evidence by the defendant and its expert, Mr. Carr, mean that the court ought not to treat this evidence as reliable or probative in determining whether nuisance is made out.

Purpose of the plaintiffs' audio recordings and the associated graphs

390. Both parties agreed that the court should hear the MAS audio recordings and consider the associated graphs. However, the defendant contends that this data is relevant for "context" only. Beyond that, it is said, the court ought to pay it no further regard.

391. Mr. Carr contended that the MAS approach of presenting such data to the court was novel and bespoke and would not be considered best practice.

392. By contrast, Mr. Stigwood states that no other existing methodology allows one to appreciate the complainant's noise environment. He states that the same audio/graphical presentation method has been adopted both by MAS and by opposing experts in every wind farm nuisance case in which he has been involved.

393. Mr. Stigwood used a barking dog analogy to illustrate the drawbacks of relying solely upon average decibel levels to assess nuisance. The leq 10 of a barking dog over a ten-minute period tells one nothing about the character or intermittency of the barking. One loud bark might produce the same average decibel level average as ten lower barks. Yet, a single bark might disturb for ten seconds whereas ten lower barks would pose considerably greater disturbance. Further, as L90 considers only the level exceeded 90% of the time, neither the single loud bark nor the ten lower barks would alter the L90 decibel level.

394. I accept that both the L90, and to a lesser extent the 10 or 15 minute leq averages, are relatively insensitive to rapid fluctuations in noise level such as AM. A complaint centred on the changing character and nature of AM cannot be analysed by average decibel level alone pursuant to either the L90 or leq metric. Moreover, WTN can present at higher or lower frequencies giving rise to swish and thump AM respectively. Yet, these cannot be distinguished using either L90 or leq.

395. Because the plaintiffs complain of high AM values, it would undoubtedly have been of considerable assistance if either party had performed a long term assessment of external AM values at NF or HH in strict accordance with the IOA RM. This however had not been achieved.[49] On the other hand, the defendant has not contended that the IOA RM can differentiate between the impact of swish and thump AM, which is one of the plaintiffs' crucial complaints. The plaintiffs also complain of other features which the IOA RM is not designed to capture or assess - such as erraticism, impulsivity, variability/intermittency and general unpredictability of the AM.

396. Any robust noise nuisance investigation must engage with the complaint actually made. It simply cannot be credibly argued that - an assessment of whether these plaintiffs' subjective complaints are objectively justified - requires no more than a comparison with the noise limits set out in the planning permission and in WEDG 2006.

397. Indeed, it appears that even a planning compliance investigation often involves actually listening to the noise, Supplementary Guidance note 5 advises:

> *Irrespective of the requirement to carry out tonal analysis, it may be useful to carry out audio recordings for 2 minute samples in every 10 minute interval in all cases to allow for subjective evaluation of any noise effects and particularly of any time histories produced to assist with any discussions about the acoustic character of the noise...., It should be noted that a subjective assessment of this nature would normally be carried out with regard to a diary of complaints or certain wind conditions that have been found to correlate with complaints since listening to all data would usually be impractical.*

398. In short, the nuisance assessment requires an engagement with and an evaluation of the plaintiffs' complaints in light of all of the evidence which tends to either corroborate or undermine those complaints. In my view the audio recordings of the WTN and the associated graphs are important components of this evidence.

399. I emphasise that the exercise undertaken by MAS is not simply to assess nuisance by listening to the WTN. Rather, the plaintiff's evidence places the features of the WTN - such as its AM values and the presence of thump AM - in context. MAS estimate general AM values on site in a manner that enables one to compare these values to guidance (such as the Phase 2 Report and draft WEDG 2019) which identify AM values at which annoyance is known to

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[49] Indeed, MAS had intended to conduct a formal IOA RM analysis on foot of the 2021 NF external data. For reasons I will explain, however, this data is not sufficiently robust to provide a valid basis for IOA RM analysis.

occur. MAS does not merely identify thump AM on the audio recordings. It correlates the WTN by using spectrograms to confirm the presence of lower frequency sound energy manifesting as audible thump AM. Although Mr. Carr is no doubt correct in stating that various people have various different opinions about what constitutes an unreasonable interference; it is unfair for him to imply that MAS simply played the audio recordings of the WTN to the court and then said, "*isn't this awful?*".

Contamination/Differentiation

400. The defendant submits that the audio recordings might be contaminated by ambient noise, principally wind noise.

401. Mr. Stigwood and Ms. Large did not subjectively listen to the several months of audio recordings collected at both residences. However, Mr. Stigwood did listen to and screen - both aurally and visually (including by spectral correlation) - the audio recordings played to the court and forming the basis for the associated graphs presented in the MAS reports. Therefore, the data presented to the court, and to which I have had regard, has been screened by MAS.

402. Mr. Stigwood was confident that he could discriminate as between ambient sounds and WTN. After listening to almost 25 such recordings (excluding the 2021 NF external audio recordings), I accept that this is generally the case for both the external and internal audio recordings. When AM is present - as it was on virtually every single recording - the WTN is rhythmic in nature, albeit highly changeable and unpredictable. It rises and falls, often quite sharply, every couple of moments. It also disappears and returns again, fading in and out. This noise is distinctive and quite unlike wind or other extraneous noise. Wind gusts, birdsong, footsteps, etc can in the main be separately identified and discerned.

403. The defendant was furnished with all of the audio recordings and the associated graphs well in advance of the trial and has had a full opportunity to review the material. It was suggested to Mr. Stigwood in cross-examination that Mr. Carr would assert that "*many of the recordings*" included wind noise in addition to WTN. In fact, this evidence was not given by Mr. Carr who identified extraneous noise in only a handful of recordings. In each case, the extraneous noise was either entirely obvious or had already been highlighted by Mr. Stigwood in his graphs or oral evidence.

404. Furthermore, as Ms. Large and Mr. Stigwood note, different noise sources carry different frequencies. Therefore, spectrum analysis by means of a spectrogram informs one of the source of the noise and identifies - and thus assists in the exclusion, if necessary – of extraneous noise, such as wind gusts and birdsong.

405. Mr. Stigwood stated that in order for wind noise to play a significant role in the general character or loudness of the sound environment presented on the audio recordings, it would have to be of a nature and at a level far in excess of that which he would consider normal. No convincing evidence was given to contradict this.

406. In this regard, I note that it is not disputed that Ms. Large correctly set up and calibrated the monitoring equipment and used a double skinned windshield to protect the microphone from wind noise when capturing the 2017 external NF audio recordings.

407. The 2021 MAS data was set up by the plaintiff's solicitor under the instruction of MAS. Inadvertently, the microphone was not fitted with a double skinned windshield. However, for internal recordings (the 2017 internal HH audio recordings and the 2021 internal NF and HH internal audio recordings) I consider this to be of minor importance. As Mr. Stigwood points out, the room in which the recording equipment was placed effectively serves as a windshield; internal audio recordings will only be materially affected by wind over the microphone when there is a through wind inside the room. This in turn requires windows or doors to be wide open on both sides of room; these were not the conditions of measurement.

408. Therefore, save during stormy periods, which were clearly identified to the court, I find that wind noise does not contribute substantially to the sound environment on the 2017 internal HH audio recordings or the 2021 internal NF and HH internal audio recordings played to the court (and in the graphs presented in the MAS reports). I am satisfied that extraneous noise can be - or had been - separately identified and does not distort one's aural appreciation of the impact of the WTN on the audio recordings or one's interpretation of the associated graphs.

409. I accept the opinion of Mr. Carr that the position is different in respect of the 2021 NF external data which, as I say, was gathered without a double skinned windshield. I accept that wind contamination cannot confidently be excluded. I also accept that placing the monitoring equipment too close to the exterior façade will tend to increase noise levels by up to 3 dB,

which also has the potential to distort AM values. Mr. Carr's related criticism that one cannot take façade measurements where there is a significant low frequency content to the noise, was not put to Mr. Stigwood, which reduces its weight. However, in light of the first two difficulties just discussed, I have in any event entirely disregarded the 2021 NF external data (the audio recordings and all associated graphs) in all of my consideration.

Are the audio recordings selected for playback and analysis representative of the WTN on site?

410. Clearly, MAS did not record the plaintiffs' entire soundscape for the last seven years. Equally, it would not be possible to present to the court all of the audio recordings as this spans several months of monitoring. MAS therefore selected only certain audio recordings (and the associated graphs) on which to focus in their reports and only a subset of these were played to the court. No doubt the recordings (and the associated graphs) chosen were those adjudged to best represent the different features of the WTN complained of by the plaintiffs. Indeed, this is made clear by Mr. Stigwood in his report of October 2022.

411. However, this is really the only practical way to present the audio recordings (and the associated graphs) of the WTN to the court. Crucially, the defendant's expert made no suggestion that the audio recordings selected were unrepresentative of the features of the WTN of which the plaintiffs complain. Mr. Carr has listened to all of the audio recordings referred to in the MAS reports (and has presumably examined all of the associated graphs) and did not contend that those chosen for presentation to the court were unrepresentative of the audio recordings (and the associated graphs) as a whole.

412. Mr. Carr accepted that the audio recordings (and associated graphs) accurately captured and represented the sound environment at the positions where the microphones were placed. He was present in court throughout the presentation and analysis of the audio recordings (and the associated graphs) and did not demur from the opinions expressed by the plaintiffs' experts as to the identified features of the WTN. He did not suggest that the various features identified by MAS occurred only rarely or usually on the audio recordings. There is no suggestion that these features were "outliers". Rather, Mr. Carr's view was that, having "*dipped in and out*" of the full suite of MAS audio recordings, (taken over several months), the general picture was broadly similar.

413. In short, therefore, the court can, and indeed should, have regard to the 2017 external NF data, to the 2017 internal HH data and to the 2021 internal HH and NF data, all of which together are representative of the character of the WTN.

Issues arising in relation to internal audio recordings

414. Although Mr. Carr accepted that the internal audio recordings accurately capture the sound at the location where the microphone was positioned, allowance must be made for *"room modes."* Noise measurements within buildings can be inconsistent due to the influence of room acoustics such as acoustic reflections from surfaces and absorption from soft furnishings, carpets and beds etc. This can create different sound fields resulting in potential over or underestimation of the typical exposure in the room.

415. The defendant contends that to counteract the impact of room modes ISO 1996-2, 2017 recommends the use of several different recording devices at various locations throughout the room rather than via a single microphone. I am concerned that this objection was not adequately put to Mr. Stigwood.

416. I note that ISO 1996-2, 2017 applies to all environmental noise sources such as road and rail noise, aircraft and industrial noise. Unlike the Defra Guidance therefore, ISO 1996-2, 2017 is not WTN specific. Ms. Large and Mr. Stigwood's evidence was that all internal measurements complied fully with the Defra Guidance which states that the effects of sound reflections and absorption can be appropriately managed by positioning the microphone at least 0.5m from any sound reflecting vertical room surface or sound absorbing objects such as items of furniture or curtains etc.

417. I accept that, for present purposes, this is an adequate response to the issue of room modes. This is particularly the case as the plaintiffs' primary complaint does not relate to noise levels *per se* but to noise character.

418. The plaintiffs' experts do not contend that the audio recordings played to the court precisely replicates WTN noise levels at every point in the room or indeed in every room in the house. Rather they are intended to convey an impression of the plaintiffs' sound experience

and to demonstrate and corroborate the features of the WTN of which the plaintiffs complain. I am satisfied that the internal audio recordings are more than adequate for that purpose.

419. The defendant also submits that because the 2021 HH and NF internal monitoring was set up by the plaintiffs' solicitor, rather than by experts, it ought to be disregarded. This, in my view, would be a wholly disproportionate response to the minor criticisms advanced by the defendant, such as for example, the position of the microphone flex. I can see no point of real substance here, and I will therefore have regard to this data.

Criticisms of the plaintiffs' experts' presentation and analysis of the AM on site

420. Ms. Large and Mr. Stigwood presented and analysed the AM on site by reference to the audio recordings and associated time domain graphs. Their opinion was supplemented by their own experience on site. In Ms. Large's opinion, the AM on site is substantial and excessive. Mr. Stigwood's view is to similar effect. He states that there sustained periods of AM of the highest levels of modulation variation that he has ever seen occur commonly. His view is that this AM *"impacts on residential amenity in a manner and form rarely found so excessive"*.

421. The defendant advances several interrelated criticisms of the plaintiffs' experts' presentation and analysis of the AM on site:

a. AM may only be presented or analysed through the application of the IOA RM;
b. The MAS presentation and analysis of AM by way of audio recordings and time domain graphs is unreliable and ought to be disregarded in any nuisance assessment.
c. The MAS presentation and analysis of AM by way of audio recordings and time domain graphs exaggerates AM.

422. Separately, Mr. Stigwood also sought to the apply the IOA RM to the 2021 MAS data and to present the results of that analysis. The defendant advances two interrelated criticisms of Mr. Stigwood's IOA RM analysis of the AM on site

d) The 2021 MAS data is unreliable and the IOA RM cannot be reliably applied thereto either to derive a penalty or at all.
e) The 2021 NF external data is unreliable and the IOA RM cannot be reliably applied thereto either to derive a penalty or at all.

f) The 2021 NF and 2021 HH internal data is unreliable and the IOA RM cannot be reliably applied thereto either to derive a penalty or at all.

423. I will consider these points in turn.

(a) Exclusivity of the IOA RM in nuisance investigations

424. The defendant's attitude towards the IOA RM is somewhat contradictory. On the one hand, the defendant contends that the only acceptable method for demonstrating AM to the court is via the IOA RM. Yet, despite acknowledging that "*this case is all about AM*", the defendant has not itself carried out an IOA RM assessment of the AM on site.

425. Ms. Large and Mr. Stigwood both accept that the IOA RM can provide useful information tending to confirm the level of AM present in the audio recordings (as depicted on the associated time domain graphs). However, in their view, the IOA RM provides no more than an overall impression of the extent and regularity of such impact. They reject the position that it is mandatory to apply the IOA RM to an AM complaint in a nuisance case and point out a number of drawbacks to the methodology (none of which were in substance disputed by the defendant's experts):

- The IOA RM depicts average AM values in a specific ten minute period as a point on a graph but tells one nothing about the quality of the AM during the period. It may not identify many features of AM said to be most intrusive in this case such as erraticism and impulsivity. Crucially, it is not contended by the defendant that the IOA RM can discriminate between swish and thump AM.
- The IOA RM produces a single value for a 10-minute period. It is not apt to fully represent AM that is variable or intermittent -i.e., AM that disappears and returns again or fades in and out - which is one of the plaintiffs' main complaints. Purely by way of example, if a particular ten minute period has five 60-second blocks of high AM value interspersed by five 60-second blocks of low AM value, the IOA RM will derive an AM value which is the approximate average of the AM depicted over the entire period. Alternating high and low AM, which can be extremely intrusive, is not accommodated by the IOA RM. The same lacunae might equally result from the requirement of the IOA RM that at least 50% of the 10-second blocks in the relevant 10-minute period contain detectable AM before even being included in the analysis.

- The IOA RM can produce both false negatives and false positives. As above, periods of substantial AM can, be smoothed out by the averaging effect. False positives, such as dogs barking, or cars backfiring cannot be recognised and filtered out because the IOA method is effectively automated.

426. The IOA AM report states that its primary goal is to develop a methodology which can be used within the planning regime. It also states that consideration could be given to its use within the (United Kingdom) statutory nuisance regime as well. The IOA RM has several merits and provides an objective benchmark for rating AM. However, the report emphasises that it is possible for AM to be evaluated in different ways, including subjectively. It states that noise nuisance investigations, for example, need not be limited to any particular method of assessing WTN and would often involve many other factors such as the time of day and the character of the neighbourhood. Furthermore, factors such as the duration and frequency of occurrence may be relevant in determining subjective responses. Therefore, the report acknowledges that the availability of the IOA RM does not preclude other assessments being made.

427. I therefore reject as ill-founded the defendant's argument as to exclusivity of the IOA RM in nuisance investigations. In considering the impact and level of AM on site, it is appropriate to have regard to the MAS audio recordings and associated time domain graphs even though these are not, and do not purport to be, presented by way of an IOA RM analysis.

428. Having said that, the IOA RM analysis, in contradistinction to the audio recordings and time domain graphs (which cover short periods only) is apt to demonstrate AM values over more extended time periods. However, in the present case such a more consistent picture is demonstrated by Mr. Stigwood's IOA RM analysis of the 2021 internal HH and NF data on which I comment below.

(b) can audio recordings and time domain graphs be used to present/assess the AM on site?

429. The defendant also criticises the use by MAS of time domain graphs to present and assess AM in this case. The IOA AM report considers their use as follows:

The use of the time-domain method

Most respondents agreed that a time-domain method, based on examination of a time-series plot to determine the typical, average, or maximum peak-to-trough values, is very suitable for the assessment of short-term 'clean' WTN data with minimal corruption by other ambient noise. The method has the benefit of relative simplicity. However, the strong majority view was that it was not suitable for rigorous assessment of AM, especially when there was significant noise from other sources, because it was unable to discriminate between fluctuations in noise levels resulting from wind turbine AM and those resulting from variations in other ambient noise. Significant subjective (visual or aural) screening is required to overcome this fundamental deficiency, which is considered to be impracticable for the analysis of long-term data (perhaps covering periods of weeks or months)…

AMWG comments

There is some benefit in having a simple method of assessing AM, for example for the purpose of forming an initial conclusion about the validity of a noise complaint…

Any output from such a method would be open to question unless accompanied by time histories which demonstrated (on subjective judgement) the presence of clear AM with no significant contribution from other ambient noise, or using tools such as autocorrelation spectra. However the AMWG does not consider that the method is a robust basis for an assessment metric which may be adopted in a planning condition. Wind turbine AM, where it occurs, is an intermittent occurrence. The assessment of AM on a particular site would generally involve long-term measurements to establish the frequency and duration of occurrence and the particular wind conditions. Reliance on a time-domain method only, which may appear more direct to non-specialists, is not considered to be practicable or robust, because unlike a frequency-domain method, it is unable to detect WTN AM on the basis of its distinctive periodicity and therefore requires significant subjective 'filtering'.

430. The concern of the IOA was that the time domain method would require significant subjective (visual or aural) screening to discriminate between fluctuations in noise levels resulting from wind turbine AM and those resulting from variations in other ambient noise. Therefore, the output would be open to question unless accompanied by time histories which demonstrated (on subjective judgement) the presence of clear AM with no significant contribution from other ambient noise, or using tools such as autocorrelation spectra.

431. This is in substance the exercise carried out by MAS in relation to the audio recordings and time domain graphs it presents.

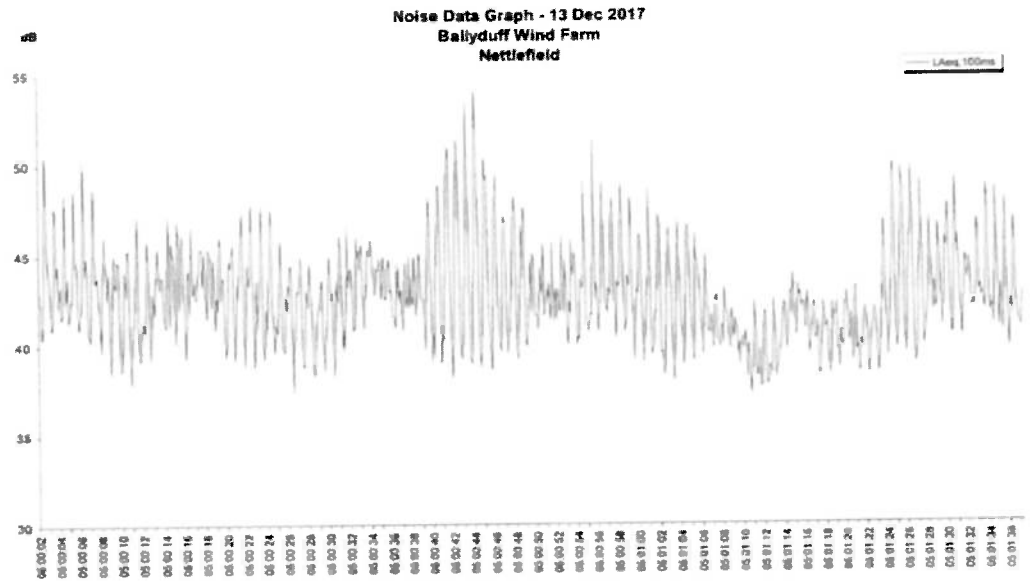
432. Further, the time domain data demonstrates consistency between the AM values typically presenting at both properties over both periods of monitoring. In my view, this

consistency strongly supports the proposition that, overall, MAS's method of presenting and calculating AM values is reliable.

433. With the exception of the 2021 NF external data, I therefore find that the MAS time domain data is sufficiently robust to reliably demonstrate the features of wind turbine AM and to calculate AM values over the periods presented in the graphs[50].

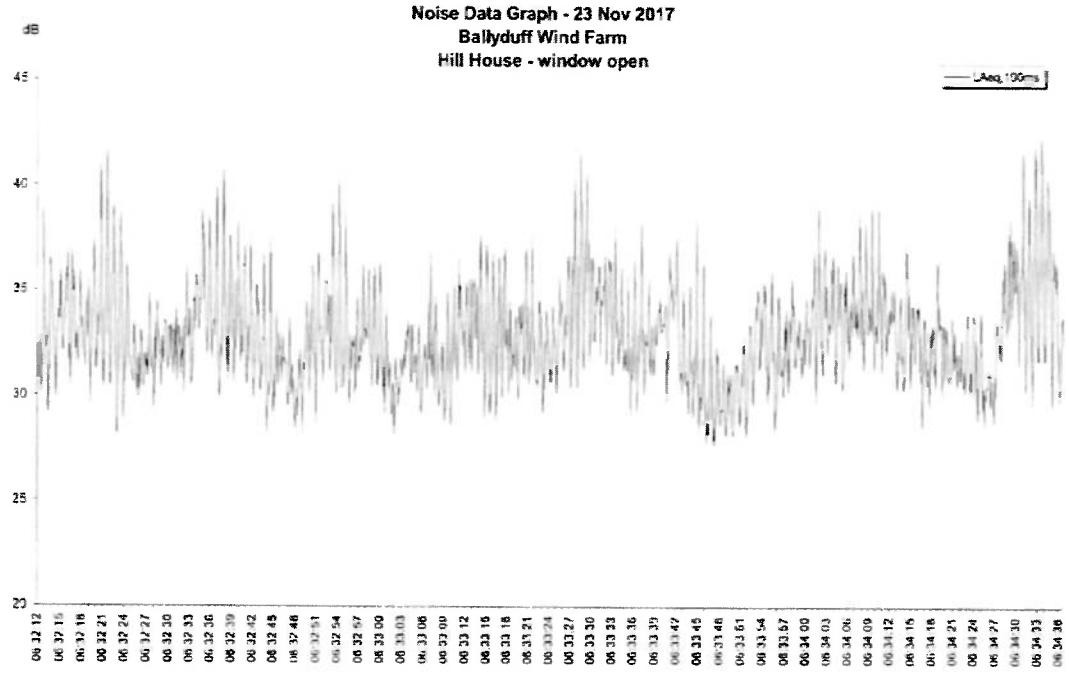
434. Purely for illustrative purposes, I attach below one of Ms. Large's time domain graphs demonstrating the AM externally at NF on 13th December, 2017 at 05.00.

Figure 26: Amplitude modulation -Nettlefield - 13/12/2017 05:00



435. I also attach one of Ms. Large's time domain graphs demonstrating the AM internally at HH (with the window open) on 23 November, 2017 at 06.32.

[50] I deal separately below with the far more extensive data used as an input to Mr. Stigwood's IOA RM analysis.



(c) Do time domain graphs exaggerate AM?

436. Ms. Large and Mr. Stigwood have computed AM values by calculating the differential between the highest peak and lowest trough sound levels in any particular modulation. The defendant states that this may overstate the AM when compared to the IOA RM. This is because the IOA RM calculates AM values by subtracting the L95 from the L5 over the relevant 10 second and 10 minute periods. Mr. Carr emphasises that Mr. Stigwood's report acknowledges that IOA RM derived values "*will typically understate AM peak to trough values*...(when compared with the time domain method) *by 1-2 dBA*". Mr. Carr did not however contend that the likely divergence as between the two methodologies would be any greater than this.

437. Although not calculated over specific 10-second or 10-minute intervals, I accept that the plaintiff's experts' calculation of average or typical AM values as derived from the totality of the time-domain graphs is sufficiently reliable to inform this court's analysis.

(d) Use of 2021 MAS for IOA RM analysis

438. As stated, the plaintiffs' experts' calculation of AM value is derived from their time domain graphs. These graphs represent specific time intervals only. Although the defendant's experts did not contend that the audio recordings and time domain graphs were unrepresentative of the WTN generally, more extensive data would have been of value in

assessing long term average AM values at a range of windspeeds. Further, although I reject the proposition that the IOA RM is the exclusive methodology for presenting and analysing AM in general or AM values in particular, one would nonetheless reasonably expect that, in a case which is *"all about AM"*, the plaintiffs' experts (and indeed the defendant's experts) would have formally applied the IOA RM in this case.

439. Indeed, it is clear that Mr. Stigwood set out to perform just such an exercise and to apply the IOA RM to the six weeks of data gathered on foot of the 2021 monitoring. To that end, his October 2022 report presents three IOA RM graphs: first, an IOA RM graph prepared on foot of the 2021 NF external audio recordings; second, an IOA RM graph prepared on foot of the 2021 NF internal audio recordings and third an IOA RM graph prepared on foot of the 2021 HH internal audio recordings. Each such graph plots the average 10-minute AM value over the relevant six weeks as calculated in accordance with the IOA RM. However, for different reasons which I will now explain, none of these three graphs is prepared in full compliance with the IOA RM methodology.

(e) Use of 2021 NF external data for IOA RM analysis

440. Mr. Stigwood's opinion is that the IOA RM analysis of the 2021 NF external audio recordings suggests that average AM values over the six weeks of data were in the order of 8 dBA and would incur an AM penalty of 5 dB under draft WEDG 2019.

441. Mr. Carr indicated that he was unable to stress test this conclusion because he could not discern how the data had been post-processed and analysed by Mr. Stigwood. It is hard to give this much credence. The defendant has had Mr. Stigwood's report and all of the underlying data for some time and could have performed its own IOA RM analysis.

442. However, I accept that due to the absence of a double skinned windshield and because the external NF 2021 audio was recorded at façade level, it cannot form the basis of a valid IOA RM analysis, and I do not accept it for that purpose. I consider immediately below the IOA RM analysis of the 2021 NF and HH internal audio recordings.

(f) use of 2021 NF internal and 2021 HH internal data for IOA RM analysis

443. The defendant correctly observes that the plaintiff's most serious complaints concern indoor noise particularly at night. It nonetheless objects to MAS's presentation of an internal IOA RM analysis.

444. The IOA AM report considers the usefulness, for its purposes, of internal measurements.

> **Is it appropriate to measure AM outdoors in free-field?**
>
> This question generated considerable discussion. Most respondents observed that complaints regarding AM often concerned indoor noise, particularly at night. It could therefore be thought logical to measure noise inside dwellings. Furthermore experience suggests that there is a variable 'transfer function' between indoor and outdoor perception of AM and in some cases, higher levels of AM may be detected indoors than outdoors. However, most respondents accepted the difficulties in measuring noise inside, including the influence of room modes and the resulting spatial variations in noise level, as well as the influence of domestic noise sources…
>
> For the purposes of defining and applying a method for rating AM, most thought that measuring indoors presented too many practical difficulties and outdoor measurements were strongly preferred. Measuring outside is also consistent with most other environmental noise assessment procedures. It was suggested by some that additional indoor measurements would be appropriate if complaints related specifically to noise indoors.
>
> **AMWG comments**
>
> The working group's objective is to define a metric that can be used reliably within the planning system, and external measurements are the only practicable option. For specific complaint or nuisance measurements, investigators are of course free to make internal measurements and assessments in connection with the specific issues. Indoor measurements are problematic for a variety of reasons including, access difficulties, corruption by other sources, and room modes which could result in different responses in different positions in the room. These factors can cause a large variation in noise levels which can affect reproducibility. It is considered unnecessary to account for all of these factors when wind turbine AM can be measured reliably outdoors.

445. Ultimately, therefore, the IOA AM report concludes that as the objective of the working group is to define a metric that can be used reliably within the planning system, external measures were the only practical option. This is entirely logical as it would not be possible for a planning noise condition to be set by reference to internal measurements at specific houses. However, the IOA AM report also acknowledges that for a specific complaint or for nuisance measurements investigators are free to take internal measurements.

446. In considering the robustness of the IOA RM analysis of the internal data, two specific issues arise.

447. First, unlike the other data presented to the court, MAS has not subjectively screened the six weeks of 2021 internal NF and HH data input into the IOA RM for contamination from domestic sources. However, I note that the Carty-Shortens moved out of the master bedroom at NF bedroom in July 2017. Even at the time of the 2017 MAS data collection[51] the master bedroom was therefore unoccupied. Moreover, at the time of collection of the 2021 MAS data[52] the whole house was unoccupied. This tends to mitigate if not exclude many potential sources of domestic contamination which might otherwise undermine the analysis of long term internal data under the IOA RM.

448. The position is different in relation to HH which was occupied during all monitoring periods. As there may be undetected contamination from domestic sources, the IOA RM of this data is less robust. However, as there is no suggestion that there is a significant difference between the AM or the AM values experienced as between the two properties, the 2021 NF internal data may be seen as a fair proxy for the AM values experienced internally at HH.

449. Second, as the IOA points out room modes could result in different responses in different positions in the room. This would be an obvious problem if one was using the data collected to calculate potential AM penalties for the purposes of a planning condition. This requires consistency and ease of replication as between different affected dwellings. However, as room modes have been adequately dealt with by compliance with the recommendations in the Defra Guidance,[53] there can be no objection to the use of the internal data to derive a general picture of AM values at the two properties.

450. I accept therefore that the IOA RM analysis of the 2021 NF internal data is sufficiently robust. Whilst therefore strictly speaking it is not a "formal" IOA RM analysis (because the IOA RM is only formally applicable to external free field data), it is nonetheless evidence of weight.

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[51] Note: the 2017 MAS data was not used for the IOA RM analysis but for the analysis of AM values using the time domain method.
[52] Note: this was the data used for the IOA RM analysis
[53] See para 416 above.

451. As such, I accept the opinion of Ms. Large and Mr. Stigwood that the impression of AM gained from the audio recordings and time domain graphs is confirmed by the IOA RM analysis of the internal data. I attach Mr. Stigwood's internal IOA RM analysis pertaining to both NF and HH for the time period 4th December, 2020 - 18th February, 2021 below.

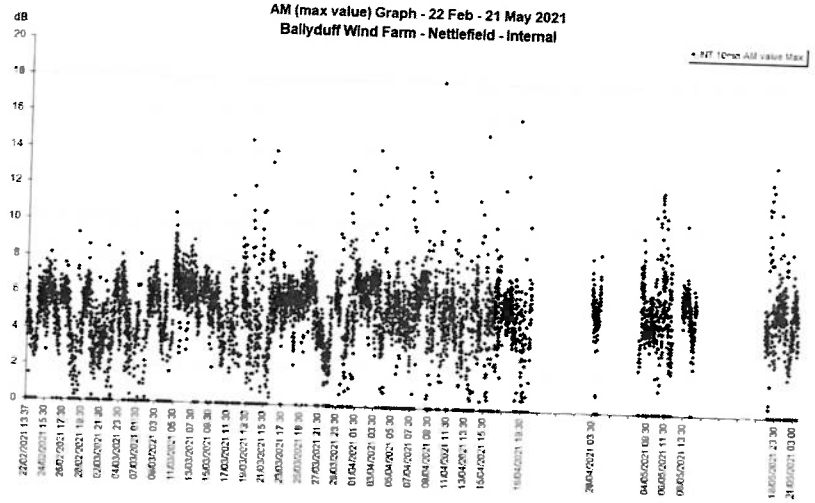
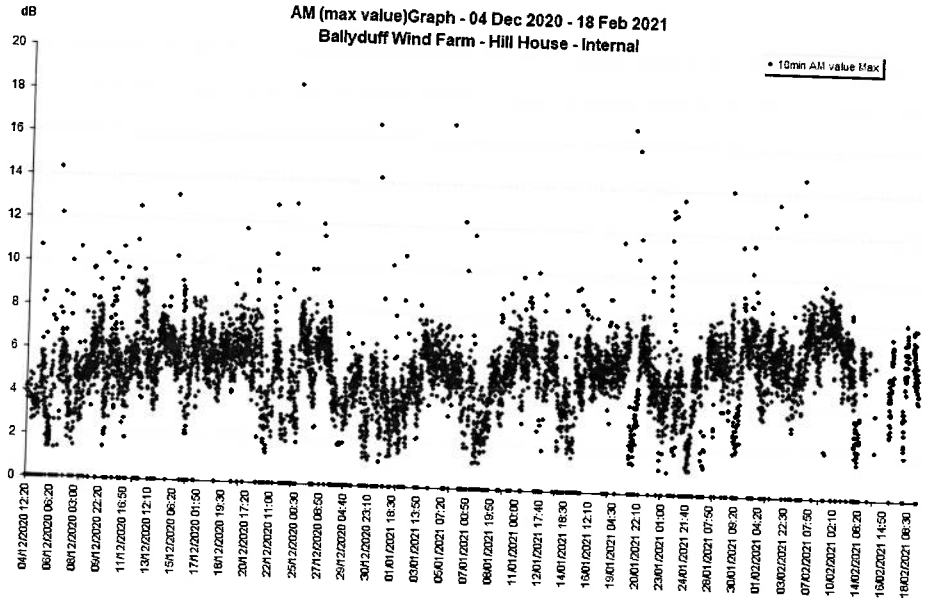


Figure 36: Summary of IoA AM analysis – Nettlefield - Internal



Absence of measurements in HH bedroom

452. In general, measurement errors can occur when a room is occupied at the time of noise monitoring. In NF, the master bedroom was unoccupied, and monitoring was conducted without difficulty. However, HH has been in continuous occupation. Further, due to the WTN,

Ms. Webster finds the master bedroom is the only room where she can sleep in. It would clearly not have been practical or reasonable to require her to vacate this room for an extended period of time to facilitate monitoring. Internal monitoring was therefore conducted in a home office situated downstairs at the back of the house facing the turbine. The master bedroom is on the other side of the house and faces the valley.

453. The defendant's legal submissions argue that Ms. Webster and Mr. Rollo have not made out a case in nuisance because there are no noise measurements or internal audio recordings from the master bedroom at HH.

454. Ms. Large's evidence was that an internal noise assessment is an assessment of the house in general. The intent is to find a location that is reasonably representative of the noise impact at that dwelling rather than to place a microphone in every single room. Ms. Large's view was that the home office where the microphone was placed was representative of the noise level in all of the rooms at the rear of the dwelling, upstairs and downstairs. Whilst she accepted that noise levels at the front of the house, where the master bedroom is situated, would probably be different, there was no evidence of a significant change in the overall character and impact of the noise.

455. Mr. Carr did not suggest that the AM values or indeed the impact of AM and thump AM would be appreciably reduced as one proceeds from the back to the front of the house. Whilst there will always be some variation throughout a dwelling, WTN, particularly with low frequency content, is not well attenuated by structures and will penetrate buildings.

456. Although therefore AM values cannot be accurately calculated for the HH master bedroom specifically, this is of little import. As I understand it, Mr. Carr, who has carried out many nuisance investigations, has never considered it necessary to take any internal readings at all for the purposes of measuring internal AM values. Nor has he ever performed an internal IOA RM analysis. There can therefore be little objection to approximating AM value in the master bedroom by reference to the values presenting in another room in the same house.

Issue 6: Does an analysis under the Defra criteria support the argument that characteristics of the WTN amount to a substantial interference with the plaintiffs' use and enjoyment of their land?

457. I set out below my analysis of the Ballyduff WTN under what I call the "Defra criteria". In doing so, I primarily consider the relevant expert evidence advanced by both parties on each criterion. In this regard, whilst the plaintiffs' experts carried out an in-depth analysis of the WTN by reference to the Defra criteria, the defendant's experts did not. However, in so far as the defendant's experts addressed the issues arising, I set out below the key aspects of their response to the evidence of the plaintiffs' experts in respect of each criterion. As will be apparent, although I do not accept all of the conclusions of the plaintiff experts, e.g., their calculation of background sound levels and their application of the 2009 WHO Lmax limit - I accept the substance of the other points made which together are more than sufficient to establish on the balance of probabilities that the impact of the WTN is objectively unreasonable.

Sensitivity of the complainant

458. In *Smyth v. RPA*, the uncontradicted evidence of the RPA's acoustic expert was that the Smyths were not among a group who could be classified as "ordinary". Rather they were highly sensitive and representative of only a very small proportion of the population - 2.5% - who would experience a high level of annoyance at the noise levels demonstrated. In the present case the defendant has tendered no evidence whatsoever that any of the plaintiffs are highly sensitive or hypersensitive to noise, or indeed otherwise.

459. On the contrary, the evidence of the medical experts is that Ms. Webster is a woman whose basic disposition is one of considerable resilience and fortitude who does not allow herself to become overwhelmed by emotion. She approached the turbine with an open and optimistic frame of mind and did not expect it to negatively impact on her enjoyment of her property to a substantial extent. In addition, there is no suggestion of significant sleep disturbance prior to the commencement of the operation of the turbine. In the case of Ms. Webster (and indeed Mr. Rollo), this is confirmed by discovery of several years of prior medical records.

460. I also accept Dr. Murray's opinion, that Ms. Webster has not suffered from any pathological reaction to the WTN. I find that Ms. Webster's reaction to her experience of the

windfarm at least for the first several years of its operation – was entirely proportionate and in no way hypersensitive. She has, as Dr. Murray said, coped with a difficult situation by managing her reaction to it and managing her emotions. In accordance with Prof. Gournay's view, I further find that, although Ms. Webster describes the WTN as getting worse - which objectively is unlikely to be the case – this perception can reasonably be attributed to its cumulative impact which is becoming more difficult for her to cope with.

461. In so far as concerns Mr. Rollo, the evidence of both medical witnesses is that he is a robust person who is not risk adverse or hypersensitive. I find that Mr. Rollo did not meet the diagnostic criteria for depression until mid to late 2020, three years after the turbine was erected. From mid to late-2020, I find that the WTN brought about a hypersensitive condition in Mr. Rollo who was formerly a well-balanced person. Even at this stage, Prof. Gournay's opinion was that whilst there will always be a difference between how two normal people will respond to the same stimuli, a substantial number of reasonable people would react in precisely the same way as Mr. Rollo. As Charleton J. stated in *Lanigan v. Barry*, although a plaintiff cannot be a sensitive soul who complains unreasonably, the defendant cannot use this argument if his own conduct has resulted in the plaintiff being hypersensitive to the intrusion in question (quoting from *Salmond on the Law of Torts* (London, Sweet & Maxwell, 1977).[54]

462. In short, all indications are therefore that the Webster-Rollos are reasonable, tolerant individuals. I have no reason to believe that the position is otherwise in relation to the Carty Shortens.

463. I also accept the truthfulness of their evidence as to their experience of the WTN. In this, I am assisted to some extent by the clinical impression of both medical witnesses that Mr. Rollo was very straightforward and was not attempting to present a false impression. Dr. Murray stated that "*everything points to a very genuine responder who was not exaggerating his symptoms*". Both medical witnesses also formed a similar impression in relation to Ms. Webster. I formed a similar view in relation to all four plaintiffs.

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[54] As will become apparent, this observation may have a particular resonance with respect to Mr. Rollo.

464. Overall, I find that, to quote Henchy J. in *Hanrahan*, the *"notions and standards of behaviour and responsibility* [of all four plaintiffs] *correspond with those generally pertaining among ordinary people in our society at the present time, who seldom allows emotions to overbear reason, whose habits are moderate and whose disposition is equable.* In short, the plaintiffs are, to quote Henchy J. again, ordinary persons *"whose requirements are objectively reasonable in all the particular circumstances"*. To quote from the defendant's legal submissions, the plaintiffs are *"ordinary* [persons] *with reasonable objective expectations"*.

465. Establishing that the plaintiffs are ordinary persons *"whose requirements are objectively reasonable in all the particular circumstances"* and that their evidence of the turbine impact is unexaggerated is of course only one step in the assessment of nuisance. This is because the primary focus of the assessment must remain on the objective nature of the interference itself.

466. I therefore move on to consider the other Defra criteria.

Level of the noise/ loudness

467. The plaintiffs' experts time domain data presents only short term measurements and therefore does not inform one of general noise levels at a range of windspeeds. For this, one needs to rely upon the defendant's planning compliance data as described at 300 *et seq* above.

468. Mr. Carr's view was that the overall noise levels from these wind turbines should be a significant factor in determining whether nuisance is made out. He states that the Ballyduff noise levels are *"very low"*[55].

469. However, this tells us comparatively little as it would be the case with WTN in general. In contrast to other forms of industrial noise, WTN is not by its nature received at high dBA levels; hence the relatively low absolute noise limit suggested in draft WEDG 2019 of 43dBA L90/45dBA leq.

---

[55] This fed into Mr. Carr's impression that this was not a borderline or *"critical"* case requiring a more nuanced assessment.

470. In order to consolidate his view that the Ballyduff noise levels are "*very low*" Mr. Carr stated that the HH data demonstrates that the WTN complies with this recommended limit in draft WEDG 2019. Indeed, he states that there is "*headroom*" to spare. He further asserts that the WTN would comply with this recommended limit regardless of any character penalty that could be applied.

471. As I mention above at para 214, I fail to see a valid basis for this assertion. To summarise:

- Unlike WEDG 2006, draft WEDG 2019 proposed a relative rated noise limit of 5 dBA above existing background noise within the range of 35 to 43 dBA L90. Compliance cannot therefore be established without assessing background noise levels.
- Even if noise levels were within range, character penalty for AM may well result in non-compliance. The defendant has made no attempt to calculate - or even estimate - what level of possible character penalty might apply.
- There is no HH night hours data from comparatively low windspeeds of 8 m/s.
- The *"headroom"* contended for is in part at least premised on a 3 dB façade deduction from the measured noise levels at HH. In light of the lack of clarity as to Mr. O' Reilly's measurement position at HH and due to the failure to record and calculate the angle of incidence, I am not satisfied that this 3 dB façade deduction can be applied (see para 320 -325 above)

472. The NF data - upon which Mr. Carr did not comment - is even less convincing in this respect. During night hours, total operational noise is either at or slightly beyond the maximum total permitted noise level in draft WEDG 2019 (43 dBA L90) from windspeeds of 9.5m/s. There is no assessment of either background noise levels or potential AM penalty. Depending upon how these factors play out, there is a clear potential for breach of the indicative limit in the draft WEDG 2019.

473. In Mr. Carr's view, the overall noise levels from these turbines are well below the point at which a breach of planning permission or nuisance would arise. In actual fact, on the correct interpretation of condition 15, total operational noise at both locations is well above the 40 dBA leq limit set in the permission.

474. One of the defendant's other key submissions was that average sound levels below 30 dBA leq could never constitute nuisance. Provided this is understood to apply to external sound levels, this is generally correct. It is also however somewhat beside the point as total operational noise during night-time exceeds 30 dBA leq at HH and NF at windspeeds above 4 m/s and 6 m/s respectively. In addition, the MAS 2017 NF external data includes numerous examples, albeit for brief time intervals, when external sound levels are 41, 42, 43 dBA leq.

475. Turning to internal sound levels, Mr. Carr states that noise levels below 30 dBA leq would not be expected to impact one's ability to sleep.

476. Again, this point goes nowhere as the defendant's planning compliance data shows that total operational noise externally at NF rises to 40 dBA leq at windspeeds of 7m/s and to 45 dBA leq at windspeeds of 9 m/s. Allowing for an external to internal transfer function of approximately 10 dBA (with windows slightly open), one would anticipate that internal levels would be above 30 dBA leq on a regular basis.

477. In direct examination, Mr. Carr was asked about his impression of the WTN in the main bedroom at HH where he spent 5 to 10 minutes during the site visit on 8th November, 2018. Mr. Carr confirmed that the purpose of this visit was "*more of a listening experience... just hearing it rather than there to take measurements to show any compliance or otherwise*". He stated that he could hear the wind turbine outside but that the impact of the turbine reduced significantly internally. Mr. Carr's evidence was that he stood in the HH master bedroom with the window open and couldn't hear the turbine.

> *Q. And in terms of your own experience inside the property, would you have considered the noise that you were able to barely hear to comprise a nuisance or not?*
> *A. No, not inside that bedroom.*

478. Although my own experience on the day of the site visit was different, I fully accept that Mr. Carr was unable to hear WTN in the HH master bedroom over this 5 to 10 minute period. However, it cannot realistically be contended that such a short visit could ever mirror the plaintiffs' experience of the WTN in the master bedroom over so many years.

479. Whilst the key complaint here is not of the absolute average decibel levels, I conclude that as total operational noise during night hours externally at NF reaches 45 dBA leq (and due to a paucity of data, maximum sound levels at HH are unknown), there is significant potential for dominance and unacceptable intrusiveness when combined with other features.

Type of noise

480. I fully accept Mr. Carr's opinion that the AM values calculated by Ms. Large and Mr. Stigwood on foot of the time domain graphs cannot be directly equated with values derived under the IOA RM. In other words, the application of different metrics will yield different AM values.

481. However, Mr. Stigwood's report-suggests that the AM values calculated on his time domain method would differ by 1 or 2 dBs from those likely to be yielded on foot of the IOA RM. As I observe at para 436 above, Mr. Carr did not contradict this passage and indeed drew it to the court's attention. In my view, it is reasonable to expect that when the AM is regular rather than intermittent/ variable (i.e. AM that disappears and returns again or fades in and out), the AM values derived under both methods for a particular time interval would generally be of a similar order.

482. In this regard, I further accept Mr. Stigwood's opinion that the data derived from his application of the IOA RM to the 2021 NF and HH data is generally consistent with and confirmatory of the AM values shown on the time domain graphs produced by Ms. Large in 2017 (on foot of the 2017 NF external audio recordings and 2017 HH internal audio recordings). I further accept that this IOA RM data is also generally consistent with and confirmatory of the AM values on the time domain graphs produced by Mr. Stigwood in 2021 (on foot of the 2021 internal NF audio recordings and the 2021 HH internal audio recordings).

483. I further accept the views of both Ms. Large and Mr. Stigwood that the IOA RM analysis of six weeks of continuous internal data from NF and HH (the 2021 HH and NF internal data), demonstrates regular and substantial internal AM. The primary relevance of this internal IOA RM analysis is in demonstrating consistency of impact over a longer period of time than that represented by the intermittent audio recordings and time domain graphs. This

IOA RM analysis cannot be used for the purposes of calculating potential AM penalties for planning purposes. Indeed, it was not tendered by Mr. Stigwood for that purpose.

484. Draft WEDG 2019 notes, citing the Phase 2 reports that the setting of a threshold for excessive AM is not straightforward and that the available research does not identify a clear onset of increased annoyance from AM or a clear level at which the impact of WTN or AM becomes *'significant'*, *'excessive'* or *'unacceptable'*. It goes on to note an onset of perception for AM at about 2 dB and an association of rising annoyance with increasing depth of AM above 2 dB. Furthermore, Draft WEDG 2019 recommends attaching penalties for AM values in excess of 3dBA.

485. I accept Ms. Large's evidence that AM values of 5 dBA and above, if audible at a sufficient level, are capable of amounting to an unreasonable impact. This is consistent with the rationale behind the Phase 2 Report and draft WEDG 2019.

486. I further accept Ms. Large's evidence that, on foot of the 2017 monitoring, AM values significantly in excess of 5 dBA are a substantial feature of this WTN. The MAS reports summarise the time domain graphs as showing that: (a) typical AM values on foot of the 2017 HH internal data were 7-13 dBA, (b) typical AM values on foot of the 2017 NF external data were 8-13 dBA, (c) typical AM values on foot of the 2021 HH internal data were 5-12 dBA and 5-14 dBA and (d) typical AM values on foot of the 2021 NF internal data were 5-12 dBA and 5-10 dBA. Mr. Carr accepts that the time domain graphs accurately reflect the sounds at the microphone locations, and he did not dispute the accuracy of these summaries.

487. I conclude that even on the most conservative analysis, the time domain graphs reveal a common thread of AM value in excess of 5 or 6 dBA. Although, as I say these typical AM values cannot be directly translated to values of the same order derived on foot of the IOA RM, this conclusion is nonetheless highly significant. In this regard it must be recalled that the view that AM values in excess of 3 dBA leads to increasing levels of annoyance emerged well before the IOA developed the IOA RM for rating AM. This consensus as to the increased annoyance occasioned by higher value AM therefore developed before and independently of the IOA RM.

488. Ms. Large's evidence went even further. She stated that the time domain graphs show that an AM value of 10 dBA is frequently present both externally and internally. Mr. Carr did

not dispute this finding. He accepted that externally such AM values would be experienced as a doubling and halving of loudness.[56] Mr. Carr was inclined to emphasise that this doubling and halving of loudness was only momentary. I fail to see how this ameliorates matters. If anything, rapid peak to trough rise and fall can be particularly distracting and attention drawing.

489. When further cross examined on this issue, Mr. Carr's view was that internally these 10 dBA peak to trough differentials would not necessarily be appreciated as a halving and doubling of noise because the troughs would be below the level of audibility. I accept the logic of this. On the other hand, he also accepted that internally AM peaks of 40 dBA leq and above - which I emphasise are a regular occurrence internally - would be clearly audible. Indeed, the audio recordings demonstrate that this is manifestly the case. Although therefore internal AM values would not necessarily be experienced as a doubling and halving of loudness *per se*, it cannot reasonably be disputed that this characteristic is highly intrusive and unreasonable, particularly in HH where lower frequency sound and vibration also feature prominently.

490. I accept that the AM is likely to be experienced somewhat differently at each property and that it varies somewhat externally to internally as well as between different rooms and different floors of the houses. However, this does not alter the broad picture emerging.

491. Despite criticising the methodology of the plaintiffs' experts, Mr. Carr did not carry out any monitoring capable of identifying AM values. Nor did he engage with the vast amount of external and internal data collected by the plaintiffs' experts over two lengthy periods of monitoring. This data, which was then painstakingly presented by the plaintiffs' experts in almost 100 separate time domain graphs illustrating AM values (and the other characteristics of the AM), was just brushed over by the defendant's expert.

492. Irrespective entirely of its AM values, I also find that the audio recordings (and the associated graphs) support the plaintiffs' evidence as to the varying character of the WTN. I accept that on occasion the sound is more swishy, constant and monotonous with little variation. This in my view is a sound that one would be expected to habituate to. However, I also accept, and again this was not disputed by Mr. Carr, that the WTN also displays a clear

[56] In this respect, it is common case that a rise or fall of 10 dBA will be perceived as a doubling or halving of volume.

whoomphing sound and distinct thump AM. I accept the evidence of the plaintiffs that this whoomphing and thumping is highly variable and unpredictable.

493. I further accept that the audio recordings and time domain graphs support the plaintiffs' evidence that, overall, the WTN is highly changeable and unpredictable. I accept MAS's view that the AM displays considerable impulsivity (sudden changes in sound level), erraticism (with no clear periodicity or rhythm, exhibiting spikes and double spikes of AM) and variability/intermittency (when AM disappears and returns again). None of this was disputed by Mr. Carr. These latter characteristics, which are particularly evident in light of the high AM values, mean that the WTN lacks any pattern to which one could acclimatise and therefore impacts coping mechanisms.

Aggravating features - Spectral content of the noise

494. Low frequency noise (sound up to approximately 150 hertz) only slightly above the threshold of audibility can cause considerable disturbance and is more difficult to mask and get used to than other types of noise.

495. Ms. Large conducted a spectral analysis of the data collected during the 2017 monitoring period. Her conclusion is that whist there is substantial variability in the spectral content of the noise, low and lower frequency energy is present externally and internally.

496. Ms. Large states that there are many periods when the sound energy is dictated by lower frequency energy at 200/250 hertz. This is important because it impacts upon the character of the AM. Thus, whilst AM in the range of 500 to 800 hertz would be heard as a swish, AM below 315 hertz will be heard as a lower pitched whoomph or rumble or thump. Sound at this end of the spectrum is rumbling in nature and is described as being felt like a vibration as well as merely heard. Ms. Large's evidence was that during the 2017 monitoring period there were also regular periods characterised by lower frequency sound within the 100 to 200 hertz third octave bands. This was manifest both externally at NF and internally at HH. If this low frequency noise occurs at peaks of AM, then it will be heard as a thump or a beat.

497. Ms. Large indicated that this low frequency impact is particularly prevalent internally at HH and notes that low frequency noise propagates further and is more effective at transmitting through structures. Thump AM will therefore be enhanced indoors because it is

less well attenuated by structures. In addition, the ETSU Review observes that thump AM is more prevalent at night, due to atmospheric conditions.

498. All of this is entirely consistent with Ms. Webster and Mr. Rollo's description of thumping noise which comes through the walls and ceiling of their bedroom, particularly at night. Ms. Large also referred the court to the Defra low frequency curve against which the acceptability and audibility of low frequency noise is assessed. Whilst spectrograms of the WTN at HH showed that average sound levels were just below the low frequency curve, lower frequency sound modulated above the curve and would therefore be audible. Ms. Large's report demonstrated that audible low frequency sound at peaks of AM were present on multiple occasions within measurement periods as short as 2 minutes.

499. Ms. Large also gave evidence that in both dwellings she personally experienced periods of significant low frequency noise producing thumps, rumbles and thudding. Subsequent correlation with spectral frequency identified that the periods were impacted by significant low and lower frequency sound energy. Mr. Stigwood's evidence was that the thumping rise and falls of the WTN was the dominant noise internally even with the window shut.

500. Mr. Carr's written report noted that a particular period of low frequency noise identified by Ms. Large would not fall within the audible range. However, he did not give any oral evidence to this effect. In any event, Mr. Stigwood referred the court to other data in Ms. Large's reports which demonstrated that lower frequency noise was clearly audible.

501. Mr. Carr did not conduct any monitoring capable of identifying low frequency characteristics. In his direct evidence to the court, he did not contradict the plaintiff's experts in relation to the presence, and at times, dominance of sound at the lower frequency end of the spectrum. Nor did he contradict the proposition that the audio recordings and time-domain graphs (with associated spectral correlation) confirm that this lower frequency is manifesting as thump AM.

502. When cross examined about the impact of low frequency noise and low frequency AM in particular, Mr. Carr's response was once again to refer to the IOA RM as the appropriate manner in which to present, assess and rate AM. This, in my view, was a wholly inadequate response. Although the IOA AM report expressly recognises that there are two manifestations

of WTN – blade swish and periodic thumping or whoomphing noise containing relatively low frequencies - the metric described in the report does not reflect any change in subjective response with modulation frequency. The defendant does not contend that the IOA RM distinguishes between AM of the swish variety and AM of the thump variety. Therefore, whilst recognising the existence of whoomph or thump AM, the IOA metric is relatively insensitive to it.

503. In light of the above evidence, I find on the balance of probabilities that whilst low frequency noise is not the dominant characteristic of the WTN, there is a significant element of audible low and lower frequency noise which manifests as thump AM. I also accept the evidence of the plaintiffs, and indeed of Ms Large that, even with the windows entirely shut, thump AM is evident and further that one can feel the vibration of thump AM in the structure of both houses.

Characteristics of the neighbourhood

504. The impression I gained of the area during the court visit fully supported the plaintiffs' account of the character of the locality. This is a quiet, rural area and the sound environment is characterised by the sounds of nature. Absent the WTN, there would otherwise be a fairly predictable pattern of noise (e.g. decreasing noise levels at night-time, temporarily increasing noise levels at dawn during the dawn chorus and largely unintrusive levels of noise throughout the day from local traffic and other manmade noise).

505. As this is not in dispute, I accept that the location is in a wind shadow sheltered from the prevailing winds. One would expect that wind related noise at the plaintiffs' properties would, more often than not, be fairly low.

506. Generally, therefore there is little specific manmade noise in the area which the plaintiffs' experts argue contributes to the nuisance posed by the *"alien"* and *"industrial"* character of the WTN. In so doing the plaintiffs' experts assume that, absent the nuisance, the character of the locality would include no WTN at all.

507. This is a false comparison. Mr. Carr's opinion is that it is not appropriate to "set" baseline noise at the level that would be expected without any turbines in the vicinity. As a matter of principle, I agree with Mr. Carr. There is planning permission for a windfarm at this

location which carries with it the assumption of a level of WTN and associated AM and on occasion lower frequency noise. In assessing the character of the area, the court must have regard to the fact of the permission and the existence of such turbines.

508. As I state above, the wind was low at the time of the court's site visit and the 10 m standardised windspeeds at T2 varied and averaged between 4.1 and 4.8 m/s. Although T2 was therefore only turning slowly, the WTN was audible inside and outside both HH and NF. It is common case that, although audible, the WTN evident on this occasion would not be considered unreasonably intrusive.

509. However, the clear and unavoidable conclusion from the audio recordings is that both the external and internal soundscape is dominated by the WTN. Although certain background and extraneous noise is discernible, it rarely masks the characteristic rise and fall of the turbines which is the predominant noise. On the majority of the audio recordings, both external and internal, the WTN is the *only* noise that one can consistently identify. It constantly draws one's attention. Other ambient noise might ebb or flow, but it does not mask the WTN to any appreciable extent. With very few exceptions, the defendant did not by reference to the audio recordings, realistically contend to the contrary.

510. I cannot say whether this dominance is a function of the level of exceedance of the WTN over background noise levels (as to which see below), the high AM values, the comparatively low spectral frequency or the other attention drawing characteristics of the WTN. Most likely it is a combination of all these features. One can say however that this dominance exacerbates the dissonant qualities of the WTN to an extent that an ordinary person would not be expected to tolerate. I am satisfied that windfarm noise such as this cannot be considered part of the character of the locality.

511. Demonstrably, the degree of dominance evident on the majority of the audio recordings is not a constant state of affairs. For a start it must occur at speeds of rotation in excess of those pertaining at the time of the court visit. However, I accept the evidence tendered by the plaintiffs that such dominance occurs commonly and for sustained periods. Such dominance will also be particularly evident at night when the impact of AM - in particular thump AM - is more prevalent and when other background sounds are lower.

The exceedance of WTN over background noise

512. An overriding theme of the cross-examination of Ms. Large and Mr. Stigwood was that they had failed to assess background noise levels at a range of different windspeeds. There is no doubt that this impedes the analysis. For example, whilst total operational noise appears to be above the limits fixed in condition 15, without accounting for background noise one cannot draw a definitive conclusion on planning compliance. For present purposes, it also means that one cannot assess whether this is a "*low noise environment*" within the meaning of WEDG 2006. Nor can one assess the level of exceedance of WTN over background noise in order to benchmark the WTN against the commonly applied relative limit of 5 dBA over background noise (see both WEDG 2006 and draft WEDG 2019).

513. The problem, however, is that a formal background noise assessment cannot be carried out unless both turbines are turned off for a substantial period which is wholly outside the control of the plaintiffs and wholly within the control of the defendant.

514. Mr. Carr stated that the plaintiffs could have estimated background noise levels in a number of different ways, such as in upwind conditions. However, at this proximity, Mr. Stigwood says that WTN would elevate noise levels even in upwind conditions. Alternatively, Mr. Carr suggested that one could estimate background noise levels using a proxy location. However, given that Mr. Carr did not identify a suitable proxy location, I can comment no further on this.

515. In the absence of a formal background noise assessment, both parties advance other evidence to approximate background noise levels.

<u>Evidence of the plaintiffs' experts on background noise</u>

Comparing windy periods with still periods

516. Ms. Large and Mr. Stigwood compared noise levels during periods when T2 was turning very slowly - or not at all - with periods when it was turning more rapidly. The difference in sound levels is then said to approximate the "turbine off" noise level versus the "turbine on" noise level .The contention is that the former approximates "background sound" and that T2 increases background sound levels internally at HH by 10-15 dBA (with the window open) and by 9-11 dBA (with the window shut). In each case, Ms. Large states that

this is more than a doubling of volume.[57] It is also contended that T2 increases background noise levels externally at NF by 15-19 dBA above background noise levels - almost a quadrupling of volume.

517. However, this approach ignores that fact periods of high WTN are generally also characterised by higher windspeeds which, even absent the WTN, would be associated with commensurately higher levels of background wind noise. Windier periods are noisier than still periods.

518. To meet this difficulty Mr. Stigwood argues that residents will be disturbed by high WTN irrespective of the fact that it might be somewhat noisy even without the WTN. He states that psychologically speaking, residents will compare periods of high WTN to periods of calm when WTN and wind noise are absent. Not only do I find his view unconvincing but, in expressing it, Mr. Stigwood was beyond the limit of his area of expertise.

Comparing periods of lull in the windfarm activity with periods of activity at the same windspeed

519. To estimate background noise and approximate the "turbine off" noise level, Ms. Large's report presented data pertaining to a lull in WTN shortly after 4 a.m. on several mornings every week. By correlating this data with the SCADA data for T2, Mr. Stigwood ascertained that an adjustment of the blade angle of T2 occurred at the time of each lull. During the lull, there is a discernible drop in overall noise - by as much as 14 dBA - but crucially, no associated drop in windspeed. He therefore concludes that the drop in noise levels is attributable to the adjustment of T2 and further that background noise at the relevant time is less than the noise level pertaining during the lull (as T1 is still operational). This all suggests that at the times in question WTN exceeds background noise by substantially more than 5 dBA.

520. However, even assuming that this is correct, one cannot extrapolate from here to a proposition that this is generally the case. These lulls, although occurring on a regular basis, are of very short duration (no more than a minute or so).

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[57] In this respect, it is common case that a rise or fall of 10dBA will be perceived as a doubling or halving of volume.

521. In any event, a formal assessment of exceedance of WTN over background noise levels is calculated by reference to a range of windspeeds. The plaintiffs' experts merely estimate such exceedance at the particular time of each audio recording without reference to windspeed. This is not a robust assessment methodology.

522. In short, I cannot be satisfied on the balance of probabilities that the WTN exceeds background noise by in excess of 5 dBA such as to breach this aspect of modern planning guidance (WEDG 2006 and draft WEDG 2019).

Evidence of the defendant's experts on background noise

523. I am equally unconvinced by the defendant's suggested approach to the assessment of background noise levels. This was to derive same from Mr. O'Reilly's HH planning compliance graph. The HH planning compliance graph shows that at low windspeeds, the trend line is above 30 dBA L90 which Mr. Carr tentatively suggests might approximate background noise levels. This is not a recognised method of calculating background noise levels. A trend line is designed to present noise levels over the entire graph. Mr. Carr accepted that if a trend line were to be derived for these lower windspeeds only, this would "*pull down the polynomial line*".

524. In any event, applying the same methodology to Mr. O'Reilly's NF compliance graphs suggests very low background noise levels both during quiet waking hours (well below 30 dBA L90) and night-time hours (well below 20 dBA L90). Furthermore, a line of data points at 20 dBA on both the NF quiet waking hours graph and the NF night-time hours graph which is indicative of unrecorded sound levels below the level of sensitivity of the sound recording instruments. This would pull the trend line down still further, implying that background levels at NF are very low indeed.

Conclusion on background noise

525. Overall, I find that neither the plaintiffs nor the defendant's estimation of background noise levels are reliable.

526. It has not been established that the WTN is in breach of the commonly applied relative noise limit (5 dBA above background noise levels). Nor can I be satisfied on the balance of probabilities that this is a "low noise environment".

527. Notwithstanding this, and recalling my observations at para 509-511 above, I find that on account of its characteristics (rather than its absolute decibel level) the WTN commonly dominates the plaintiffs' sound environment over sustained periods of time.

528. The intent of a relative noise limit is that background sound might mask WTN to a degree, rendering it less distinguishable. Therefore, although it may not be possible to formally assess exceedance over background noise levels, I am nonetheless satisfied that WTN which dominates the plaintiffs' sound environment can fairly be characterised as inconsistent with the purpose and intent of relative noise limits.

The impact of the noise on basic needs such as sleep

EPA Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites ("EPA NG3").

529. In June 2011, the EPA produced a guidance note on the noise assessment of wind turbine operations at EPA licenced sites, EPA NG3. Although EPA NG3 is not applicable to this windfarm, it is nonetheless relevant to note that it expressly recognises the additional annoyance and sleep disruption that can be occasioned by AM. EPA NG 3 records that excessive audible AM attracts attention, particularly if heard while trying to get to sleep either at the start of a night or when a person has been woken by other causes. It states that although the level of noise generated internally, even with windows open, is usually insufficient to cause sleep disturbance, the stress it may generate, even if only just audible, may be sufficient to extend the time required to fall asleep. Such effects may give the impression of a noise which is 5 dBA or more louder than a noise of the same level without any such components. EPA NG3 notes that it is therefore necessary to develop appropriate corrections for regulatory purposes.

WHO Guidance Lmax and Lden

530. Both parties rely on World Health Organisation guidance in relation to the level of sound thought to effect sleep, health and wellbeing. Ms. Large notes that the 2017 HH internal

data shows AM peaks (known as the Lmax) of 40-43 dBA leq with the window open and 20-21 dBA leq with the window closed. She also notes that the 2017 NF external data demonstrates that Lmax is regularly in the regions of 50-50 dBA leq but also reaches 54-57 dBA leq. Ms. Large states that AM demonstrating Lmax of this magnitude would be viewed by the WHO 2009 Night Noise Guidelines for Europe ("WHO 2009") as likely to cause sleep effects.

531. However, this focus on the Lmax of noise has not been carried through to more recent WHO Guidance, the 2018 Environmental Noise Guidelines for the European Union (WHO ENGER). WHO ENGER, which, unlike WHO 2009, contains recommendations on WTN specifically sets a *"conditional recommendation"* for WTN of 45 dBA leq on an Lden basis.

532. Mr. Carr suggests that the noise limits set out in the Ballyduff permission complies with the WHO ENGER recommendation. He also maintains that, as Mr. O'Reilly's compliance graphs show that total operational noise is below 45 dBA leq during quiet waking hours and night hours, the WTN also complies with WHO ENGER.

533. However, Lden is an entirely different measurement metric to either L90 or leq. The Lden (also referred to as "DENL") indicator is calculated as the A-weighted average sound pressure level, measured over a 24-hour period, with a 10 dB penalty added to the average level at night, a 5 dB penalty added to the average level during the evening and no penalty during the daytime. The penalties are introduced to indicate people's extra sensitivity to noise during the evening and night.

534. Neither parties' experts have even attempted to calculate how one might convert the data in Mr. O'Reilly's compliance graphs to the appropriate Lden metric, which in any event should presumably be ascertained for all wind directions (and not solely downwind).

535. Overall, there is entirely insufficient evidence to apply the WHO Lden conditional recommendation in ENGER to this site.

536. In any event, ENGER acknowledges the low quality of the evidence reviewed in the formulation of this recommendation, which is conditional only. Therefore, although the guidance of WHO clearly carries much weight, I do not consider it a robust framework for

assessing whether or not the WTN in the present case is likely to disturb sleep to the extent of posing a nuisance.

Conclusion on sleep impacts

537. Rather, the potential impact of this WTN on sleep must be assessed by reference to the audio recordings (and the associated graphs), all of the expert evidence as to the characteristics of this WTN and to the factual evidence of the plaintiffs, Ms. Doran, Ms. McGinn and the plaintiffs' experts as to the "real world" sleep impacts experience as a result of this WTN. For the reasons set out above, I am satisfied that high AM values and thump AM due to the presence of lower frequency sound energy are common and sustained features of this WTN. These are also the primary characteristics of which the plaintiffs complain. ENGER notes that these characteristics are not captured by standard methods of measuring and that this differentiates WTN from other noise sources. These are characteristics which are known to heighten annoyance and disturb peace, rest and sleep. I therefore find that there is more than adequate evidence in this case to make the case of substantial sleep impacts.

How easily the noise can be avoided/ Measures to reduce or modify the noise

538. Externally, limited measures are open to the plaintiffs to reduce or modify the noise. Although they can attempt to mask the noise by playing music or wearing headphones, this is an unsustainable long term solution. I also find that given its characteristics (e.g., with typical AM values exceeding 5 or 6 dB and regular thump AM etc), the WTN regularly intrudes to an unacceptable degree into the plaintiffs' homes over sustained periods of time. Although overall noise levels will be lower with the windows completely shut, at higher speeds of rotation the WTN- and associated vibration-still intrude to an unacceptable degree. In any event, a large part of the population desire to sleep with their windows slightly open and having to close windows effects, fresh air and connection with the outside world. In a quite rural location such as this (albeit one which includes permission for two turbines) , it is not reasonable to compel residents to shut their windows in an attempt to partially mitigate the impact of unacceptable noise instruction.

539. During the day, this WTN may be somewhat masked by the sounds of household appliances, the dogs and conversation. However, it will be obvious during times of calm. At

night, the plaintiffs have already taken such measures as are reasonably open to them to mask the sound to aid sleep.

540. Whilst the defendant contends that insulation would assist, Ms. McGinn states that this has made very little difference at NF.

541. I do not find the defendant's suggestion that the plaintiffs should simply avoid the worst affected rooms is a reasonable means of escape from the noise. There is no authority whatsoever for this proposition. A resident should be able, without nuisance, to relax or sleep in any room they chose. Having to avoid the rooms where the noise is most intrusive merely demonstrates adverse impact on the ordinary comfort and enjoyment of the house as a whole.

542. There are, however, a range of options identified by Mr. Mayer which could be implemented by the defendant to modify or reduce the noise such as constraining the speed of rotation of T2. None of these have been adequately explored to date by the defendant.

How often the noise occurs and the time of day or night when the noise occurs

543. The intrusiveness of the noise varies as between different audio recordings, each of which will be rendered more or less intrusive by reference to a range of factors such as their sound pressure level, their AM characteristics etc. Moreover, the intrusion noise likely to arise varies with the time of day and the duration over which the noise represented by the recording persists.

544. Unquestionably, the most intrusive feature of the WTN is its AM and thump AM in particular. I accept that, as is typical, this is more pronounced at night. The ETSU Review suggests that the same is true of the early mornings and evenings. This means that the worst noise is likely to conflict with the most sensitive periods of the day when background masking sound levels are lower as compared to WTN. This all tallies entirely with the evidence of the plaintiffs and their experts.

Frequency and duration of noise impact

545. Frequency and duration of impact are critical factors in assessing whether nuisance is made out. One can confidently say that if the conditions complained of pertained only for short periods or on rare occasions then nuisance would not be made out. Equally, if there were a less

intrusive noise source present all day every day, then this also might not be a cause of nuisance. There is no hard and fast level of intrusion which can be set as the barometer for nuisance. One has to make a judgment call based on all of the factors identified above as to how the plaintiffs as objectively reasonable people could be expected to relate to the noise.

546. However, bearing in mind that the defendant's experts did not contend that the MAS audio recordings (and the associated graphs) were unrepresentative of the general WTN on site, I accept the evidence of the plaintiffs' experts (and the plaintiffs themselves) that the conditions so demonstrated occur commonly and on a sustained basis.

Issue 7: What is the response of the defendant and its experts to the plaintiffs' case? Does the evidence of the defendant's experts suggest that the WTN is not a substantial interference with the plaintiffs' use and enjoyment of their land?

547. As will be apparent from the above, I find that the analysis of the WTN - as demonstrated by the MAS audio recordings and the associated time domain graphs and spectrograms - under the Defra criteria strongly corroborates the plaintiffs' evidence of unreasonable interference with residential amenity. It is now appropriate to relate the overall response of the defendant and its experts to all of the above. Does this argument or evidence suggest that the WTN is not a substantial interference with the plaintiffs' use and enjoyment of their land or otherwise incline the court towards a finding that nuisance is not made out?

548. In the preceding sections of this judgment, I have set out and analysed the defendant's experts' evidence on the various issues falling for consideration under the Defra Guidance. At substantial risk of repetition, I will make the following more general observations.

549. Mr. Carr , the defendant's principal witness, gave evidence over the course of approximately 6 days. He appears to have attended the properties for a total of 40 minutes on 8th November, 2022.

550. The following extract from the beginning of his cross-examination assists in an appreciation of Mr. Carr's general approach to this case.

Q. So you got that material [the 2017 and 2021 MAS data]. And what I'm concerned about is, you're

complaining about the listening, and my impression is that you don't see value in the [MAS] recordings, is that right?

A. *Yes.*

Q. *You don't see value in the recordings, is that your evidence, is that right?*

A. *It is. I don't -- I don't believe that the [MAS] recordings were taken in a way that the conclusions or the information that came out of them stand over for the reasons that we have said in relation to how the recordings were taken.*

Q. *Well I'll go back then to my question. Why did you not advise Mr. Brazil to make his own recordings?*

A. *Judge, as I understand this, we have to meet the case that's put to us. We assess the site for compliance with the guidelines and the guidance as I know them and then I reviewed the additional information [i.e. The MAS recordings and their reports], and to my mind the evidence wasn't there to show a nuisance.*

Q. *I see. So, at this point, on reflection, do you think you might be better advised, and Mr. Brazil be better advised, if he had his own measurements?*

A. *Judge, the requirements on Mr. Brazil was to assess -- my understanding of it was to assess compliance with the planning and then to look at any evidence in relation to the other guidelines. And to my mind there still isn't evidence of a nuisance there because the way the other data was obtained.*

Q. *Because of the way the other data was obtained?*

A. *And presented.*

Q. *So, the reality of it is then that the Defendant is meeting this case relying on compliance and relying, in essence, on your advice that there isn't a nuisance, isn't that right?*

A. *Well --*

Q. *Isn't that right?*

A. *The overall noise levels from this wind turbine are a significant factor on whether there is going to be a nuisance there or not. In my mind the overall noise levels from these turbines are well below a threshold that would be significant which point to breach of planning, breach of licensing or a nuisance.*

Q. *So that's the advice you gave to Mr. Brazil and that's really the basis on which this case is fought, is it?*

A. *Well that's my advice.*

This passage exemplifies the three main components to Mr. Carr's evidence.

1. The starting point appears to be to assess whether the WTN complied with the planning permission and with "*guidelines* "and "*guidance*" which in Mr. Carr's opinion it did. The only real data pertaining to the WTN on site put before the court by either of the defendant's witnesses was the planning compliance graphs prepared by Mr. O'Reilly. Mr. Carr's report and oral evidence was based exclusively upon the HH planning

compliance graphs and he did not appear to have informed himself of the NF planning compliance graphs.

For all of the reasons already set out, I do not accept that planning permission is the determinant of nuisance in this case. Furthermore, I do not accept that planning compliance is demonstrated in this case.

The primary pieces of "guidance" relied upon by Mr. Carr were WEDG 2006 the IOA RM and draft WEDG 2019. Although I accept that compliance with WEDG 2006 is demonstrated on the balance of probabilities, this guidance does not in my view, delineate the parameters of nuisance in this case. The IOA RM does not set any "*threshold*" for "*noise levels*" at all, whether for by decibel level or AM values. The defendant's attitude to draft WEDG 2019 varies. On the one hand its counsel submitted that WEDG 2019 is draft only and cannot be the determinant of nuisance. On the other hand, Mr. Carr asserted that the WTN complies with draft WEDG 2019, "*with headroom*". I prefer the point made by counsel: whilst draft WEDG 2019 might give some indication of the likely future approach to balancing wind turbine development with protection of amenity (which, it appears likely, will involve a combination of relative noise limits and character penalty), it has since been withdrawn and cannot be the determinant of nuisance.

Further, although Mr. Carr asserts that the WTN complies with draft WEDG 2019, this is not even close to being demonstrated on the balance of probabilities.

2. Mr Carr's view is that the overall noise levels are "*very low*" and well below any "*threshold of significance*". Given his overall assessment of the noise levels, this was not a "*critical*" case requiring him to listen to the WTN or to engage in further monitoring.

   However, how is this threshold of significance to be set? In a case which is "*all about AM*", it cannot be set by the bare noise limits designated in the planning permission or in WEDG 2006.

   Further, in so far as draft WEDG 2019 might be said to provide any indication of the "*threshold of significance*", there is no valid basis for Mr. Carr's assertion that the WTN is well below this threshold or otherwise "*low*". On the contrary, Mr. O'Reilly's NF compliance graph shows that from windspeeds of 9 m/s total operational noise levels at NF is right at or slightly over the 43 dBA L90 maximum threshold recommended by draft WEDG 2019 (irrespective entirely of any possible character penalty). The noise levels on the HH planning compliance graphs are admittedly lower,

but these graphs can only inform one on noise levels at comparatively low windspeeds. Likewise, background noise is an unknown so compliance with the draft WEDG 2019 relative limit cannot be assessed at either location.

In short, I do not see compliance with draft WEDG 2019 *"with headroom"*.

3. Mr. Carr sees no value in any of the MAS data by reason of the manner in which it was collected and presented.

Insofar as concerns the collection of the MAS data, there could be no legitimate criticism of the manner in which Ms. Large collected the 2017 MAS data. The 2017 NF external data was recorded with a double skinned windshield in an appropriate free field location and the 2017 internal HH data was recorded in accordance with the Defra Guidance for internal measurements.

I am fully satisfied that even if one relied upon the 2017 data alone, same is sufficient to confirm high AM values, lower frequency sound content, thump AM etc. Moreover, Ms. Large's opinion, on which she was not contradicted, is that there is no material difference between the 2017 and 2021 data. This supports the conclusion that the 2021 internal data is reliable. Although therefore there is legitimate criticism of the 2021 NF external data (which I therefore disregard), the analysis of the internal NF and HH 2021 data is on balance robust.

Insofar as concerns the presentation of the MAS data, I am satisfied that the methodology used reliably presents the key features of the plaintiffs' general sound environment - the dominance of the WTN and its erraticism, impulsivity and variability. I am also satisfied that reliance can be placed upon MAS's calculation of AM values which is supported by the application of IOA RM to the 2021 internal data (in particular the 2021 NF internal data which was recorded in an unoccupied house). I am further satisfied that spectral analysis demonstrates significant lower frequency sound manifesting as thump AM.

For all these reasons, it is entirely illegitimate for Mr. Carr to place "*no value*" on all of this data and to effectively ignore it.

551. Beyond criticising their methodology, the defendant's evidence did not engage at all with the plaintiffs' expert's audio recordings (and the associated graphs). Unless one accepts the contention that the planning permission and WEDG 2006 are the determinants of nuisance, the defendant's experts gave the court very little to go on. Mr. Carr offered little or no substantive evidence in response to the audio recordings (and the associated graphs) illustrating

and analysing the features of WTN. He and Mr. O'Reilly ignored the propositions of the plaintiffs' experts outlined in exhaustive detail that this demonstrates that AM values are excessive, and that low frequency characteristics and thump AM are commonly present in the WTN.

552. The defendant's evidence did not engage in any meaningful way with the evidence of the plaintiffs as to their experience of the WTN. Mr. Carr has not read the Webster Rollo noise diaries. He did not comment in any detail on how the sound might present itself to the residents.

553. The defendant's experts, both of whom are extremely experienced in relation to windfarms, offered no substantive evidence that the impact of the WTN was not as described by the plaintiffs and their experts. There was, for example, no suggestion that the level of erraticism, impulsivity and variability described by the plaintiffs in the AM was not present on the audio recordings or on site. Nor did the defendant's experts contend that thump AM was not a regular feature of the WTN. They did not contradict the plaintiffs' experts finding that this was evident on the audio recordings and indeed, during their visits to the site. Although many passages in the guidance to which he referred noted the distinction between swish and thump AM, Mr. Carr did not address the reported impact of regular, substantial and sustained thump AM at this site.

554. The defendant's experts did not assist the court in understanding how they contend that the experience described by the plaintiffs and features of the WTN highlighted by the plaintiffs' experts on the audio recordings (and the associated graphs) do not represent an unreasonable intrusion on amenity. If indeed this was their opinion it was not, by reference to any of the MAS data (or any other data), either explained or substantiated.

555. Neither Mr. Carr nor Mr. O'Reilly contradicted the view of Ms. Large and Mr. Stigwood that the noise from the Ballyduff turbines is exceptionally intrusive and out of the ordinary for WTN. I therefore accept the evidence of the plaintiffs' experts that this WTN is considerably more intrusive than one would usually encounter. Although Mr. Brazil states that the WTN is not unusual, I cannot accept this as Mr. Brazil has paid only a short visit to the plaintiffs' homes and beyond that has only heard the WTN from the public road which is set back from their properties.

556. Mr. Carr stated that in general he would advise wind turbine operators that if there is an issue with AM complaints, they should try and identify the environmental circumstances under which this occurs to ascertain if mitigation measures are required or can be devised. This is a step which for reasons best known to itself the defendant and its experts have steadfastly declined to take.

557. In many cases, in untangling an issue on which expert evidence has been given, particularly one on which the crux of the case in large part depends, only one of the two competing experts' views can be preferred. This case is somewhat different because whilst the plaintiffs' experts addressed the features of the WTN said to give rise to nuisance in detail, the defendant's experts have not. To emphasise the "appalling vista" that would present should this court find for the plaintiffs, the defendant and its experts stressed that a large number of windfarms are situated within 500 meters of a residence. I have no reason to doubt this. But this case is not about statistics. It is about *this* noise from *this* windfarm as heard at *these plaintiffs' residences*. This is the issue on which I would have appreciated the assistance of the defendant's experts.

Issue 8: Did the acousticians experts fail to discharge their duties to the court?

558. Both sides criticise the experts of the other for failing to understand their duty to the court. The defendant submits that the MAS reports (and Mr. Stigwood's oral evidence in particular) displayed many of the features which were sharply criticised by the Court of Appeal in *Duffy v. Mcgee* [2022] IECA 254. The plaintiffs maintain that Mr. Carr deliberately curated his evidence to focus only on planning guidance and that he deliberately ignored the separate issue of nuisance. It is said that he thereby brought only part of his expertise to the court.

Defendant's criticisms of Mr. Stigwood and Ms. Large

559. Mr. Stigwood is an acoustician who has no metrological, scientific or statistical qualifications. The defendant criticises him for giving evidence touching upon these issues. However, such evidence was not advanced in a vacuum. Rather, the vast majority of such evidence was advanced either by reference to the contents of established guidance and standards which were themselves the subject of extensive comment by both parties (such as ETSU, the IOA AM report, draft WEDG 2019 etc) or by reference to relevant guidance on the assessment of nuisance (such as the Defra Guidance and EPA NG 4). At other times the views

expressed - e.g. that the plaintiffs' residences were in a wind shadow or that the position of T2 on a height would increase the impact of windshear- was uncontested and /or was common sense. This criticism is not therefore merited.

560. The defendant criticises Ms. Large's first report for citing legal authority. However, it is evident that the primary purpose of these passages is to place the expert evidence in context and to draw attention to the factors which are viewed by the court as relevant to the assessment of noise nuisance. In any event, the factors discussed[58] either have their genesis in the Defra Guidance on assessing statutory nuisance or they are so self-evidently relevant to a noise nuisance assessment as to be uncontroversial. Detailing these factors does not imply a failure to understand an expert's duty to the court.

561. Nor do I view the evidence of either Ms. Large or Mr. Stigwood assessing the Ballyduff WTN as against these factors as anything other than relevant, helpful and thorough. Rather, I agree that Mr. Carr's failure to substantively engage with these factors is regrettable. As a result, Mr. Carr did not assist the court on matters which are demonstrably relevant and within his field of expertise.

562. The defendant also criticises the plaintiffs' experts for citing various publications and expressing their opinion in relation to the functioning of the human brain and aspects of neuroscience. In so far as concerns Ms. Large, this criticism is entirely ill founded. This is a case about noise annoyance and factors likely to decrease or increase noise annoyance are of obvious relevance. Ms. Large's written and oral evidence, whilst containing some limited commentary on one's physiological response to noise – in each case, citing appropriate publications – did not in my view stretch the limits of her expertise as an acoustician. Much of this evidence - for example in relation to the enhanced impact of low frequency noise – was in the field of (or intersected with) acoustics. Other considerations discussed by Ms. Large- e.g. that unpredictable, unexpected noise is more annoying than steady, monotonous noise - are common sense.

563. I agree that, at times, particularly under cross-examination, Mr. Stigwood's answers strayed over the line of his expertise into matters of physiology. I have rejected such evidence

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[58] Essentially the Defra criteria.

where appropriate - e.g. Mr. Stigwood's view that one's appreciation of background noise levels should be calibrated by reference to periods of low windspeeds rather than by reference to increasing background noise levels at increasing windspeeds.[59] However, over the course of extremely lengthy testimony, this was a rare occurrence and does not overall undermine his evidence.

564. The defendant also criticises Ms. Large and Mr. Stigwood for expressing the opinion that the data collected by MAS "*corroborates*" the evidence of the plaintiffs. I accept that it is not the function of an expert to express views as to whether one piece of evidence corroborates another. This is clearly a matter for the court. On the other hand, context is everything. This opinion was offered as part of the presentation of the audio recordings of the WTN at the plaintiffs' homes (and the associated time domain graphs). In this context, the plaintiffs' experts presented the features of the WTN – high AM values, thump AM etc- to demonstrate correlation with the plaintiffs' complaints about those self-same features of the WTN. I do not view this as an illegitimate exercise.

565. The defendant submits that the court should attach diminished weight to Mr. Stigwood's evidence because he acted as a partisan advocate throughout the trial. Although there were times when this might have been so, I do not in general accept this characterisation. Much of Mr. Stigwood's dogged perseverance can be explained by the fact that for many years he has argued through his research and publications that the standard ETSU approach does not protect windfarm neighbours against excessive AM. In this, he has been largely proved by contemporary science to be correct. His views are therefore held, and expressed, with vigour, as one would expect in the circumstances. Further, it would be hard to escape the impression that Mr. Stigwood, and indeed, Ms. Large have considered the impact of AM - both in general and at Ballyduff in particular - at far greater length and in far greater depth than Mr. Carr, who did not even attempt to address or assess its impact.

566. Having said that, Mr. Stigwood was at times overly defensive, occasionally refusing to make legitimate concessions even when on somewhat thin ice. For example, I find little merit in his argument that it is legitimate to assess exceedance over background noise by comparing windy periods affected by WTN with still periods which are not. Likewise, Mr. Stigwood gave

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[59] See para 518 above.

evidence as to likely sleep impacts by reference to the WHO 2009 to the unwarranted exclusion of the more recent WHO ENGER. As will be apparent from my analysis above, I do not accept Mr. Stigwood's views in these two respects. In addition, I accept that at times, Mr. Stigwood's use of language appeared somewhat extreme. For example, in presenting the audio recordings to the court, he tended to refer to the WTN as a *"roar"* even when - albeit intrusive and dominant - it could not fairly be so described. Emotive language such as this is unhelpful.

Plaintiffs' criticisms of Mr. Carr

567. The defendant correctly submits that it is a matter for the court to determine whether nuisance has been made out or not on the evidence. Indeed, the defendant appears to have approached the case on the basis that the expert witnesses ought not to offer an opinion on this matter at all.[60] Mr. Carr therefore offered no real commentary on the aspects of the Ballyduff WTN which the plaintiffs and their experts say are demonstrated by the audio recordings (and associated graphs) and which are said to amount to nuisance.

568. However, this rather overlooks the fact that in order to assess whether or not this particular windfarm poses a nuisance, the court must engage with the plaintiffs' complaints and attempt to assess the nature and impact of the WTN at the plaintiffs' homes. In so doing, it is appropriate for the court to be guided by the evidence of experts as to what features of the WTN might be relevant to the noise nuisance assessment, as to the presence or absence of such features in the Ballyduff WTN and as to the extent to which, if present, such features are known or recognised to increase annoyance or can otherwise be characterised as adverse or unreasonable. Contrary to the view apparently held by the defendant and its experts, an informed qualitative commentary on such features is of assistance to the court.

569. Furthermore, in a case in which the defendant relies so heavily on the fact that there is planning permission for the wind turbines, one would expect that Mr. Carr would assist the court in assessing whether the features of the WTN complained of by the plaintiffs and highlighted by the evidence of MAS, are conventional features of WTN or are, as MAS

[60] The defendant's written legal submissions argue that it is not appropriate for expert witnesses to express a view on matters of law which are for the Court to determine and that the Court should accordingly disregard entirely the assertions which have been made by MAS to the effect that nuisance has been proven on the evidence.

contends excessive, out of the ordinary[61] or otherwise non-conventional for WTN? However, Mr. Carr's evidence did not illuminate the court at all on this issue.

570. This is unfortunate not least because this court has no expertise in distinguishing between conventional and non-conventional WTN. By contrast the experts on both sides have vast experience in his area. There is nothing improper therefore in the plaintiffs' experts expressing the view that the particular features of this WTN render it non-conventional and far more intrusive than would usually be the case.

571. Like Mr. Stigwood, there were times when Mr. Carr pushed his argument too far. For example, I was surprised by his insistence that compliance with the planning permission (and with WEDG 2006) defines the parameters of nuisance. This inevitably entailed a refusal to acknowledge that the science has changed since WEDG 2006. In fact, Mr. Carr appeared to view that the primary innovation of draft WEDG 2019 was the promotion of consistency in measurement methodologies and the reinforcement of the GPG and the IOA RM. It seems that the proposed introduction of a penalty for "excessive" AM barely merited a mention. Yet the theory behind draft WEDG 2019 (and indeed behind the IOA AM report, the Phase 2 Report and the ETSU Review) can only be seen as a significant departure from the "decibel limit only" approach to planning practice espoused by Mr. Carr. Furthermore, Mr. Carr's casual assertion that the WTN would comply with the recommended limits in draft WEDG 2019 regardless of any potential AM penalty was not only unsupported by the evidence but, in my view, displayed a partisan approach.

572. I was also struck by Mr. Carr's apparent dismissal of Mr. Stigwood's view that AM is often worse at night-time due to stable atmospheric conditions, However, the relevance of stable atmospheric conditions to the enhancement of WTN AM has been clear in this jurisdiction since at least 2011. Thus NG 3 notes that features which were thought to enhance AM included stable atmospheric conditions[62] particularly at night and topography leading to

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[61] Note that my reference to "out of the ordinary" or "non-conventional" WTN should not be read as a reference to a principle of the United Kingdom law of private nuisance that even where the defendant's activity substantially interferes with the ordinary use and enjoyment of the claimant's land, it will not give rise to liability if the activity is itself no more than an ordinary use of the defendant's own land. This is not a feature of the Irish law private nuisance. My use of the words "out of the ordinary" is simply to denote particularly intrusive characteristics that are not thought to be a commonly occurring feature of WTN (such as high AM values and thump AM).

[62] Stable atmospheric conditions are conditions under which mixing of layers in the atmosphere is minimised. This leads to a much greater increase in windspeed with height.

different wind directions being seen by the blades at different points in their rotation. This view is also recently confirmed by the ETSU Review. It is difficult to understand how Mr. Carr, a highly expert witness operating in the field of acoustics, could depict Mr. Stigwood's views on this issue as somewhat exotic.

573. Overall, it is hard to disagree with the plaintiffs' submission that Mr. Carr displayed a stark failure to engage with the complaint actually made or with the evidence illustrating such complaint. There is force in the plaintiffs' argument that Mr. Carr's refusal to engage with any material which was inconsistent with his central thesis means that he brought only part of his expertise to the court.

Conclusion on issue 8

574. I should emphasise that my reservations as just outlined do not go nearly far enough to justify a finding that either Mr. Stigwood or Mr. Carr failed to discharge their duties as experts to the court. It is however the case that their evidence had less of a sense of balance than I would have expected, which inevitably impacts to some degree upon its weight. Particularly in the case of Mr. Carr, there was little sense that the propositions being put to him were being carefully considered. Rather, he repeatedly restated his central thesis.

575. By contrast, Ms. Large, gave the impression, through her evidence, of a witness who was trying to be helpful to the court and who did not in any way oversell the cogency of her argument. She conceded points where appropriate and answered all questions put with logic, thoroughness and diligence. I do not see how any complaint of partisanship or incompleteness could credibly be levelled at Ms. Large's evidence. Therefore, in adjudicating upon this complex case I have placed considerable weight upon her evidence.

Issue 9: What on the balance of probabilities are the characteristics of the Ballyduff WTN

576. I find on the balance of probabilities that the evidence supports the plaintiffs' account as to the characterises of the noise. I also find on the balance of probabilities that such characteristics occur commonly and on a sustained basis.

577. I am fortified in these conclusions by the following inter-related observations:

578. First, the descriptions given by all four plaintiffs of the particular characteristics of the WTN – (e.g. dominance, erraticism, impulsivity, excessive AM values and thump AM) - were mutually consistent and were not shaken in cross-examination. The Webster-Rollo's who gave detailed and extensive evidence about this were subject to exacting cross-examination over the course of 4 days. Mr. Shorten who gave similarly detailed and extensive evidence on the WTN was not cross-examined in relation to his experience of WTN and Ms. Carty, who did likewise, was not cross-examined at all.

579. Second, the experience of living with the WTN as described by Ms. Webster and Mr. Rollo in their evidence to the court is chronicled in daily diary entries going back over three years. As I observe above, the reliability of these diary entries was thoroughly tested in cross-examination and passed muster.

580. Importantly, Ms. Large's report correlated the description of the WTN in key parts of the 2020-diary entries with the contemporaneous audio recordings (and the associated graphs) to ascertain whether the plaintiffs' descriptions were borne out. Her report confirmed consistency between the two. Mr. Stigwood performed the same exercise in relation to key parts of the 2021 noise diaries. This is of significance as Ms. Webster and Mr. Rollo could not have known when making the diary entries what the audio recordings (and the associated graphs) would show.

581. The Webster-Rollo diary entries, Ms. Large's report and the full suite of audio recordings (and the associated graphs) have long since been furnished to the defendant. The defendant could have challenged the reliability of either the plaintiffs' diary entries or of Ms. Large's descriptions of the relevant data by contending for example that excessive AM or thump AM etc was not present on the recordings. It did not do so. This all suggests that the diary entries can be seen as a valid contemporaneous account of the plaintiffs' experience of the WTN.

582. None of this means of course that all of the features described in the diary entries (or indeed all of the features demonstrated by the MAS 2017 and the MAS 2021 data) were present on a constant basis over these years or even that all of the features described were continuously present throughout the individual days and nights represented by the relevant entries. However, the preponderance of the evidence is that these features were present on a common and

sustained basis - albeit not continuously – during the periods recorded in the diaries. Furthermore, there is no reason whatsoever to conclude that the nature of the WTN has changed since 2017 and 2021 and I accept the opinion of MAS that it has not.

583. Third, the plaintiffs' descriptions of these characteristics of the WTN were consistent with the personal on site observations of both Ms. Large and Mr. Stigwood on which neither expert was convincingly challenged. Ms. Large, spent an extended period of time at both NF and HH and gave evidence that the WTN at both sites was the worst case of WTN nuisance which she had ever experienced.

584. Fourth, the court is also informed by its own appreciation of the noise as it appears on the audio recordings presented by the plaintiffs' experts. On any fair assessment the audio recordings support the plaintiffs' evidence that the WTN disturbs their peace and disrupts their sleep. I find that the evidence comprised by the audio recordings (and the associated graphs) is consistent with the plaintiffs' description of the characteristics of the WTN.

585. Fifth, the observations of the plaintiffs' experts-- based on the audio recordings (and the associated graphs) – as to the characteristics of the WTN was consistent with the plaintiffs' own descriptions of same and further strongly supports the plaintiffs' evidence of significant adverse impact. This is important because the observations of the plaintiffs' experts (to the effect that the audio recordings and associated graphs demonstrated erratic, impulsive AM together with high AM values and thump AM) was scarcely challenged in cross-examination or in the defendant's experts' evidence. Thus, although Mr. Carr did contend that AM values should not be derived from the time domain graphs, he did not dispute that the graphs themselves, which correctly captured the noise at the microphone locations at HH and NF showed that high AM values were present over the periods depicted in the graphs. The defendant's primary response to much of the above was that the sound levels were "low" which has not been demonstrated and which furthermore misses the heart of the argument. As I explain above, WTN levels are generally "low". The point however is that, even if the decibel level of the Ballyduff WTN is roughly as one might generally expect, it is its other features thereof which render it objectively unreasonable and, indeed, dominant.

Findings of fact in relation to the characterises of the WTN

586. On the basis of all of the above, the following are my findings of fact:

587. Generally, T1 is barely audible from the plaintiffs' homes and, when audible is not intrusive.

588. By contrast, when it is turning, T2 is audible at all times in the gardens and recreational area outside the plaintiffs' properties. When T2 is turning, even slowly, WTN is also audible from inside the plaintiffs' homes with the windows only slightly ajar. Whether the WTN is audible with the windows closed will depend upon the speed of rotation of the rotors and on other ambient noise. Likewise, whether at any given time audible WTN - and associated vibration - causes an unreasonable interference externally or internally- will also vary with the speed of rotation of the rotors, with other ambient noise and with metrological conditions.

589. I find that there are frequent and sustained periods during which AM values are conservatively in excess of 5 or 6 dBA. I also find that there are regular periods during which the AM values are considerably in excess of 6 dBA, in the order of 10 dBA or more. I find that such high AM values exacerbate the other intrusive features of the AM such as its erraticism, impulsivity and intermittency. I find that although noise levels will be lower when the windows are fully closed, high AM values remain. I find that there is a significant audible lower frequency component to the WTN. This produces clear whomping, thumping and whacking sounds. These whoomphing and thumping sounds are themselves highly variable and unpredictable. In addition to being heard, this lower frequency WTN is felt as a vibration or a sense of pressure. The WTN is audible and "felt" both outside and inside NF and HH, including in the master bedrooms at both properties. I find that, when even with the windows are entirely shut this lower frequency noise is clearly audible throughout both houses and that thump AM can be felt as a vibration in the structure of NF and in particular HH. I am satisfied that this thump AM is commonly present over sustained periods.

590. I find that when the turbine is turning slowly- as exemplified at the time of the court's visit – it is not particularly intrusive. However, I also find that at higher speeds of rotation as a result of the characteristics outlined above, the WTN dominates the plaintiffs' sound environment both externally and internally. I find that at moderate to high speeds of rotation

the impact of the WTN far exceeds masking levels; it is the primary noise that is experienced in the plaintiffs' sound environment.

591. I further find that although internal noise levels are lower in both houses when the windows are shut, at higher speeds of rotation the WTN is nonetheless dominant particularly due to the sense of vibration associated with thump AM.

592. I further find the WTN AM is more prevalent during the night, early morning and evening periods than during the daytime. This is in all likelihood due to the atmospheric and situational conditions that prevail at these times, contributing to increased AM occurrence, and potentially enhanced sound propagation.

593. As I explain above,[63] bearing in mind current scientific uncertainty on this issue, the most that the various guidelines (such as the WHO guidance variously relied upon by both parties' experts) can do is illustrate the likely sound level at which sleep impacts are anticipated. As in *Hanrahan* such evidence cannot dethrone the factual evidence of the plaintiffs that the combined characteristics of the WTN are such as to regularly disturb their sleep. I accept that the WTN is such as to cause sleep disturbance at both NF and HH with the windows open and with the windows closed. I accept the evidence of all four plaintiffs as to the sleep difficulties experienced as a result of the WTN. I accept that Ms. Webster continues to do all that she can to mask the noise but nonetheless continues to experience serious sleep disturbance. In Mr. Rollo's case I accept that the impact of the sleep disturbance was profound and unremitting. I accept that this sleep deprivation was ultimately instrumental in causing Mr. Rollo to suffer a psychiatric injury.

594. I accept that during spring and autumn the turbines intermittently cause shadow flicker, albeit that I am not satisfied that this pertains for more than 30 minutes per day such as to exceed WEDG 2006.

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[63] See para 536 above.

Issue 10: Does the court accept the plaintiffs' evidence that the characteristics of the noise amounts to an unreasonable interference with the plaintiffs' enjoyment of their property? Is liability in nuisance established?

595. As will be apparent from all of the forgoing, the answer to this question is a resounding affirmative.

596. The Ballyduff planning permission does not delineate the parameters of noise nuisance in this case principally because it does not assess or regulate the aspect of the WTN complained of, which is AM. Even if the planning permission did delineate the parameters of noise nuisance, total operational noise at both NF and HH is above the applicable 40 dBA leq limit for windspeeds above 7 and 6ms/ respectively. Although, the absence of a formal background noise assessment means that planning non-compliance has not been demonstrated on the balance of probabilities, nor can the defendant make out the defence advanced.

597. I find that two features in particular of the WTN AM render the WTN an unreasonable interference. First, there are frequent and sustained periods during which the AM manifests typical AM values at a level widely acknowledged to be associated with high levels of annoyance. Second, this WTN displays periods of thump AM. The oral evidence of all four plaintiffs and the Webster-Rollo diary entries all suggest that thump AM, together with its association vibration, is the most intrusive quality of the WTN. This thump AM vastly adds to the nuisance posed by the wind farm. In combination, I find that this is WTN which reasonable people would find it impossible to habituate to.

598. Regular and sustained AM values of this order and thump AM combine to produce WTN which is a world away from the usual noise that one would associate with wind turbines – viz. reasonably regular and monotonous swish AM. Mr. Lawlor, the defendant's planner, stated that the understanding of planners is that blade swish is "*normal AM*". He stated that whoomphing or thumping AM is called "*adverse AM*" or "*other AM*". As the ETSU Review notes it is also commonly described as *"abnormal AM"* or *"enhanced"* AM. Mr. Lawlor acknowledged that whoomphing or thumping AM, "*is likely to cause adverse reaction in the community*". Although he stated that this form of AM is thought to occur only for short durations of time at very specific meteorological conditions, I am satisfied that the evidence

establishes that it is a common and sustained feature of the Ballyduff WTN, particularly at night, in the early morning and in the evening.

599. I am satisfied that these two features combine to render the WTN the dominant noise in the plaintiffs' sound environment. These are the features of WTN that one hears and feels both outside and inside HH and NF with the windows open and closed. Such an intrusion of noise and vibration into the plaintiffs' homes could not be an objectively reasonable impact of a windfarm located in a quiet rural environment such as this, albeit one which includes permission for a windfarm.

600. I accept the evidence of the plaintiffs' and their expert witnesses that the noise impact demonstrated on the audio recordings and graphs occurs commonly and for sustained periods. To expand on this somewhat, I do not find that high AM values and thump AM occur constantly in the Ballyduff WTN. Their level and presence fluctuates. However, I accept that these features occur commonly albeit at irregular intervals. These irregular intervals are frequent and can occur on repeated occasions in a 24 hour period. Sometimes these intervals are sufficiently frequent and sustained in duration as to define the relevant day or night from the perspective of those experiencing it. On such occasions, the overriding impression will be of adverse impact punctuated by periods of more acceptable WTN; e.g. when it is more steady and monotonous with AM of the swish variety. On other occasions the opposite might be the case and the adverse intervals will be infrequent or of short duration meaning that the overriding impression will be of acceptable WTN punctuated by periods of adverse impact.

601. This provides context to Ms. Webster's broad estimation that the WTN unreasonably intrudes on her comfort and enjoyment up to 80% of time. Objectively speaking, it is unlikely that these adverse intervals persist for 80% of the time overall. Such periods of adverse impact are of their nature likely to be intermittent. However, I am equally satisfied that there are few 24 hour periods that escape substantial intervals of sustained adverse impact. Even if not present for the majority of a given 24 hour period, a substantial number of intervals of sustained adverse impact means that the day/night in question cannot fairly be characterised as a period of respite. Crucially, the unpredictability of occurrence and the plaintiffs' lack of control over when and for how long these unacceptable impacts manifest increases the level of nuisance overall. Although therefore adverse impact comes and goes, the annoyance occasioned thereby largely persists. My strong sense is that if the overall intensity or prevalence of these adverse

intervals were mitigated, then the perception of overall nuisance would reduce considerably and probably exponentially.

602. For all the reasons set out above, the plaintiffs' complaints of nuisance are objectively justified. The WTN interferes to a substantial extent with the ordinary comfort and enjoyment of their homes. I am satisfied and find, on the balance of probabilities, that nuisance is established.

603. As appears from the audio recordings, the plaintiffs' evidence and that of their experts, T1 does not cause a nuisance to the plaintiffs. However, I hold that T2 causes a nuisance to Ms. Webster and Mr. Rollo and also caused a nuisance to the Carty-Shortens while they lived at NF.

604. While the WTN is liable to annoy during the working day, it does not substantially interfere with the plaintiffs' enjoyment of their property. This is because, although there will still be some intrusion, AM is likely to be less prevalent due to meteorological conditions and further it is reasonable to expect that during this time the occupants of NF and HH would be working and further that ambient noise will assist in masking the WTN. Although this is a narrow judgment call, I therefore find that the noise can reasonably be tolerated and/or masked during working hours.

605. On the other hand, I find that the noise from the turbine poses a nuisance to the plaintiffs in the evenings and indeed at weekends (in other words during quiet waking hours) when one could expect to be enjoying recreation in the garden and/or peace in one's dwelling. Although one is more likely to be spending time outside during the summer months, one should also be able to do so during the winter months.

606. Equally, I have no hesitation whatsoever in finding that the WTN poses a nuisance at night (in other words during night hours) when a quiet environment is at a premium. Although it is more likely that windows will be closed in winter one should, if one chooses to be, able to open windows for ventilation at night. It is unreasonable to expect occupants of a house to have to sleep with windows shut in an attempt to mitigate unreasonable WTN. In any event, as a result of its characteristics, the WTN-and associated vibrations-is an unreasonable inference even when the windows are shut.

607. I also find that in spring and autumn the shadow flicker caused by the turbines is intrusive and unpleasant. Whilst this is not in and of itself sufficient to constitute nuisance, this shadow flicker is wholly avoidable with inexpensive mitigation measures. Such mitigation should long since have been put in place and ought now to be actioned.

608. As such, the plaintiffs are entitled to damages for unreasonable interference with the enjoyment of their properties (but not to damages for personal injuries, as to which see below). The measure of such damages is accepted by both parties as being for module 2. The plaintiffs argue that nuisance has been established and that the defendant has not suggested any mitigation measures. As such the plaintiffs argue that they are entitled to a permanent injunction as of right to restrain the nuisance. However, I accept the defendant's argument that whether an injunction ought to be granted and if so the terms of such injunction is for module 2. Likewise, the issue of whether the plaintiffs ought to be confined to damages in lieu of an injunction is for module 2.

Issue 11: Does the court accept the defendant's submission that the evidence of Ms. McGinn means that nuisance is not made out in this case?

609. I considered Ms. McGinn's testimony as part of my overall assessment of the evidence in the case. However, in light of the reliance placed by the defendants on Ms. McGinn's evidence, it is convenient to separately explain here my approach to her testimony.

610. As stated above, I accept that the plaintiffs represent *"ordinary person/s with reasonable objective expectations"*. Although I find that Mr. Rollo's reaction to the WTN ultimately became disproportionate by mid to late 2020, this was not the case for the vast majority of the time that he lived beside the turbines. Nor is there evidence that this was ever the case in respect of the other plaintiffs. Further, there was no suggestion that any of the plaintiffs are generally "bad sleepers", hypersensitive to noise or unusually intolerant.

611. The defendant submits that "*Ms McGinn represents an ordinary person with reasonable objective expectations, and, these expectations are not being exceeded by the Defendant herein*". The defendant argues that this rules out interference with the ordinary comfort and enjoyment of the property of the plaintiffs "*beyond what an objectively reasonable*

person should have to put up with in the circumstances of the case" (to quote Henchy J. in *Hanrahan).*

612. Liability in nuisance depends on whether the amenity *of the property* has been unreasonably interfered with. Would ordinary members of society - the putative reasonable person - consider that their amenity is unreasonably impacted by the WTN?

613. Although Ms. McGinn is a *"good sleeper",* there is no evidence that she is hypersensitive to noise. I fully accept that, in everyday parlance, Ms. McGinn is a reasonable person - indeed she struck me as such. However, the question is whether, in her response to the WTN, Ms. McGinn represents the putative objectively reasonable person, which as a legal construct, is a different issue.

614. The plaintiffs rely on aspects of Ms. McGinn's evidence which they contend demonstrate that, even from her perspective, the WTN interferes with her comfort and enjoyment of NF. The WTN is "*pretty obvious*". It makes a "*whoomph*" noise as the blades spin that can generally be heard all the time, both externally and internally. As a result of the WTN, Ms. McGinn takes longer to fall asleep. WTN wakes her from her sleep, albeit only occasionally. Ms. McGinn has made a conscious effort to ignore the WTN and is afraid that if she focussed on it, the noise would "*get in on [her] more".* All of this is indicative of some degree of "*interference with"* Ms. McGinn's "*ordinary comfort and enjoyment of the property.*"

615. The defendant relies upon other aspects of Ms. McGinn's evidence. Although the WTN kept her awake on her first night in the house, this was the loudest night she experienced it. She likes the master bedroom in NF and is "*sticking with it*". Ms. McGinn gave evidence that she has either got used to the noise or ignores it and that she did not regret buying NF (albeit that her view is that she purchased NF for a lower price which reflected the presence of the turbines). The defendant places significant emphasis upon the following extract from Ms. McGinn's cross-examination:

> *Q. Yes. So you have effectively habituated to it, and it doesn't seem, just from what you have said, to be creating a terribly great problem for you in your enjoyment of the property?*
> *A. In general, no.*

616. Despite her answer to this particular question, in light of the general tenor of Ms. McGinn's evidence, the submission that the WTN "*does not adversely affect Ms McGinn's enjoyment of the property*" goes too far. Ms. McGinn has clearly made a conscious and deliberate effort to ignore the WTN and, to that extent, she has habituated to it. Such coping strategy is necessary because the WTN is audible both outside and inside her home. The very need for such a coping strategy suggests some level of interference with the comfort and enjoyment of NF. Despite this, Ms. McGinn is prepared to *"put up with*" the WTN.

617. However, as the defendant says, the test is objective. Whether or not interference by way of noise is beyond "*what an objectively reasonable person should have to put up with*" will depend on the objective nature of the noise. The individual experience of particular occupants of the relevant property - past or present - whilst relevant, is not determinative.

618. In so far as coping strategies are concerned, one must assess whether it is reasonable to expect occupants of a property to deploy such coping strategies, and of course whether, if reasonable, such coping strategies are likely to be effective or ineffective for the putative reasonable person. None of this can be determined solely from the individual perspective of either Ms. McGinn or the plaintiffs themselves.

619. Ms. McGinn is not a litigant in the case and her evidence is of course more impartial than that of the plaintiffs. She also lives in one of the affected properties unlike Ms. Doran (albeit that the latter lives in the locality). Ms. McGinn's evidence is therefore non-partisan and relevant. As part of the overall assessment, the court must therefore pay careful attention to her evidence.

620. Overall, although there are features of Ms. McGinn's evidence which can be said to support either party's case, in the round, her depiction of the WTN is undoubtedly less negative than the evidence of the plaintiffs. The point however is that such dichotomous thinking - in which only the evidence of Ms. McGinn or that of the plaintiffs can be accepted - is somewhat simplistic. Despite their superficial discordance, both sets of evidence can be and, to my mind are, simultaneously, true.

621. It is perfectly plausible that a reasonable person - in the lay sense of the term - would be prepared, for their own reasons, to put up with a particular noise even though it is objectively

unreasonable. Indeed, I imagine that this occurs reasonably regularly. I find that, for her own reasons, Ms. McGinn is prepared to put up with noise that, objectively speaking, she should not have to put up with. I find that, although she is a reasonable person (in everyday parlance), in her reactions to the turbine, Ms. McGinn does not represent the putative objectively reasonable person. I hold that the reaction of such an objectively reasonable person would be akin to that of the plaintiffs.

622. The assessment of whether the noise is an unreasonable interference with amenity is not a numbers game; it is an exercise in judgment in which the court must consider the totality of the evidence. This includes that of Ms. McGinn, Mr. Brazil and the defendant's acoustic, medical and planning experts. It also includes that of the plaintiffs, Ms. Doran and the plaintiffs' acoustic, medical and planning experts. Further, the court must consider the audio recordings of the noise on site (and the associated graphs) and the evidence gained on its site visit. The court must also consider guidance concerning the appropriate noise measurement techniques and the features of WTN thought to contribute to the annoyance levels. Ms. McGinn's reaction to the noise is undoubtedly of relevance to the issues in the case. But the court would be falling into error were it to conclude that the evidence that she is prepared to put up with from WTN outweighs the other evidence in the case which in my view established that, objectively speaking, the WTN is intolerable and unreasonable.

623. It is reasonable to expect people to be tolerant and to cope as best they can with the vicissitudes of living beside a turbine for which permission is granted. If, judged objectively, the noise can be ignored and effectively habituated to, then the noise in unlikely to be adjudged a nuisance. However, there will be circumstances in which, although some people will be prepared to deploy coping strategies to tolerate the noise, the fact remains that the character of noise is such that it is unrealistic to expect that such strategies will, in the main be effective or successful. Having regard to the totality of the evidence and to my above analysis of the WTN under the DEFRA criteria, I find that this point has been well passed in the present case. The WTN causes a serious adverse noise impact exceeding reasonable tolerability by a substantial margin.

Concluding remarks on nuisance

624. The Defra Guidance recognises that the emission and propagation of WTN is often strongly dependent on meteorological conditions, investigation of statutory noise complaints should therefore include detailed measurement and recording of the windspeed and direction,

rainfall, temperature and relative humidity simultaneously with any noise observations or measurements. The plaintiffs' experts did not adhere to this aspect of the Defra Guidance. Their view is that their data clearly establishes unreasonable noise impact and that it is for the defendant to investigate the cause of this and the possibility of mitigation measures.

625. I have some sympathy for the defendant's frustration at this failure to identify the prevailing conditions under which adverse impact arises. Presently, the court has data from the defendant correlating windspeeds with noise levels (at certain wind directions) and data from the plaintiffs illustrating the features of the WTN complained of. However, there is no correlation between the two.

626. My sympathy for the defendant is not unlimited. The defendant undertook several weeks of monitoring at both NF and HH in 2017 which Mr. O'Reilly used to populate the planning compliance graphs. In addition, the defendant has long since been furnished with all of MAS's audio recordings (and the associated graphs) detailing the noise impact complained of. If the defendant had wished to further analyse either set of data, as against IOA RM or otherwise, it could presumably have done so. It could also have used the SCADA data to correlate periods of adverse impact identified by the plaintiffs' experts with speed of rotation, blade pitch, windspeeds and other meteorological conditions.

627. The plaintiffs' experts do not control the operation of the turbine or have real time access to the SCADA data for simultaneous correlation with noise observations as required by the Defra Guidance. Nor could the plaintiffs' experts secure turbine shut down to ascertain potential exceedance of WTN over background noise at a range of winds speeds. Such constraints might explain why modern planning conditions require the wind turbine operator, and not the complainant, to carry out noise monitoring in response to a WTN complaint in order to identify the conditions under which the alleged nuisance presents and, more importantly to devise appropriate mitigation measures.

628. I am satisfied that it is not necessary for the plaintiffs to establish the precise conditions under which nuisance arises in order to succeed on liability. Rather, this will inform module 2 which will determine the appropriate remedy for nuisance.

629. One cannot presently know why this particular turbine is causing WTN nuisance. Counsel for the defendant emphasised that this Court should turn its face against any finding which suggests that all turbines within 500 metres of a residence are likely to cause nuisance. I make no such finding. It is clear that although planning guidance since WEDG 2006 has recommended a separation distance of at least 500m, this is primarily to combat visual intrusion and not noise intrusion. Although it is quite possible that proximity to the plaintiffs' homes is part of the problem here there are many other factors which may contribute to the particular characteristics of this WTN. I have in mind factors such as the relative height of T2 as compared to the plaintiffs' homes, the fact that these homes are in a sheltered location/wind shadow, the blade pitch of T2, inflow turbulence from T1, unanticipated wake effects and the many acoustic and meteorological factors associated with thump AM, which presently are not well understood.

630. On the other hand, as discussed above, it is reasonable to conclude that adverse impact occurs at windspeeds/speeds of rotation in excess of those which were prevalent at the time of the court's visit. Indeed, although absolute sound levels are not a reliable determinant of nuisance, there is a strong link between WTN sound levels, and the annoyance caused by other characteristics of the WTN. Even if high value AM is present on a fairly sustained basis, I believe that it is at higher speeds of rotation that this characteristic comes to the fore. This impression is endorsed by the ETSU Review which concludes that the interaction between absolute sound levels and AM value influences response. In other words, the louder the WTN, the more likely the AM is to annoy. Further, although thump AM is slightly different - in the sense that it is experienced, a vibration as well as heard- rapidly turning rotors is a common denominator in the plaintiffs' descriptions of its impact.

631. Albeit that this will potentially require to be re-visited in module 2, it is highly likely that the worst features of this WTN are associated with at least moderately higher speeds of rotation. It is also highly likely that features often coincide with the most noise sensitive periods of the day (early morning, evening and nighttime). However, it is not presently possible to be more specific than that.

632. Due to the complex range of interrelated causative factors, identifying the conditions under which unreasonable adverse impact presents and discerning mitigatory measures will be an iterative exercise. Such an exercise is uniquely unsuited to the adversarial arena. As Mr.

Carr states, mitigation of WTN nuisance is often a process of trial and error. This is best approached on site and not in a court room. A court order is an unsuitably blunt instrument with which to tailor a solution to address the WTN nuisance without unnecessarily inhibiting the operation of T2.

633. The defendant cannot rest its laurels on the proposition that the generation of renewable energy is a socially valuable activity which it is in the public interest to continue. As noted by Richards J. in *Noel Uren v. Bland Hills Wind Farm Pty Ltd,* there is not a binary choice to be made here between the generation of clean energy by the wind farm, and a good night's sleep for its neighbours. It should be possible to achieve both.

634. However, effective mitigation will require a far more constructive attitude than has thus far pertained in this case. In their insistence that planning compliance negates nuisance, the defendant has exhibited an unwarranted rigidity in its response to the plaintiffs' complaints. On the other hand, the plaintiffs must realise that, in light of its social utility, this court will be reluctant to order the shutdown of T2, even just at sensitive periods (early morning, evening and nighttime) if a more tailored solution can ameliorate the nuisance.

635. I set out the above as a prelude to the exercise of my inherent jurisdiction to direct the parties, in advance of module 2, to engage in mediation in relation to appropriate mitigation measures and with a view to resolving all outstanding issues between them. I am conscious that mediation has not thus far proved fruitful. However, with the benefit of this court's judgment, it is reasonable to expect that mutually acceptable mitigation measures are capable of being agreed.

Issue 12: Are Mr. Rollo and Ms. Webster entitled to an award of damages for personal injuries?

636. I am satisfied on the balance of probabilities that Mr. Rollo has suffered personal injury in the form of a recognisable psychiatric illness. I also find that this injury was caused by the sleeplessness caused by the WTN, and so caused by the nuisance in suit.

637. The following matters arise:-

- The impact of the Personal Injuries Assessment Board Act 2003 ("the 2003 Act") on the claim to damages for personal injuries

- The recoverability of damages for pure psychiatric injury unaccompanied by physical injury

Application of the Personal Injuries Assessment Board Act 2003

638. The defendant states that this aspect of the plaintiffs' claim is in breach of s. 12 of the 2003 Act and out be struck out.

Section 12 of the 2003 Act provides:-

> *"Unless and until an application is made to the* [Personal Injuries Assessment Board] *under section 11 in relation to the relevant claim and then only when the bringing of those proceedings is authorised..., no proceedings may be brought in respect of that claim."*

639. Section 3 applies the 2003 Act to civil actions which, in turn, are defined by s. 4 as *"an action intended to be pursued for the purpose of recovering damages, in respect of a wrong, for personal injuries, or for both such injuries and damage to property".*

640. As originally instituted, these proceedings sought both injunctive relief and damages for nuisance together with injunctive relief pursuant to s. 160 of the Planning and Development Act 2000 (as amended). No claim to damages for personal injuries was originally advanced. It is common case that at inception, the proceedings were not a civil action.

641. After Mr. Rollo's diagnosis with a major depressive disorder, the plaintiffs notified the defendant by letter dated 21st December, 2020 that they intended to include a claim for personal injuries. The plaintiffs took no step to amend the pleadings until very shortly prior to the trial.

642. The plaintiffs' application to amend the proceedings was objected to by the defendant, *inter alia*, on the basis that it infringed s. 12 of the 2003 Act. On the authority of *Clarke v. O'Gorman* [2014] 3 IR 340, I determined that s. 12 of the 2003 Act did not operate as a jurisdictional bar to the initiation of personal injury proceedings (or to the amendment to include such a claim). The application of the 2003 Act was rather a matter for the defendant to plead in its defence. Accordingly, I allowed the amendments sought and the defendant duly delivered an amended defence pleading, *inter alia*, that, as the necessary PIAB authorisation had not been obtained, the claim ought to be struck out.

643. Relying upon *Clarke v. O'Gorman*, the defendant maintains that, even if the claim to damages was based on nuisance, the term "civil action", as defined by s. 4(1) of the 2003 Act does not refer only to the particular cause of action pursued. It is a description of the type of damage suffered as a result of the facts giving rise to the cause of action. Civil actions for personal injury are, therefore, not limited to those wrongs in which proof of personal injury is a necessary element of the cause of action. As such an action in nuisance is still capable of being a civil action within the meaning of the 2003 Act where the remedy sought includes damages for personal injuries. Therefore, a claim to nuisance which, *inter alia*, advances a claim to damages for personal injuries cannot proceed without the relevant authorisation.

644. In response, the plaintiffs invoke the *caveat* set out at s.4(b)(i) of the 2003 Act which exempts an action intended to be pursued in which, in addition to damages for personal injuries, it is *bona fide* intended and not for the purpose of circumventing the operation of the Act to claim damages or other relief in respect of any other cause of action. The plaintiffs argue that the proceedings are intended to claim relief in respect of another cause of action, namely both the underlying nuisance claim and the claim to injunctive relief pursuant to s. 160.

645. If the plaintiffs' only cause of action - whether based in nuisance or otherwise - advanced a claim to damages for personal injuries, then there would be merit in the defendant's argument. However, this is not the case. Here the plaintiffs also pursue a s. 160 application. It has not been submitted that the plaintiffs' application for injunctive relief pursuant to s. 160 is advanced for the purposes of circumventing the operation of the 2003 Act. Indeed, both parties called extensive evidence on the issue of planning compliance. It is not, of course, necessary for this additional cause of action to succeed in order for the proceedings as a whole to benefit from s. 4(b)(i). Accordingly, I reject the defendant's submission that the claim to personal injuries must be struck out as being in breach of s. 12 of the 2003 Act.

May damages for personal injury may be sought in the context of a claim to nuisance?

646. The defendant argues that nuisance is a property-based tort which imposes liability in respect of a substantial interference in the enjoyment of land and that damages for personal injury may not be awarded.

647. This is established law in England and Wales. In *Hunter v. Canary Wharf*, [1997] AC 655 where a claim for nuisance was brought by residents who claimed that construction work had been interfering with their television signal strength, Lord Hoffman gave the leading judgment and stated :-

> *"In the case of nuisances "productive of sensible personal discomfort," the action is not for causing discomfort to the person but, as in the case of the first category, for causing injury to the land. True it is that the land has not suffered "sensible" injury, but its utility has been diminished by the existence of the nuisance. It is for an unlawful threat to the utility of his land that the possessor or occupier is entitled to an injunction, and it is for the diminution in such utility that he is entitled to compensation."*

648. Lord Hoffman suggested that any personal injury claim should be pursued through negligence, rather than through nuisance.

649. As an adjunct to the principle that damages for personal injuries were not payable, Lord Hoffman also found that damages are not increased by there being more than one occupier.

> *"I cannot therefore agree with Stephenson L.J. in* Bone v Seale [1976] 1 W.L.R. 797 *when he said that damages in an action for nuisance caused by smells from a pig farm should be fixed by analogy with damages for loss of amenity in an action for personal injury...*
> *There may of course be cases in which, in addition to damages for injury to his land, the owner or occupier is able to recover damages for consequential loss. He will, for example, be entitled to loss of profits which are the result of inability to use the land for the purposes of his business. Or if the land is flooded, he may also be able to recover damages for chattels or livestock lost as a result. But inconvenience, annoyance or even illness suffered by persons on land as a result of smells or dust are not damage consequential upon the injury to the land. It is rather the other way about: the injury to the amenity of the land consists in the fact that the persons upon it are liable to suffer inconvenience, annoyance or illness."*

650. It appears that this has not been the approach taken in jurisdiction. In *Patterson v. Murphy*, [1978] ILRM 85 (*"Patterson"*) blasting on the defendant's land caused physical harm to the plaintiffs' residence. The plaintiffs were awarded damages for the repair of the property, but it was also held that general damages were payable to each of the plaintiffs separately for annoyance, discomfort, inconvenience and mental distress.

651. More importantly, some of the discussion in *Hanrahan*, appears to run directly counter to the proposition that a personal injury claim should be pursued in negligence, rather than through nuisance. The Supreme Court, per Henchy J., noted that although originally advanced in both negligence and nuisance, the claim had centred on nuisance and would be determined accordingly. Having concluded that the defendant was liable in nuisance, the court then went on to hold that its environmental pollution has caused Mr. Hanrahan to suffer damage to his health - in the form of lung disease.

652. The question of whether, as a matter of principle, damages for personal injury were recoverable as a property based tort does not appear to have been argued in *Hanrahan.* Rather, the court's consideration focused upon causation. However, there is no suggestion that the Supreme Court viewed damages for personal injuries as restricted to negligence and in terms of outcome, the case was remitted to the High Court for the assessment of damages.

653. The plaintiffs submit that irrespective of whether the matter was argued in *Hanrahan*, I am bound to apply that authority if satisfied that the interference found to constitute the nuisance in this case is causative of personal injuries. In so far as concerns this *"property based tort"* ground of objection, I accept that this is so.

654. However, it seems to me that the present case is distinguishable from *Hanrahan* as Mr. Rollo does not allege personal injury in the form of damages to his physical health but rather personal injury comprising pure psychological injury. The entitlement to damages for pure psychological injury unaccompanied by physical injury has always been treated by the courts as somewhat *sui generis*. As the recoverability of damages for this type of injury was not in issue in *Hanrahan*, I must therefore consider separately whether different considerations might apply.

Does *Kelly v. Hennessy* apply to all claims for damages for pure psychiatric injury?

655. The defendant maintains that there is no basis for recovery of damages for purely psychiatric injury in this jurisdiction save when occasioned by a sudden calamitous event. The defendant relies upon *Warren Harford v. Electricity Supply Board* [2021] IECA 112. In that case, the Court of Appeal, per Noonan J., considered a claim brought by a network technician employed by the defendant for damages for posttraumatic stress disorder occasioned as a result

of his apprehension that he had narrowly missed being electrocuted and suffering death or very serious injury in the course of his work.

656. It is important to emphasise that the claim in *Harford* was not of course for the tort of nuisance but negligence. Specially, it was a claim for nervous shock. It was therefore common case that the plaintiff had to satisfy the 5 criteria set out in *Kelly v. Hennessy* [1995] 3 IR 253, in which, Hamilton C.J. in a judgment in which Egan J. concurred, held that:

> *"1. ...a plaintiff must prove that he or she suffered a recognisable psychiatric illness...*
>
> *2. A plaintiff must establish that his or her recognisable psychiatric illness was 'shock-induced'...*
>
> *3. A plaintiff must prove that the nervous shock was caused by a defendant's act or omission...*
>
> *4. The nervous shock sustained by a plaintiff must be by reason of actual or apprehended physical injury to the plaintiff or a person other than the plaintiff.*
>
> *5. If a plaintiff wishes to recover damages for negligently inflicted nervous shock, he must show that the defendant owed him or her a duty of care not to cause him a reasonably foreseeable injury in the form of nervous shock.*
>
> *...It is not enough to show that there was a reasonably foreseeable risk of personal injury generally. Deane J. stated in Jaensch v. Coffey,* 155 C.L.R. 540*:*
>
> > *'a duty of care will not arise unless risk of injury in that particular form (i.e. psychiatric injury unassociated with conventional physical injury) was reasonably foreseeable.'"*

657. In *Harford*, although, satisfied that the plaintiff had suffered a recognisable psychiatric illness, the court was not satisfied that he fulfilled either the second or fourth criteria in *Kelly v. Hennessy*. In particular, the Court of Appeal was not satisfied that the plaintiff's injury was *"shock induced"*.

658. The defendant accepts that Mr. Rollo's claim to damages for psychiatric injury is not a claim to nervous shock *per se*. However, it relies upon para. 34 of the judgment in *Harford* in which Noonan J. states *"Thus, psychiatric injury is not compensable, even though reasonably foreseeable, unless it is accompanied by physical injury or alternatively is the result of "shock"."*

659. The defendant therefore submits that, in this jurisdiction, damages for pure psychological injury can never be recovered outside the boundaries of a nervous shock claim.

Thus articulated, the defendant's submission overreaches. It is clear that damages for negligence causing a recognisable psychiatric illness have been awarded beyond the strict confines of nervous shock cases. For example, in the case of employer's liability, damages may be awarded for psychiatric injury occasioned as a result of workplace bullying or occupational stress.

660. However (although once again in the negligence context), it is undoubtedly the case that the courts have been extremely cautious in expanding the boundaries of cases in which damages will be awarded for pure psychiatric injury. In the negligence context, control mechanisms on the recovery of such damages have been developed over time to restrict both the limits of the duty of care and the limits of the types of damage recoverable. The second of these considerations – the limits of the types of damage recoverable - is in my view relevant here. In this respect, the issue of reasonable foreseeability has been key to the question of remoteness and to the consequent imposition of liability in cases of pure psychological injury. I will now consider the approach adopted to foreseeability of pure psychological injury in negligence before turning the question of foreseeability of both physical injury and pure psychological injury in nuisance.

The role of foreseeability

The role of foreseeability of pure psychological injury in the tort of negligence

661. In *Fletcher v. Commissioner for Public Works* [2003] 1 IR 465 the Supreme Court considered whether, and if so, to what extent and subject to what limitations an action may lie in negligence where the sole injury is a psychiatric condition resulting from fear of contracting an illness (in that case, asbestos related disease) in the future, as a consequence of the admitted negligent acts and omissions of the defendant.

662. Keane CJ. emphasised the requirement of foreseeability in an action in negligence in which the plaintiff claimed damages for pure psychological injury:

> *"The issue, accordingly, which this court has to resolve is whether the plaintiff was entitled to recover damages for the impairment of his "mental condition" which, according to the evidence of the psychiatrist, has resulted from his exposure to the risk of contracting mesothelioma, a risk which, it is beyond argument, was created by the failure of the defendants to take the precautions which a reasonable employer would have taken to ensure that he was not exposed to any such risk.*

That in turn depends, initially at least, on whether the consequences which have ensued for the plaintiff ought reasonably to have been foreseen by the defendants.
It is unnecessary, in my view, to arrive at any conclusion as to whether this is so because, if the personal injury was not foreseeable, liability in negligence cannot arise or because, if it was not foreseeable, the damage was too remote. In either case, reasonable foreseeability is a precondition to liability. The question as to whether those consequences were reasonably foreseeable cannot, of course, be answered by assessing the state of knowledge of the defendants at the material time. The test is an objective one, i.e., as to whether a reasonable person would have foreseen that the consequences suffered by the plaintiff might be the result of the defendant's want of care."(Emphasis added)

663. In his concurring judgment, Geoghegan J. noted that *Kelly v. Hennessy* did not govern the claim as it should only be taken to relate to "aftermath damages". Given that the courts in all common law jurisdictions show caution in relation to the circumstances in which damages for psychiatric injury could be recovered, Geoghegan J. stated that it was important to consider each kind of liability situation separately. Unless, therefore, one puts all psychiatric injury on an exact par with all physical injury, it makes little or no sense to regard a nervous shock case as being analogous to a fear of disease case. Therefore, in approaching the fear of disease case, Geoghegan J. regarded the court as being in virgin territory.

The role of foreseeability of (physical) personal injury in the tort of private nuisance

664. There has been no express consideration in this jurisdiction of the requirement of foreseeability of personal injury in a nuisance claim.

665. This may be because foreseeability has generally been analysed in a negligence context as being one of the components of the imposition of a duty of care. As liability in nuisance does not require want of care, it may at first blush be doubted that foreseeability is a necessary ingredient for recovery of damages for nuisance.

666. However, foreseeability has a role to play, not only in the imposition of a duty of care, but also more generally in tort in relation to remoteness of damages. The dual relevance of foreseeability was referenced by Keane CJ. in the extract quoted above: " *if the personal injury was not foreseeable,* liability *in negligence cannot arise or because, if it was not foreseeable, the damage was too remote.*". Whilst I fully appreciate that this consideration was in the context of negligence, foreseeability - in the sense of remoteness - is a more general ingredient in the law of tort.

667. Returning to *Hanrahan,* on the facts of that case, it is unsurprising that foreseeability was not separately analysed. The plaintiffs (and many others in the vicinity) had complained of the emissions for years. Once causation was held to have been established, damage to health may be seen as a wholly foreseeable impact of the particular nuisance in issue, i.e. toxic emissions. In a less stark case, foreseeability of personal injury is likely to require closer examination - even in the case of physical injury. However, it is not necessary to consider this further as this case does not involve physical injury of the kind considered in *Hanrahan* but pure psychological injury which, as I say, has always been treated as *sui generis.*

The role of foreseeability of pure psychological injury in the tort of private nuisance

668. It is clear that foreseeability of damages "*of that particular kind*" is an essential precondition to recovery of a claim for pure psychiatric injury arising from a defendant's negligence. However, in considering Mr. Rollo's claim to pure psychiatric injury arising from the defendant's noise nuisance, this court is in virgin territory unguided by any Irish precedent.

669. It is important at the outset to delineate the ingredients of nuisance from those of negligence. The former tort unlike the latter does not depend on the establishment of breach of duty of care. There is in my view no room for arguing that liability in nuisance (as opposed to negligence) turns upon foreseeability. In *Hanrahan,* Henchy J. stated:

> *It is sufficient if it is shown as a matter of probability that what they complain of was suffered by them as occupiers of their farm in consequence of the way the defendants ran their factory...*
> *In this case the plaintiffs' main complaints, namely that the emissions from the factory damaged their health and that of the livestock on the farm, are of so pronounced and serious a nature that no question of nicety of reaction arises. Either those complaints were caused by the emissions from the factory or they were not. If on the balance of probabilities they can be said to derive from factory emissions, then the case for nuisance has been made out.*

670. Therefore, foreseeability is not relevant to the establishment of liability in nuisance. However, as emphasised above, foreseeability plays a dual role and *Hanrahan* does not analyse its second iteration. This is that, whilst, foreseeability of the risk of harm may be irrelevant in establishing liability in nuisance, foreseeability of the type of harm suffered is nonetheless relevant in considering the issue of remoteness of a particular category of damages.

671. This accords with common sense. If a plaintiff in a negligence action may claim damages for pure psychological injury only where they can prove foreseeability of that particular kind of injury, it is difficult to see why a plaintiff should be in a stronger position to claim such damages for interference with the enjoyment of land which has occurred without any negligence or want of care?

672. As a matter of principle and practicality, I am of the view that, in the tort of nuisance, reasonable foreseeability of pure psychiatric injury is a precondition to the award of damages for such injury. The test is an objective one, i.e., as to whether a reasonable person would have foreseen that the consequences suffered by the plaintiff might be the result of the nuisance alleged.

673. In analysing whether this test of remoteness has been met one must distinguish between mental distress and psychological injury. Damages for mental distress may be awarded - as in *Patterson* - as an aspect of damages for loss of amenity. It is in my view, wholly foreseeable that constant and intrusive noise will lead to mental distress – annoyance, frustration and lack of calm. It is also foreseeable that it will lead to loss of sleep, irritability, loss of concentration etc. It is not however generally foreseeable that a recognisable psychiatric illness would ensue.

674. There is likely to be significant overlap as between the damages for loss of amenity and diminished enjoyment on the one hand, and any damages likely to be awarded to Mr. Rollo for pure psychiatric injury. The former includes damages to reflect inability to relax in the property and sleep disturbance. Although it may seem illogical to compensate the plaintiffs for mental distress but not for psychological injury, this is because the former can be accommodated in loss of amenity and the latter cannot.

675. Although this was not determined in *Hanrahan*, I would tend to the view that foreseeability is also relevant in a claim to damages for (physical) personal injury. However, even if I am wrong in this, the approach of the courts to pure psychological injury has always been to proceed with caution and, most particularly to insist on a form of supercharged foreseeability in which not just injury but psychological injury specifically must be foreseeable. To proceed otherwise in this case would not be in harmony with the courts' cautious approach to damages for pure psychological injury. In short, I believe that foreseeability is a separate ingredient in a claim for pure psychological injury caused by nuisance.

Conclusions on issue 12.

676. In summary, on this issue, the relevant questions and my answers are as follows:

1. **Should the claim to damages for psychiatric injuries be struck out as being in breach of the 2003 Act?**
   No.
2. **Is foreseeability necessary to establish liability in nuisance?**
   No. This was not expressly addressed in *Hanahan* but seems to me to have been impliedly excluded. As a matter of first principles and given that nuisance does not depend upon the establishment of a duty of care and its breach, foreseeability of the risk of harm is irrelevant in establishing liability in nuisance.
3. **Can general damages for personal injuries be recovered for nuisance given that same is a property based tort?**
   The question of whether damages for personal injury were recoverable for the tort of private nuisance does not appear to have been argued in *Hanrahan.* It will fall to the Supreme Court in an appropriate case to consider whether, as a matter of principle, damages for personal injuries should be awarded for a property based tort.
   However, one can say that the outcomes of *Hanrahan* and *Patterson* suggest that the answer to this question is in the affirmative. It seems that such general damages can include compensation for loss of amenity, property damage, damage to capital value, loss of rent, temporary relocation costs, damage to human, animal health and plant life, damages for diminution in enjoyment, (which can include e.g. sleeplessness, lack of ability to rest and enjoy the property and mental distress).
4. **Is foreseeability of the type of harm necessary to establish liability for general damages for personal injuries in nuisance?**
   In my view, yes. Although this issue was not the subject of argument or analysis in *Hanrahan,* I take the view that whilst foreseeability is generally irrelevant in determining whether liability for nuisance is established, foreseeability of the type of harm remains relevant in determining whether the type of injury claimed is too remote.
5. **Even if I am incorrect at 3 above, is foreseeability of the type of harm suffered nonetheless a prerequisite to recovery in the case of pure psychological injury?**
   Yes.

677. In this case, I am not satisfied that psychiatric injury was reasonably foreseeable. Therefore, echoing Noonan J. in *Harford,* imposing liability for such injury in this case would

involve an extension of the existing law in this jurisdiction of the circumstances in which an award is made for such injuries. This would ultimately be a matter for the Supreme Court.

Issue 13: is the defendant guilty of negligence?

678. The case in negligence was not in truth pressed with any real vigour and can be briefly dealt with.

679. It seems that the primary evidence relied upon to establish negligence is Mr. Mayer's opinion that the defendant ought to have recognised at the time of installation that there was a significant risk of unreasonable WTN impact.

680. As stated above, I am not satisfied as to Mr. Mayer's expertise to give this opinion evidence. In any event, this evidence provides far too vague a basis for a finding of breach of duty of care. The plaintiffs have not detailed the kinds of investigations which the defendant ought to have carried out prior to applying for or implementing the planning permission. No evidence has been given as to industry standards in this regard. For the avoidance of doubt, I wholly reject any suggestion that it can be considered negligent to locate a wind turbine within 500 meters of a residence or that in doing so, one ought to reasonably anticipate a noise nuisance.

681. Post implementation, I am of the view that the defendant adopted an inflexible and overly rigid attitude towards the plaintiffs' complaints. This however does not amount to a breach of duty of care.

682. Although the plaintiffs complained about the WTN in 2017, the defendant was not put on notice of the severe difficulties experienced by Mr. Rollo as a result of his sleep disturbance until this psychiatric condition had already emerged. There was no intervening occasion on which a duty of care could have arisen.

683. As neither the parameters of any duty of care nor the specifics of any breach thereof have been identified, the plaintiffs cannot succeed in a claim for negligence.

Issue 14: Have the plaintiffs made out a case for relief under Section 160?

Alleged breaches of the planning permission

684. Arising from a report of Ms. Mulcrone, the plaintiffs' plead that the defendant has breached the terms of the planning permission and seeks an injunction pursuant to s. 160 of the 2000 Act. The defendant's response to this case was based on the evidence of Mr. Lawlor.

685. As I explain above, compliance with the planning permission is part of its defence to the nuisance action and, in that context, the defendant bears the onus of proving such compliance.

686. The position is arguably slightly different in the context of the s. 160 application. In such applications, the usual position is that the onus of proving compliance with the relevant planning permission would be on the developer. In the present case, I have concluded that total operational noise exceeds the condition 15 limits and further that the defendant has not demonstrated that this exceedance may be explained by background noise. In other words, the defendant has failed to discharge the onus of proving compliance with planning permission.

687. Does this mean that the plaintiffs can and should succeed in their application for a s. 160 injunction? I would answer this question in the negative.

688. There is generally no provision for exchange of pleadings in a s. 160 application. Notwithstanding this, in the present case, the plaintiffs fully pleaded each and every aspect in which they contended that the defendant had beached the planning permission (with each of which I deal below). No case was advanced in pleadings - or indeed in expert evidence - that the WTN exceeded the condition 15 permission limits. Likewise, as neither party had apparently directed their mind to the correct interpretation of condition 15 of the permission, it goes without saying that no case was advanced to the effect that the WTN exceeded the permission limits as interpreted above. Therefore, whilst it is not in general permissible for a defendant to pray in aid a pleading point as a ground for resisting a s.160 injunction, this case is an exception.

689. Granting a s.160 injunction at this stage for non-compliance with condition 15 would in my view perpetuate a significant unfairness upon the defendant. In the present case, the

defendant had no prior notice that the plaintiffs would allege breach of the condition 15 limits and prepared its case on that basis. In addition, because the correct interpretation of the permission only arose for the first time during the course of trial, the defendant also had no real opportunity to carry out appropriate background noise studies to demonstrate whether the exceedance of total operation noise over the permission limits - when correctly interpreted - may be attributed thereto. This also means that the court has not been able to properly weigh and apply many of the important discretionary factors which would usually influence the grant or withholding of relief pursuant to s. 160. For example, this court has no evidence as to the extent of any breach of the permission limits. Is the exceedance minor or technical; or is it significant? None of this is yet established or even argued as of yet.

690. For all of these reasons, I do not believe it is feasible for this court to presently attempt to adjudicate upon whether the exceedance of total operational noise over the permission limits is such as to merit an order pursuant to s.160. Furthermore, remedy is in any event for module 2.

691. I will therefore confine this analysis to the breaches advanced in the plaintiffs' pleadings and evidence.

692. Ms. Mulcrone contends that the defendant is in breach of conditions 1, 10 and 15.[64]

Condition 1

693. Condition 1 required *"the development to be carried out strictly in accordance with the plans and particulars lodged with the planning application except.... as otherwise required by the conditions of (the) permission"*. The stated reason was *"to ensure that the proposed development strictly accords with the permission and that effective control is maintained"*.

694. Ms. Mulcrone's view is that the defendant has breached condition 1 because the grid connection did not follow the indicative route set out in the planning application documents but was secured via a different substation (which at the time of the initial planning application was neither built nor permitted).

[64] Although breach of condition 9 was initially alleged, this was not proceeded with.

695. In my view, the indicative grid connection did not bind the defendant to comply rigidly therewith. It was made clear in the planning application that the proposed route was indicative only and that a firm grid connection offer had not yet been made by ESB networks.

Condition 10

696. It is common case that the laying of underground cables and the construction of overhead transmission lines for conducting electricity would usually be exempted development pursuant to Classes 26 and 27 of Schedule 2, Part 1 of the Planning and Development Regulations 2001 ("the Regulations"), as amended. However, Article 9 (1) of the Regulations de-exempts such development if same contravenes a condition attached to the grant of planning permission.

697. Condition 10 provides that *"prior to the commencement of the development, planning permission shall be obtained for the erection of power lines to facilitate the connection of the proposed wind turbines to the national grid"*. The stated reason is "*in the interests of proper planning and development*".

698. The plaintiffs argue that the combined effects of Article 9 (1) and Condition 10 is to de-exempt the grid connection, which is therefore required planning permission. By contrast, the defendant maintains that condition 10 only applies to a grid connection facilitated by overhead powerlines and not to underground grid connection which is in issue here.

699. Ms. Mulcrone's view is that if the planning authority had wished to confine condition 10 to an overground route only, it would have stated this quite clearly. The Oxford dictionary defines "erection" as to "*establish or build*". The definition of "*development*" under the Planning Act comprises works in, on or under land and would therefore catch an underground connection route. Ms. Mulcrone contends that this is a pre-commencement condition, meaning that lawful implementation of the permission is predicated on a second permission for the grid connection, which has not been obtained. This, Ms. Mulcrone classified as a *"very serious breach of the planning code"* rendering the entire infrastructure unauthorised *ab initio*.

700. As pointed out by Mr. Lawlor, the indicative grid connection route in the permission application documents included both overhead and underground elements. In my view, the

reference to the *"erection of powerlines"* refers to the overground element only. The words *"erection of powerlines"* are more likely to be interpreted by the reasonable person having some knowledge of these matters as referring to overhead powerlines and not to an underground connection. As such, the condition only obliges the defendant to apply for permission in respect of an overground grid connection.

701. In support of her interpretation of condition 10, Ms. Mulcrone relies on four decisions of An Bord Pleanála on s. 5 references in respect of four other wind farms in the locality. In each case, the Bord determined that permission had been required for the relevant grid connection. However, these s. 5 references were determined against a different factual backdrop. Three of the relevant permissions required the developer to apply for permission for a grid connection *simpliciter* (with no reference to overhead or underground connection). Although the condition in the fourth permission also expressly referred to overhead lines, the grid connection for the wind farm in question was via a combination of underground and overground lines/cables. As such, the failure to apply for permission for that grid connection appeared to be in breach of the parent permission irrespective of whether or not same applied only to grid connection by overhead lines.

702. In short, I find that, because in this instance grid connection in this instance was completed wholly by way of underground cables, no enabling planning permission was required.

Condition 15

703. Ms. Mulcrone correctly observed that there is no evidence of assessment of likely noise impact in either the planning application or on the planning authority's file. The only reference to noise is in condition 15 which, after setting out the specific noise limits already discussed, states: *"...In the event that the reviews show that any turbine may have a detrimental impact, mitigating measures shall be proposed and submitted for the agreement of the Planning Authority."* The stated reason is *"In the interests of residential amenity and the proper planning and development."*

704. In Ms. Mulcrone's view, the two parts of condition 15 must be read disjunctively. The defendant must comply with the noise limits specified. In addition, even if the WTN complies

with the noise limits on the permission, *"reviews"* must be carried out to establish if detrimental impact is shown and, if so, the developer must propose mitigation measures to the planning authority for its agreement.

705. Mr. Lawlor accepts that the condition is poorly worded. Although it provides for "reviews" there is no express statement as to what triggers such review. Nor is there any indication by whom or how frequently such reviews may be requested and/or must be carried out. One would expect that a planning condition such as this would set out a methodology for post completion noise surveys and reporting together with a documented complaints handling process.

706. I cannot accept the plaintiffs' argument that condition 15 must be read disjunctively. This interpretation would render the condition so vague as to be unworkable. In my view, the requirement to carry out reviews and mitigation is triggered by WTN in excess of the condition 15 limits and not by a more general complaint of *"detrimental impact"*. Overall, therefore, I agree with the defendant that if the windfarm is operating in compliance with the noise limits set out in condition 15, the permission does not require the developer to carry out further review or mitigation.

707. In the present case, I have found that the defendant has not demonstrated that the windfarm is operating in compliance with the noise limits set out in condition 15. If non-compliance is born out, this could trigger the condition 15 requirement for reviews, assessment of detrimental impacts and potentially mitigation measures. However, in light of the considerations outlined at para 689 above, I do not view this potential non-compliance as having been fully investigated by the defendant. For that reason, I am not presently prepared to make any order under s. 160 in this regard.

Conclusion on issue 14

708. I am not satisfied that the plaintiffs have made out a case of breach of permission on any of the grounds pleaded. As such, the application pursuant to s.160 must fail.

THE HIGH COURT

[2025] IEHC 300

Record Number: 2018 8457P

BETWEEN:

MARGARET WEBSTER AND KEITH ROLLO

PLAINTIFFS

AND

MEENACLOGHSPAR (WIND) LIMITED

DEFENDANTS

AND

Record Number: 2018 8458 P

BETWEEN:

ROSS SHORTEN AND JOAN CARTY

PLAINTIFFS

AND

MEENACLOGHSPAR (WIND) LIMITED

DEFENDANTS

JUDGMENT of Ms. Justice Emily Egan delivered on the 27th day of May, 2025

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Summary of judgment

At the conclusion of Module 1 of this trial, I held that one of the two turbines operated by the defendant ("T2"), caused a nuisance to the plaintiffs during night hours and quiet waking hours ("sensitive periods"). I directed the parties to attempt to agree appropriate mitigation measures to abate the nuisance in advance of module 2. The defendant trialled just one potential mitigation measure: it operated T2 in a lower power mode. This reduces the rotational speed of the turbine blades and marginally reduces WTN.

The plaintiffs maintain that this lower power mode has not abated the nuisance and seek an order directing the shutdown of T2 during sensitive periods. The defendant's principal argument is that the WTN does not pose a nuisance even in its *"full"* power mode and that no mitigation is therefore required.

The defendant sought to adduce new evidence to persuade the court to revisit the finding on liability made at module 1. This new evidence comprises an analysis of the raw noise monitoring data presented to the court by the plaintiffs in the course of module 1. The defendant contends that this shows that, even allowing for amplitude modulation ("AM"),[1] the WTN levels are lower than the noise limit fixed by current Irish planning guidance on wind energy developments (WEDG 2006).

I have determined that this new evidence could with reasonable diligence have been obtained for use at module 1. I reject the defendant's argument that a new technical specification on noise measurement techniques provides scientifically robust guidance on what level and nature of WTN causes unacceptable interference with residential amenity. I also conclude that the defendant's new evidence does not comprise a useful or complete baseline assessment for the purposes of crafting abatement measures. I further find that, even if admitted, the defendant's new evidence would not substantially impact or alter my finding on liability. I therefore decline to admit this evidence or to revisit my finding on liability.

[1] In brief, AM refers to periodic variation in WTN levels.

As such, I have not found it necessary to decide whether the plaintiffs are correct in their argument that the new evidence does not in fact show that night time WTN levels are within the noise limits fixed by WEDG 2006, as contended by the defendant.

After reviewing the evidence I find as a fact, on the balance of probabilities, that the lower power mode trialled by the defendant does not ameliorate the nuisance. Applying the principles set out in *Shelfer v. City of London Electric Company*, I hold that the plaintiffs are entitled to an injunctive remedy.

Renewable energy is of benefit to the public, which is of relevance in crafting an injunctive remedy. Therefore, if I can be satisfied that measures short of the complete shutdown of T2 during sensitive periods would abate the nuisance, it is appropriate to fashion a remedy accordingly.

I then consider what form of injunction is just in all the circumstances of the case. It seems that the only potential way to abate the nuisance is to reduce noise levels (at relevant windspeeds/wind directions) by a clearly noticeable degree. A 5dB reduction or increase is thought to be an easily noticeable noise differential. However, to simply order a 5 dB reduction in the WTN would require further extended monitoring and ongoing court supervision. It would also lead to further dispute and continuing nuisance. I therefore prefer to proceed by restricting the operation mode of T2 provided this can, when necessary, reliably and consistently reduce WTN by 5dB.

I am satisfied that it is reasonable to restrict T2 to certain lower operating modes during quiet waking hours at certain wind speeds and wind directions. However, this would not be an acceptable solution during night hours. This is partly because I am not satisfied that the noise level reductions which are predicted to occur by altering the power mode of the turbine can be reliably and consistently achieved at night. It is also because constant sudden changes to the WTN at night, as the wind rises and falls, would have a jarring effect, disturb sleep and thus cause ongoing nuisance. I therefore order the shut down of T2 at night for windspeeds of 5m/s to 11 m/s inclusive in those wind directions associated with high AM values and thump AM.

Issues arising for determination at module 2

1. On 14th July 2022, O'Moore J. directed a modular trial of this nuisance action. Module 1 was to determine the issue of liability for nuisance. If required, module 2 would then determine the appropriate remedy and quantum of damages for nuisance.

2. The trial of Module 1 concluded on 6th November 2023. By judgment of 8th March 2024 ("the principal judgment"), I held that one of the two turbines operated by the defendant ("T2"), caused a nuisance to the plaintiffs during night hours and quiet waking hours ("sensitive periods"). Although a *"narrow judgment call",* I decided that the wind turbine noise ("WTN") could be tolerated during other times.

3. I was satisfied that, on the majority of the audio recordings, the WTN is the *only* noise that one can consistently hear. It was also clear from the audio recordings that the WTN displayed the

particular intrusive characteristics complained of by the plaintiffs such as "*erraticism, impulsivity, excessive AM values and thump AM*".[2] I was also satisfied that the clear and unavoidable conclusion from the audio recordings taken by the plaintiffs' experts was that their external and internal soundscape was dominated by the WTN. In all likelihood, this dominance arose from a combination of the level of exceedance of the WTN over background noise levels, its high AM values, its comparatively low spectral frequency and its other attention drawing characteristics.[3]

4. I found that two features in particular contributed towards this dominance rendering the WTN an unreasonable interference: first, frequent and sustained periods of AM values widely acknowledged to be associated with high levels of annoyance and second, thump AM which, together with its associated vibration, was the most intrusive quality of the WTN.

5. In the principal judgment, I determined that the dominance of the WTN which was evident on the majority of the audio recordings was not a constant state of affairs. On the contrary, the nature of WTN is that periods of adverse impact are likely to be intermittent. However, I accepted that adverse impact occurs commonly, persists for sustained periods, and would be particularly evident at night.

6. Liability having been determined, remedy and quantum of damages would require to be adjudicated in module 2.

7. In the principal judgment, I found that due to the complex range of interrelated causative factors,[4] identifying the conditions under which unreasonable adverse impact arises and devising mitigation measures would be an iterative exercise. As noted by the defendant's expert, Mr. Carr, mitigation of WTN is often a process of trial and error. This is best approached on site and not in a courtroom. A court order is an unsuitably blunt instrument with which to tailor a remedy to address WTN nuisance without unnecessarily inhibiting the operation of T2. In light of the social utility of renewable energy, I would not order the shutdown of T2, even just at sensitive periods, if a more tailored solution could ameliorate the nuisance. I therefore directed the parties to engage in mediation in an attempt to agree appropriate mitigation measures to abate the nuisance in advance of module 2.

8. The mitigation exercise subsequently ran from 15th July to 30th September 2024. The defendant trialled just one potential mitigation measure. T2, which was manufactured by Enercon, normally operates in Enercon mode 2,300 KW ("the 2300 mode"). The defendant trialled Enercon mode 1,600 KW (" the 1,600 mode") . This operation mode reduces the speed of the rotors at higher wind speeds, with the aim of lowering WTN levels which potentially reduces power output by up to 30%. The defendant collected noise monitoring data on foot of this trial ("the 2024 1,600 mode data"). It did not carry out any further monitoring of the WTN in the 2,300 mode, to provide a baseline for mitigation measures or to investigate the conditions under which adverse impact occurs. It did not implement a period of turbine shutdown to assess background noise levels.

9. The plaintiffs maintained that the 1,600 mode does not abate the nuisance. The defendant disagreed. Both remedy and quantum of damages therefore required to be determined in module 2. In respect of remedy, the defendant submitted at case-management hearings, that the plaintiffs

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[2] See para. 576 *et seq*. of the principal judgment.
[3] The meaning of each of these concepts discussed is explained in the principal judgment. In brief, AM refers to periodic variation in WTN noise levels. AM values are a measurement of the peak to trough differential in such noise levels. When, as here, the WTN is of lower frequency, AM will manifest as a "thump" rather than a "swish".
[4] Such as windspeed, wind direction, meteorological conditions and time of day.

ought to be confined to damages in *lieu* of an injunction ("damages in *lieu*"). If the court held for the defendant on this issue, then it would be necessary to assess damages for both past and future nuisance. The court was informed that, if it ordered damages in *lieu*, Ms. Webster intended to leave Hill House ("HH") and would then seek the costs of alternative accommodation ("the accommodation claim") as part of her claim to damages for future nuisance. Irrespective of the merits or de-merits of the accommodation claim, its adjudication would add to the duration and costs of the hearing of module 2.[5] On the other hand, the accommodation claim would not arise at all should the court decide to grant an injunction restraining future WTN nuisance (rather than confining the plaintiffs to damages in *lieu* for such future WTN nuisance).[6] I therefore determined that module 2 ought to be subdivided into two parts. The first part of module 2 would determine whether the plaintiffs ought to be confined to damages in *lieu* for future WTN nuisance or whether future WTN nuisance should be abated by injunction (and the precise terms of any such injunction). If the plaintiff were to be confined to damages in *lieu,* the second part of module 2 would then assess damages for both past and future WTN nuisance. If on the other hand, future WTN was to be restrained by injunction, then the second part of module 2 would assess damages for past WTN nuisance only.

10. Accordingly, the issues for determination in this judgment are whether the plaintiffs ought to be confined to damages in *lieu* or whether the nuisance should be abated by injunction and, in the latter instance, whether this court should order turbine shut down or some other form of restricted operation. The assessment of damages for WTN nuisance does not presently arise.

11. Because they maintain that the mitigation mode has not resulted in an abatement of the nuisance, the plaintiffs seek an order directing the shutdown of T2 during sensitive periods. The defendant's position is somewhat hard to discern. Its original argument, subject to its right to appeal, was that restricting T2 to the 1,600 mode during sensitive times fully abated the nuisance. Now, however, the defendant's principal argument is that the WTN does not pose a nuisance to the plaintiffs even in the 2,300 mode and that no mitigation is therefore required.

12. The defendant has always reserved its right to appeal this court's finding on liability in module 1. There is nothing controversial about this. Such appeal should, in accordance with established principles, proceed on the evidence presented to the court in the course of module 1.

13. However, rather than confining itself to the matters falling for determination in module 2, the defendant has sought to adduce new evidence on the issue of liability, to which the plaintiffs take objection. The defendant also argues that, on the basis of this new evidence, I should revisit my finding on liability made at module 1. The plaintiff resists the re-opening of the principal judgment.

14. As same is in dispute, it is first necessary to delineate the evidence which I will admit in module 2 and to decide whether this court will re-visit its principal judgment.

The delineation of the evidence for module 2

Background chronology

15. In preparation for module 2, the parties exchanged expert reports and statements of evidence. A substantial part of Mr. Carr's report and statement is devoted to demonstrating that,

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[5] It appears that both parties intended to call a combination of expert valuers, architects, estate agents and quantity surveyors to deal with the accommodation claim.

[6] Although, of course, damages for past WTN nuisance would need to be assessed regardless.

in the 2,300 mode, total operational noise levels[7] do not cause a nuisance to the plaintiffs and that there is no requirement for noise mitigation (save where the context otherwise requires, I will refer to this as "the disputed new evidence"). The parties' reports and statements were furnished to the court several weeks before the hearing of module 2. On considering same, I listed the matter for mention. I queried the basis upon which the defendant sought to adduce the disputed new evidence given that, subject to an argument that the plaintiffs should be confined to damages in *lieu*, module 2 was confined to determining what abatement measures ought to be ordered to obviate the WTN nuisance. I indicated that the court did not propose to have regard to evidence which did not pertain to these issues.

16. No application was made by the defendant for leave to adduce the disputed new evidence. Nor, prior to the hearing of module 2, was any application made by the plaintiffs to redact or exclude same. On day 1 of module 2, I requested legal submissions from the parties on the admissibility of the disputed new evidence. Unfortunately, neither party appeared ready to address this issue at that time. I therefore took up the evidence of Mr. Brazil, the director of the defendant company. In his direct evidence, Mr. Brazil referred to part of the disputed new evidence. Before commencing his cross examination, counsel for the plaintiffs applied to exclude the disputed new evidence. I directed the plaintiffs to identify the precise portions of Mr. Carr's report and statement to which they took objection and to notify same to the defendant overnight. I directed that, in the first instance, the parties should explore whether redaction of any portion of Mr. Carr's report and statement could be agreed.

17. When the matter resumed the next morning, the parties informed me that no agreement had been reached on redaction. I therefore proceeded to hear legal submissions on the admissibility of the disputed new evidence.

18. At the conclusion of the legal submissions, I ruled that certain portions of the disputed new evidence could not, on any conceivable basis, fall within the scope and rationale of the defendant's argument for admissibility. I therefore ordered the redaction of limited portions of Mr. Carr's report.

19. I determined that, in light of a particular argument advanced by counsel for the defendant (which I will explain at para. 55 *et seq.* below), it was necessary to hear expert evidence before reaching a conclusion on the admissibility of the bulk of the disputed new evidence. I therefore received Mr. Carr's report and statement (save for the limited portions already redacted) on a *de bene esse* basis and deferred my final ruling on admissibility to this judgment. I now set out this court's ruling on admissibility.

Nature of the disputed new evidence

20. In order to understand the court's ruling on admissibility, it is necessary to describe the disputed new evidence in some detail. It comprises Mr. Carr's new analysis of the raw noise monitoring data presented to the court by the plaintiffs in the course of module 1. The raw data consists of external audio recorded by Ms. Sarah Large in 2017 at Nettlefield, which was at that time owned by Mr. Shorten and Ms. Carty ("the 2017 NF data").

21. The defendant has now carried out what Mr. Carr terms an *"AM assessment"* of the 2017 NF data. An *"AM assessment"* can be explained as follows: older planning guidelines such as *The Wind*

[7] Total operational noise comprises the WTN and the background noise

Energy Development Guidelines 2006, issued by the Department of the Environment, Heritage and Local Government in December, 2006 ("WEDG 2006"), make no express allowance for AM. However, in 2014, as the impact of AM came to be appreciated, the Institute of Acoustics ("the IOA") developed a method for measuring AM, the Reference Method ("the IOA RM").[8] Although the IOA RM sets out the methodology for calculating AM values, it does not set a limit of acceptability for AM values, either for planning or for nuisance purposes. In 2016, a Report, commissioned by the Department for Business, Energy & Industrial Strategy ("the Phase 2 Report") recommended that AM controls at the planning and development stage were best achieved by means of a suitable penalty scheme, whereby increasing levels of AM would attract a decibel penalty ("AM penalty"), which would be added to the relevant WTN levels for the purposes of fixing decibel limits and testing compliance therewith. The Phase 2 Report suggests the following AM penalties:

- For AM with a peak to trough level of less than 3dB: no AM penalty
- For AM with a peak to trough level of 3dB to 10dB: a sliding scale of AM penalties ranging from 3dB to 5dB
- For AM with a peak to trough of equal to or greater than 10dB: a 5dB AM penalty

22. The Phase 2 penalty scheme has not been adopted in either Great Britian or Ireland. However, the *Draft Revised Wind Energy Development Guidelines,* published by the Department of Housing, Local Government and Heritage in December 2019 ("draft WEDG 2019") does utilise it. Although draft WEDG 2019 has since been withdrawn, the methodology it employs, as opposed to the detailed noise limits therein, is still instructive.

23. The disputed new evidence is a new analysis of the 2017 NF data consisting of the following steps:

2017 NF data: calculation of noise levels by windspeed

24. Mr. Carr analyses the raw data gathered by Ms. Large and tabulates total operational noise levels by windspeed.

2017 NF data: calculation of AM value in accordance with the IOA RM

25. Mr. Carr has measured AM values per windspeed in accordance with the IOA RM ("Carr's IOA RM analysis").

2017 NF data: calculation of AM penalty in accordance with the Phase 2 Report

26. Mr. Carr has calculated the applicable AM penalty per windspeed in accordance with the Phase 2 Report[9] and presented same on a series of spiderweb graphs.[10]

2017 NF data: add AM penalty to the calculated noise level per windspeed

27. Mr. Carr has calculated and tabulated total operational noise levels plus AM penalties ("the penalised noise level") per windspeed.

2017 NF data: comparison of the penalised noise level per windspeed with WEDG 2006

28. Mr. Carr has then compared the penalised noise level per windspeed with the fixed night time limit in WEDG 2006, which he contends is 43dB.[11]

2017 NF data: Mr. Carr's conclusions

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[8] This methodology is explained at para 194 *et seq.* of the principal judgement
[9] The plaintiffs dispute that the Phase 2 Report has been properly applied. See paras. 102-112 below.
[10] One can see the equivalent spiderweb graphs in respect of the 2024 1,600 mode data at para. 161 below.
[11] One can see the equivalent table in respect of the 2024 1,600 mode data at p. 32 below.

29. Mr. Carr concludes that the penalised noise levels in the 2,300 mode are lower than the WEDG 2006 noise limit and that nuisance is thereby excluded. I will refer to this entire analysis as "the Carr comparative exercise". I should say that Mr. Carr has carried out precisely the same analysis of the WTN in the 1,600 mode and has reached a similar conclusion: the penalised noise levels in the 1,600 mode are lower than the WEDG 2006 noise limit and nuisance is thereby also excluded.

Legal principles regarding the admissibility of new evidence and the re-opening of a court's prior judgment

30. The defendant cites *Greenwich Project Holdings Ltd v. Con Cronin* [2021] IEHC 145 in which Hyland J. observed that where an application is made to revisit a judgment, the court must decide if there are strong reasons for so doing. The defendant argues that strong reasons exist in this case, and that, accordingly I should admit the disputed new evidence and revisit my finding on liability. In oral argument, counsel for the defendant invoked the following principles identified by Finlay C.J. in *Murphy v. Minister for Defence* [1991] 2 IR 161:

> *"1. The evidence sought to be adduced must have been in existence at the time of the trial and must have been such that it could not have been obtained with reasonable diligence for use at the trial;*
> *2. The evidence must be such that if given it would probably have an important influence on the result of the case, though it need not be decisive;*
> *3. The evidence must be such as is presumably to be believed or, in other words, it must be apparently credible, though it need not be incontrovertible."*

31. These principles were developed in the context of the admission of new evidence on appeal. However, in *Re McInerney Homes Ltd* [2011] IEHC 25, Clarke J. (as he then was), applied them to a case in which judgment had been delivered, but final orders had yet to be made. Clarke J. held that the test for the admission of new evidence in such circumstances should be at least as exacting as the test applying at the appeal stage. This was approved by the Supreme Court on appeal [2011] IESC 31.

32. In *Inland Fisheries Ireland v. O'Baoill* [2015] IESC 45, the Supreme Court applied the above principles to an application to admit new evidence in a modular trial. Clarke J. acknowledged that, in a modular trial, no formal issue of *res judicata* arises out of the findings of an earlier module. Nevertheless, formal findings of the court on a specific issue determined in an earlier module should only be reopened in exceptional circumstances. It would defeat the purpose of a modular trial if a party could easily and for little good reason, seek to reopen matters already determined, when the court came to consider later modules. Whilst the court has room for manoeuvre to do justice between the parties, it should not, without good and strong reason, enable any finding to be revisited in a subsequent module. In essence therefore, a modular trial remains in being until all modules are concluded and there is no formal jurisdictional barrier to allowing new evidence in to reopen a point already decided. However, this is a jurisdiction to be exercised sparingly.

33. Costello J. (as she then was) also considered when it might be appropriate to admit new materials to re-open a judgment in *Hinde v. Pentire Property Finance Designated Activity Company*

& *Kavanagh* [2018] IEHC 575.[12] Costello J. observed that the test to re-open a judgment contains two elements, namely:

- The new materials would probably have an important influence on the result of the case and be credible.
- Such new evidence will not ordinarily be permitted to be relied on, if it could, with reasonable diligence, have been put before the trial court.

34. More recently, in *Bailey v. Commissioner of An Garda Siochana* [2018] IECA 63, the Court of Appeal confirmed that a court of first instance has jurisdiction to revisit an issue decided in a written judgment. The test is whether the court is satisfied that there are " *exceptional circumstances"* or *"strong reasons",* which warrant it doing so.

Application of legal principles in relation to the admissibility of new evidence

35. The parties' oral legal submissions focussed primarily on *Murphy* criterion 1, whether the evidence sought to be adduced could with reasonable diligence have been obtained for use at the trial.

36. During the course of module 1, both Ms. Large and Mr. Stigwood gave extensive direct evidence presenting and commenting upon, *inter alia,* the 2017 NF data. A substantial number of graphs derived from this data were placed before the court in reports by Ms. Large, running to 150 pages. Ms. Large also gave oral evidence in relation to the features of the WTN appearing on these graphs. In addition, audio recordings taken from the 2017 NF data were played to the court by Mr. Stigwood (along with audio recordings of other data), who also provided his professional opinion in relation to the features of the WTN. Both Ms. Large and Mr. Stigwood were subject to lengthy cross examination.

37. Having considered the expert reports, the audio recordings, the evidence emerging from the direct and cross examination of Ms. Large, Mr. Stigwood, Mr. Carr and Mr. O'Reilly, together with all of the factual evidence in the case, the court accepted Ms. Large's opinion (and much of Mr. Stigwood's opinion) as to the intrusive features of the WTN and delivered judgment on that basis. The defendant may not belatedly challenge the evidence and opinion of Ms. Large (and Mr. Stigwood) by *ex post facto* analysis of the data she presented.

38. The 2017 NF data was furnished to the defendant in advance of the trial of module 1. It had every opportunity to comment upon this data, to advance a contrary analysis thereof and to challenge the opinions of the plaintiffs' experts in relation thereto. Further, although the defendant had ample opportunity to conduct the IOA RM analysis of the 2017 NF data now sought to be adduced, it carried out no analysis of its own of this data for the purposes of module 1. Indeed, I was extremely surprised that it did not do so. The defendant also had every opportunity to subject the 2017 NF data to the Carr comparative exercise now sought to be adduced. Furthermore, the defendant elected not to perform an IOA RM analysis on any of the data gathered by its own expert in Module 1, Mr. O'Reilly.

39. On this basis it could not possibly be said that the disputed new evidence *"could not have been obtained with reasonable diligence for use at the trial?"*

[12] Cited with approval by the Court of Appeal in *Gaultier v. The Registrar of Companies* [2025] IECA 58.

Does the new technical specification published by the International Electrotechnical Commission provide a justification for the introduction of the disputed new evidence?

Justification advanced in Mr. Carr's report

40. It is common case that the defendant could have put an IOA RM assessment of either the 2017 NF data or its own data before the court at module 1. Permitting the introduction of new evidence at module 2 simply because the relevant matters were not advanced at module 1 would be a recipe for procedural chaos. In apparent reply to this objection, Mr. Carr's report cites para. 375 of the principal judgment as follows:

> *"I should say that this court would place very considerable weight upon up-to-date, scientifically robust planning guidelines on wind energy developments which advised on the particular decibel level at which WTN, when combined with AM of a particular nature, is considered an acceptable interference with amenity. If responsive to the particular aspect of the noise complained of, such guidance would be highly persuasive in a nuisance action. A plaintiff who sought to argue that such guidance did not represent a reliable – if not a wholly reliable – indicator of what is objectively reasonable would, in my view, bear a heavy onus. However, no such guidance currently exists; planning guidance in this jurisdiction (and elsewhere) can fairly be described as flux and cannot identify the line of acceptability."*

41. Mr. Carr's report states since the date of the principal judgment, an important new IEC technical specification has been published *(IECTS 61400-11-2:2024, acoustic noise measurement techniques, measurement of wind turbine sound characteristics in receptor position)* ("the IEC"). The defendant argues that the IEC was not in existence and could not have been obtained with reasonable diligence for the use at the trial. Essentially, therefore, the defendant argues that the IEC is new evidence emerging since the trial and, further, that it meets the lacuna identified in para. 375 of the principal judgment. I will take these points in reverse order.

The IEC does not meet the lacuna identified in para. 375

42. The IEC does not constitute *"scientifically robust planning guidelines on wind energy developments which [advise] on the particular decibel level at which WTN, when combined with AM of a particular nature, is considered an acceptable interference with amenity"* in the sense contemplated by para. 375 of the principal judgment.

43. The IEC does not dictate or even recommend any regulatory metrics. Rather, it provides guidance on how best to isolate WTN for comparison with local regulation. It also provides guidance for the quantification of the impact of the sound characteristics of the WTN, such as AM values, again for comparison with local regulation. The IEC does not delineate what level of noise or what AM values are acceptable in terms of interference with amenity. The proposition that the IEC is responsive to the lacunae identified at para. 375 is entirely erroneous.

The IEC is not the disputed new evidence

44. It is well established that where the new evidence tendered is in respect of matters occurring after the judgment from which an appeal is brought, no special leave is required. If the evidence was not in fact *"in existence at the time of the trial"*, then the failure to adduce it is not attributable to any omission on the part of the party seeking to introduce it. The power of the court to receive

such evidence is discretionary. The interests of justice may require its admission, particularly if it would have an important influence on the result of the case.

45. In the present case, however, this does not assist the defendant. Although the IEC post-dates the principal judgment, the disputed new evidence sought to be adduced is not the IEC *per se*. The disputed new evidence is Mr. Carr's IOA RM analysis of the 2017 NF data and his ensuing comparative exercise. The IEC is merely the vehicle through which the defendant seeks to introduce this evidence.

46. The fact that the IEC had not been published prior to the hearing of module 1 cannot reasonably justify or explain the defendant's failure to carry out, and to tender to the court, an IOA RM analysis and the ensuing comparative exercise at that time. The IEC cannot justify the defendant's 13th hour attempt, after judgment has been handed down against it, to attempt to plug this very obvious lacuna in its proofs.

47. In order to link the disputed new evidence to the IEC, Mr. Carr explains that the IEC *"implements"* the IOA RM *"for quantifying AM"*. He observes that the IEC identifies the IOA RM as the chosen AM assessment method. The argument appears to be that the IEC represents best practice in the measurement and assessment of WTN and that its endorsement of the IOA RM is a new development legitimising the late admission of the disputed new evidence.

48. However, endorsement of the IOA RM is nothing new. As observed in the principal judgment, draft WEDG 2019 also identified the IOA RM as the most robust methodology for measuring AM, as did the ETSU Review of 2023. In the principal judgment, I fully accepted that the IOA RM was a robust methodology.[13] The further endorsement of the IOA RM by the IEC neither explains why the IOA RM analysis of the 2017 NF data was not presented at module 1, nor justifies its admission now.

49. Mr. Carr emphasises that the IEC is specific to WTN. However, this is irrelevant as the IOA RM was also WTN specific. He also points out that the IEC defines AM as including both swish and thump AM. This was also the case in respect of IOA RM. There is little new here to justify the admission of the disputed new evidence.

50. Despite suggestions to the contrary in legal argument and in aspects of Mr. Carr's oral evidence, the IEC is not an international standard. It is a technical specification. Para. 3.1.5 of the *'ISO/IEC Directives, Part 2', Principles and rules for the structure and drafting of ISO and IEC documents* (9th edn, 2021), defines a technical specification as being one in respect of which there is a future possibility of agreement on an international standard but for which at present:

- the required support for approval as an international standard cannot be obtained,
- there is doubt on whether consensus can be achieved,
- the subject matter is still under technical development, or
- there is another reason precluding immediate publication as an international standard.

51. Mr. Stigwood also gave evidence that the IEC has not yet been adopted by the relevant Irish or European authorities. No evidence to the contrary was presented by the defendant.

52. Furthermore, the relevant sections of the IEC dealing with the assessment of AM are said to be *"informative"*, rather than *"normative"*. Whilst a normative element of a document provides rules or guidelines, an informative element is merely intended to assist the understanding or the use of the document or to provide contextual information about its content, background or relationship with other documents. This also undermines the weight to be attached to this aspect of the IEC.

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[13] Albeit that I did not accept that it conveys the impact of AM for the listener, which Mr. Carr now concedes.

53. The IEC is not therefore a transformative piece of evidence sweeping away the defendant's omission to present the disputed new evidence. The position is all the more stark in light of the defendant's trenchant criticism at module 1 of Mr. Stigwood's failure to carry out a formal IOA RM assessment. Despite contending that the IOA RM was a robust methodology, and indeed that it was the exclusive methodology for assessing WTN AM,[14] the defendant did not carry out such an analysis. As it would stretch credulity to suggest that it had not occurred to the defendant to do so, its failure to carry out (or if carried out, to present) an IOA RM analysis at module 1, can only be seen as a deliberate decision.

54. In short, the report of Mr. Carr and its accompanying statement reveal no argument that the IOA analysis of the 2017 NF data (and the entire Carr comparative exercise) could not, with reasonable diligence have been adduced at module 1.

Alternative justification advanced by the defendant in oral legal submissions: substantial differences between the IOA RM analysis and the IEC AM analysis

55. In legal argument on day 2, the defendant introduced the concept of separate and defined IEC analysis of AM ("IEC AM analysis"). Counsel argued forcefully that there are material and substantial differences between the IOA RM analysis and the IEC AM analysis. When compared with the IOA RM analysis, the IEC AM analysis was *"a different standard that reaches a different result"*, such that Mr. Carr's IEC AM analysis is in fact new evidence that could not with reasonable diligence have been adduced at module 1.[15]

56. This was a surprising submission because Mr. Carr's report and statement did not refer to any significant or material differences between the two methodologies and their results. On the contrary, Mr. Carr's written evidence depicts the IEC as endorsing the IOA RM.

57. The nature and relevance of the apparent distinction between the IOA RM and IEC AM methodologies (and their results) appeared to me to be highly technical. In legal argument, counsel frankly conceded that he did not fully understand it. As such, I was persuaded that I could not rule on admissibility on the basis of legal argument alone. I therefore decided to receive the disputed evidence *de benne esse* so I could hear expert evidence before ruling on the admissibility of the disputed new evidence.

58. When Mr. Carr came to give evidence it became apparent that any difference between the two methodologies could not possibly justify the admission of the disputed new evidence. Mr. Carr explained that for technical reasons which it is not necessary to detail here, the IOA RM has the capacity to miss low frequency AM, and that this issue had been remedied in the IEC AM assessment methodology.[16] [17]

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[14] In my principal judgment, I fully accepted that the IOA RM was a robust assessment method but not that it was the exclusive AM assessment method for the purposes of WTN nuisance.

[15] Although not advanced as such in submissions, this also effectively amounts to a further argument that the disputed new evidence was not *"in existence at the time of the trial"*.

[16] This apparently profound innovation was not referred to, even in passing, in Mr. Carr's report.

[17] Mr. Stigwood's witness statement states that there are some *"important variations"* as between the IEC and the IOA RM. However, the point being made is that the IEC directs the measurement and reporting of an extensive range of data that was not presented in Mr. Carr's IEC AM analysis. Mr. Stigwood did not accept that there are significant variations as between the two methodologies in the sense argued by counsel for the defendant.

59. This potential under-estimation of low frequency AM neither explains nor justifies the defendant's failure to present an IOA RM analysis at module 1. Indeed, such rationale is entirely contrary to the defendant's committed position throughout module 1. This was that the IOA RM analysis was not just a reliable methodology to assess AM, including thump AM, but that it was the *only* acceptable methodology. The defendant offered no qualification to its support of the IOA RM and never allowed for the possibility that it could miss thump AM. Nor, as I recall, did the plaintiffs' experts dwell on this issue; and I did not refer to it at all in reaching my findings at module 1.

60. In addition, far from producing materially different results, Mr. Carr's evidence at module 2 was that one could expect the results of the two assessments to be broadly similar, albeit that the IEC AM assessment was *"more conservative"* than the IOA RM, because it took full account of thump AM.

61. Therefore, whilst I accept that there are some differences between the IOA RM and the IEC AM analysis, these are not of particular relevance to the issues that were before the court in module 1 (or indeed those arising in the present module) and in no way explain the defendant's failure to perform and present an IOA RM analysis at the appropriate time.

Conclusion on criterion 1 of Murphy v. Minister for Defence

62. With any diligence, the disputed new evidence could have been adduced at module 1. I am driven to conclude that the defendant has seized upon the IEC as a contrivance to, as it sees it, mend its hand. The IEC does not set a new standard for nuisance. It is a measurement methodology which is still in development. It has not yet been adopted in Ireland. The IOA RM analysis and the IEC AM analysis are not substantially different. Any distinctions between the two are of no real relevance to the issues arising in this case. The IEC cannot possibly justify the defendant in now presenting an analysis of data that was furnished to it in 2022.

63. As O'Donnell J. (as he then was) observed in *Emerald Meats v. Minister for Agriculture* [2012] IESC 48, a trial is not a laboratory experiment where one element can be substituted, all other elements maintained and a different outcome obtained. There are very few cases in which the losing side does not regret that different witnesses were not called, different evidence given or different points made in cross examination or submission. There are few cases which in hindsight could not be rerun with different witnesses, evidence, arguments or advocates. But to consider that such a course is in the interests of justice is to engage in the delusion that endless litigation is a desirable, rather than a tormented state. The court has made its decision on the evidence advanced over 51 days. The defendant may reasonably dispute the merits of this court's conclusion; but it cannot doubt that it is the conclusion. In short, the *Murphy* criteria do not permit the admission of the disputed new evidence.

Is the disputed new evidence admissible *qua* baseline assessment?

64. The defendant also submits that the purpose of collecting the disputed new evidence was not to challenge this court's findings at module 1, but to establish a baseline to guide potential mitigation strategies.

65. I fully accept that a mitigation strategy is best devised on foot of complete and reliable baseline data. However, if the defendant had wished to carry out a baseline assessment then it should have gathered data directed to that purpose, rather than re-interring the plaintiffs' 2017 NF data.

66. I am not satisfied, as a matter of fact, that the IOA RM analysis (and the ensuing Carr comparative exercise) was a *bone fide* baseline assessment. The defendant's evidence on this issue is inconsistent. In closing argument, counsel for the plaintiffs directed the court to evidence suggesting that the defendant only analysed the 2017 NF data after the 1,600 mode mitigation trial had been completed. The defendant did not reply at all to this aspect of the plaintiffs' closing submissions.

67. If the disputed new evidence was, as the defendant contends, gathered to guide the mitigation trial, then why did it not inform that mitigation? Surely a mitigation programme guided by the disputed new evidence would have focussed on reducing noise levels at windspeeds associated with the highest AM values. Yet the defendant designed a mitigation programme which did precisely the opposite; the 1,600 mode produces no reduction whatsoever in WTN at the windspeeds when AM values are highest.

68. More importantly, the disputed new evidence does not comprise a useful or complete baseline assessment. As it presents only total operational noise, it does not actually inform one on WTN levels. The disputed new evidence does not include an assessment of background noise levels in what is clearly a very quiet and sheltered rural area. It does not assist on the question of whether this is a *"low noise environment"* within the meaning of WEDG 2006.[18] No data or analysis whatsoever is presented on the important issues of emergence of the WTN over background noise or low frequency noise/thump AM (even though the IEC treats of both). As will become apparent, the lack of evidence on background wind noise levels and its efficacy in masking WTN at different windspeeds is a critical omission. The disputed new evidence does not even present AM values in the manner required by either the IOA RM or the IEC. Instead of presenting AM values, it rather presents AM penalties only.

69. A *"baseline"* is a starting point to be used for comparison. It will only be of value if it comprehensively presents the relevant data points. Here, the defendant has cherry-picked from the IEC and has presented only one suite of data (AM penalties and total operational noise levels), whilst omitting other important data, which one would expect in any valid baseline study.

70. Furthermore, whilst the disputed new evidence does present AM penalties in the 2,300 mode at a range of wind directions and windspeeds, the same information can be gleaned from the 2024 1,600 mode data. This is because it is common case that the turbine's operational mode does not alter AM values. Nor does the operational mode impact upon spectral frequency, thump AM, erraticism or impulsivity.[19] Therefore, any findings of fact that I may make in relation to these WTN characteristics in relation to the 1,600 mode apply equally to the 2,300 mode. Analysis of the 2017 NF data does not assist one's understanding of these features of the WTN.

71. I conclude that the evidence already put before the court at module 1, the 2024 1,600 mode data and the totality of the other evidence from module 2, are sufficient for the court to determine the issues at hand. I therefore decline to admit the disputed new evidence and will admit Mr. Carr's report and statement and Mr. Brazil's statement in redacted form only. Essentially whilst I admit the data pertaining to the 2024 1,600 mode, I exclude the 2017 NF data.

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[18] A low noise environment is one where background noise levels are less than 30dBA

[19] Thus, the only change in the WTN brought about by altering its operation from the 2,300 mode to the 1,600 mode is to reduce WTN by a maximum of 2.1 dB at windspeeds of 9 m/s and above.

72. However, lest I am wrong in any of my above analysis, I will now explain for completeness why the disputed new evidence (if admitted) would not have an important influence on the result of the case. In other words, even if admitted the disputed new evidence would not substantially impact or alter my findings on liability at module 1.

The disputed new evidence would not substantially impact or alter my finding on liability

The IOA RM analysis of the 2017 NF data supports, rather than undermines this court's finding on AM values in the principal judgment

73. The IOA RM analysis of the 2017 NF data, which I have decided to exclude supports, rather than undermines, this court's finding of regular and sustained periods of typical AM values at a level widely acknowledged to be associated with high levels of annoyance. This finding in the principal judgment had three components.

74. As a first component, I accepted Ms. Large's evidence that on foot of her 2017 monitoring, AM values significantly in excess of 5 dB are a substantial feature of the WTN. I found that the time-domain graphs revealed a common thread of AM values in excess of 5 or 6 dB and that they also showed that AM values of 10 dB are frequently present, both externally and internally. Indeed, this was not disputed by the defendant. Although the disputed new evidence does not comply with the IEC reporting requirements for AM assessment, it is nonetheless common case that at night in the downwind direction *average* AM values at windspeeds between 4m/s and 8m/s are between 6.5 and 10dB. Clearly, there will be periods when AM values are lower than this. However, there will also be periods when AM values are higher. Indeed, the prevalence of AM average penalty points of 4-5 dB on the spiderweb graphs, demonstrates that AM values of 10 dB occur regularly.

75. As a second component, I accepted Ms. Large's evidence that AM values of 5 dB and above, if audible at a sufficient level are capable of amounting to an unreasonable impact. This finding is in no way impacted by the disputed new evidence.

76. As a third component, this court's findings of fact that the WTN AM *was "audible at a sufficient level"* was based, *inter alia*, on its own experience of the audio recordings. I found that on the majority of the audio recordings, both internal and external, the WTN is the *only* noise that one can consistently identify. Its nature is such that it constantly draws one's attention and it was not masked by other ambient noise. This finding of fact was also based on the oral evidence of the plaintiffs themselves in relation to their experience of the WTN and on the direct evidence of their experts, none of which was undermined in cross examination. I fail to see how the disputed new evidence should incline this court to revisit any of this. In short, the evidence sought to be admitted would not have an important influence on the court's findings as to the nature and impact of the AM values.

The disputed new evidence does not undermine this court's finding on low frequency noise and thump AM

77. The principal judgment finds that there is a significant audible lower frequency component to the WTN. This is both heard and felt as a vibration or sense of pressure. This also manifests as thump AM which I found was the *"most intrusive"* element of the WTN. This finding was based on the audio recordings, the evidence of the plaintiffs and the expert evidence of Ms. Large in particular (which in this respect was essentially uncontradicted by Mr. Carr's testimony).

78. The disputed new evidence does not even address, still less undermine this finding. The defendant carried out no analysis of low frequency sound at module 1. This remains the position.

79. It is common case, that neither the IOA RM nor the IEC AM analysis differentiate between swish and thump AM. Although thump AM is widely acknowledged to be more annoying and intrusive than swish AM, these methodologies assign the same value to both forms of AM. This may be a perfectly good starting point from a regulatory perspective but it does not provide a complete answer to a nuisance claim in which thump AM is the most intrusive element.

The disputed new evidence does not undermine this court's finding on dominance

80. Para. 510 of the principal judgment, concludes that the dominance of the WTN is most likely due to a combination of high AM values, low frequency AM, the emergence of the WTN over low background noise levels ("emergence") and to its other intrusive features such as erraticism, impulsivity, unpredictability, etc. At module 1, the defendant declined to carry out or present any reliable analysis of background noise levels, emergence or of the other intrusive features just discussed. That omission persists.

The defendant's reliance on a combination of WEDG 2006, the IEC and the Phase 2 penalty scheme is misplaced

81. The defendant's "Eureka moment" is that the Carr comparative exercise shows that penalised noise levels in the 2,300 mode do not exceed *"the 43dB limit level in the WEDG 2006".* This is said to foreclose WTN nuisance in the 2,300 mode (and *a fortiori* in the 1,600 mode).

82. To develop this a little further, the defendant points to several passages in the principal judgment. These are to the effect that WEDG 2006 is not the determinant of nuisance because it is not a yardstick, objective or otherwise, against which to assess what particular AM values or what particular degree of thump AM is objectively reasonable. The defendant argues that the Carr comparative exercise now accounts for these deficits in WEDG 2006, because it penalises AM values. The Carr comparative exercise is said to supply the missing yardstick.

83. There are, to put it mildly, difficulties with this approach.

Argument inconsistent with the defendant's position at module 1

84. First the argument that such comparative exercise is the determinant of nuisance, is entirely inconsistent with the case presented by the defendant at module 1, which was that the 2004 planning permission was a wholly reliable indicator of what was objectively reasonable at this locality.

Lacuna: WEDG 2006 does not address thump AM

85. Second, even within its own four corners, the Carr comparative exercise contains a serious lacuna. It addresses only one of the two omissions just discussed. It addresses only the failure of WEDG 2006 to account for AM values. It does not address the second omission, the failure to take account of the added intrusion of thump AM.

WEDG 2006 was not drafted with nuisance in mind

86. Third, the principal judgment does not state that were it not for these two specific omissions, the WEDG 2006 noise limits (with which, for the sake of argument, the principal judgment accepted

the WTN complied), would be the determinant of nuisance. WEDG 2006 was not drafted with nuisance in mind.

WEDG 2006 was not drafted with AM in mind

87. Fourth, WEDG 2006 was also not drafted with AM in mind. The IOA RM and Phase 2 Reports, postdate WEDG 2006 by a decade. The IEC, upon which the defendant now places reliance, postdates WEDG 2006 by almost two decades. There is no logic in bolting penalties for AM developed 10 to 20 years later onto the noise limits set out in WEDG 2006. Indeed, this is clear from the IEC itself, which states that any adjustments to noise limits *"are typically defined in local regulation"* (emphasis added). WEDG 2006 does not define, or even contemplate, adjustments to noise limits by reference to AM values. WEDG 2006 is an entirely different methodology. WEDG 2006 is a round hole into which the defendant seeks to force a square peg, the Phase 2 penalties scheme.

WEDG 2006 is under review and takes no account of low frequency WTN

88. Fifth, if the Phase 2 penalty scheme is to be bolted on to any methodology as the determinant of nuisance, then why logically should that methodology be WEDG 2006? The defendant's answer to this question appears to be: WEDG 2006 is still relied upon in the planning and development of windfarms. I accept that s. 28 of the Planning and Development Act 2000 continues to require planning authorities and An Bord Pleanála to have regard to ministerial guidelines such as WEDG 2006. However, that does not imbue WEDG 2006 with talismanic significance for the purposes of a nuisance assessment.

89. WEDG 2006 is currently under review. There is evidently a range of potential methodologies that the Government might adopt to replace it for planning and development purposes. There is no reason to assume that new Guidelines will ape the *"flat"* night time noise limit of 43 dB (whether including AM penalties or not). Still less can one assume that new Guidelines will apply this noise limit irrespective of the frequency of the WTN or of background noise levels. Indeed, I would have thought that this is unlikely.

90. There is therefore no reason why this court should accept that a *"flat"* night time noise limit of 43 dB (whether including AM penalties or not) is the determinant of nuisance. The principal judgment observes that the current direction of travel in wind energy planning guidance ("the modern planning approach") is towards setting decibel limits, combined with a penalty for character such as AM. I accept that the Carr comparative exercise, which combines WTN levels and AM penalties, reflects this aspect of the modern planning approach. However, the principal judgment goes on to observe that the modern planning approach incorporates limits on low frequency noise. For example, unlike WEDG 2006, draft WEDG 2019 limits low frequency noise. This important criterion is absent from the Carr comparative exercise.

WEDG 2006 takes no account of night time background noise levels

91. Sixth, the modern planning approach in publications such as draft WEDG 2019, is to take background noise levels into account in setting WTN limits. Draft WEDG 2019, notes that the principle of a 5 dB emergence has been regarded as good practice for many years.

92. WEDG 2006 appears to consider that WTN should assessed by reference to background noise levels. It provides:

> *"Noise impact should be assessed by reference to the nature and character of noise sensitive locations.... Noise limits...should reflect the variation in both turbine source noise and background noise with wind speed."*

93. Ultimately, however WEDG 2006 appears to allow the planning authority to select a higher WTN day time noise limit of up to 45dB if considered appropriate[20] (save in "low noise environments"). It also imposes a *"flat"* 43dB noise limit at night, regardless of background noise levels.

94. By contrast, draft WEDG 2019 generally limited WTN to 5 dB above background noise levels at night time as well as during the day time (irrespective of whether the windfarm is in a low noise environment). In a typical quiet rural site this would tend to limit night time WTN to levels below 43 dB for low to moderate windspeeds. However, this modern planning approach is not reflected in the defendant's comparative exercise.

95. In short, the Carr comparative exercise translates AM values into an estimated decibel level for regulatory purposes but ignores all other important characteristics of the WTN such as low frequency noise, emergence over background noise and the time of occurrence of the AM. I am not convinced that such a methodology remotely accords with the modern planning approach or with best practice in the assessment of WTN nuisance.

S. 28 is not the yardstick of nuisance

96. Seventh, the defendant relies on *Nagle v. An Bord Pleanála* [2024] IEHC 603 (*"Nagle"*) as endorsing WEDG 2006 for all purposes, including nuisance assessment. I cannot see how *Nagle* greatly assists the defendant. It is true that Humphreys J. held that WEDG 2006 remains the relevant ministerial guideline for the purposes of s. 28. However, he also stated in the course of his judgment[21] at paras. 99-101, that a planning permission granted in accordance with WEDG 2006 would not be immune to a nuisance action by virtue of that fact.

97. I agree with Humphreys J., Planning guidelines, such as WEDG 2006 (and individual planning permissions) predict that, as regulated, WTN will not be an unwarranted intrusion on amenity. However, that prediction may transpire to be incorrect in a given location. This may be because the WTN displays unanticipated characteristics such as substantial low frequency noise or thump AM. It may be because low background noise at a sheltered location such as this has not been fully considered in the noise limits set. The WTN nuisance in this case is attributable to a combination of factors, only some of which have been assessed by the comparative exercise now undertaken by the defendant. Although I repeat that a plaintiff who asserts nuisance will bear a heavy burden if the WTN is in accordance with up to date and robust planning guidelines, which are responsive to the relevant WTN characteristics complained of, none presently exist, and the Carr comparative exercise is a world away from meeting that lacuna.

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[20] As interpreted by the defendant, WEDG 2006 does not limit WTN by reference to background sound levels save in low noise environments where the limit is 35-40 dB. See para. 188 of the principal judgment where I accept this interpretation of WEDG 2006.

[21] Referring in passing to this court's principal judgment.

WEDG 2006 does not address most of the Defra criteria

98. Eighth, the defendant argues that because neither this court nor the plaintiffs have identified a specific WTN decibel limit (whether combined with AM penalties or otherwise) as marking the boundary of nuisance, it had *"no option"* but to devise a comparative exercise which applies the *"flat"* night time limit of 43 dB set out in WEDG 2006.

99. As stated in the principal judgment a robust assessment of a WTN nuisance complaint cannot be conducted without reference to factors such as those discussed in the Defra methodology.[22] In all its evidence in the course of module 1, the defendant addressed only three of the ten criteria derived from Defra ("the Defra criteria")[23]: the level of WTN, the time of day or night when the WTN occurs and, to a limited extent, the sensitivity of the complainant. The disputed new evidence partially addresses one of the ten Defra criteria, the *"type of noise"*, by presenting average AM penalties. However, this evidence does not address other important aspects of the noise *"type"* such as variability, regularity and predictability of the noise. Further, the defendant has not considered at all the following seven important Defra criteria: whether any aggravating characteristics are present in the WTN (the spectral content of the WTN and whether thump AM is present); the characteristics of the neighbourhood where the WTN occurs; the exceedance of WTN over background noise; the impact of the WTN on basic needs such as sleep; how easily the WTN can be avoided; what measures could reduce or modify the WTN; and finally the duration and how often the WTN occurs.

The Phase 2 penalty scheme is under review

100. Ninth, Mr. Stigwood's uncontradicted evidence at module 2 is that the Phase 2 penalty scheme, which is an essential component of the Carr comparative analysis, is currently under review. In particular, consideration is being given to injecting an element to reflect modulation frequency -in the sense of the rapidity-of the AM. This could be relevant at higher speeds of rotation when AM values are lower but when AM is likely to occur with greater frequency. Mr. Carr himself drew the court's attention to clause 4.5.30 of the Phase 2 Report which includes the statement that *"This method is by necessity an interim recommendation based on the available evidence to date..."* Insofar, therefore, as the defendant relies upon the Phase 2 penalty scheme, it is under review, which lessens its evidential weight.

The IEC does not apply the Phase 2 penalty scheme

101. Tenth, the IEC itself does not, as the defendant suggests, propose that the Phase 2 penalty scheme is applied to the local regulatory limit (in this instance, WEDG 2006). The Phase 2 penalty scheme is only an example of a potential local penalty scheme. Therefore, the importance attached by the defendant to the Phase 2 penalty scheme is not, on greater scrutiny, borne out.

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[22] This methodology was developed by the Department for Environment, Food and Rural Affairs for the assessment of statutory WTN nuisance complaints. The criteria outlined are similar to the criteria applied to such complaints by the Environmental Protection Agency.

[23] These are set out at para. 385 of the principal judgment.

Plaintiffs' further argument: the Carr comparative exercise misapplies the Phase 2 penalty scheme

102. I will finally deal with a *"fall back"* argument advanced by the plaintiffs' acoustic expert Mr. Stigwood. He argues that the defendant has misapplied the Phase 2 penalty scheme. This would mean that, even if I had admitted the disputed new evidence, it does not in fact show that the penalised WTN levels are lower than the WEDG 2006 noise limit.

103. To explain, Mr. Carr's comparative exercise purports to calculate penalties under the Phase 2 penalty scheme and then compare the penalised noise to the 43 dB *"flat"* night time limit under WEDG 2006. Mr. Stigwood observes that the Phase 2 penalty scheme fundamentally differs to WEDG 2006 in its approach to night time noise limits. This is particularly relevant in low noise environments. In low noise environments, WEDG 2006 limits day time noise to 35-40 dB. However, this lower limit is not translated across to night time limits, which are set at a *"flat"* 43 dB, irrespective of background noise levels. In a low noise environment, therefore the WEDG 2006 night time limit is higher than the WEDG day time limit.

104. By contrast the Phase 2 Report recognises that noise limits which are generally higher at night time than during the day, "raise the question about whether...noise limits... which are generally higher at night, *accord with current Government policies to avoid, significant adverse noise impacts, and mitigate or minimise adverse impacts."* . Therefore, if day time noise limits are lower than night time limits, the Phase 2 penalty scheme effectively applies the lower day time noise limit at night by the application of additional penalties.

105. Mr. Stigwood's opinion has always been that, absent the WTN, Ballyduff is a low noise environment and that the WEDG 2006 day time noise limit is 35-40 dB. As the WEDG 2006 night time noise limit of 43 dB is higher than this, the Phase 2 penalty scheme would apply the lower of these two limits at night. On this methodology, the WTN would exceed the relevant night time noise limit.

106. The defendant does not dispute that, correctly interpreted, the Phase 2 penalty report imposes an additional penalty *"if, and only if, the numerical limit for night-time is set higher than that for daytime".* However, it argues that this does not result in any change to the night-time noise limit in this case. This is because the defendant contends that Ballyduff is not a low noise environment. As such the night-time limit of 43 dB is lower, not higher, than the daytime limit of 45 dB and no additional penalties apply.

107. The defendant asserts that the court concluded that Ballyduff was not a low noise environment in the principal judgment. This is incorrect. Background noise levels were a live issue in module 1, which I considered at paras. 512-528 in particular. At para. 512, I expressly noted that the absence of background noise data meant that I could not assess whether this is a low noise environment within the meaning of WEDG 2006. Therefore, as the plaintiffs contended that nuisance arose *inter alia* by virtue of the fact that Ballyduff was a low noise environment, and thus bore the burden of proof on that issue, I held that I could not be so satisfied on the balance of probabilities.

108. For the purposes of module 1, I therefore assumed *for the sake of argument* that Ballyduff was not a low noise environment.[24] I accepted *arguendo* that the WEDG 2006 day time limit was up to 45 dB and that the night time limit was 43dB. On that assumption, I was satisfied that the noise

[24] See paras. 190, 192, 221, 276, 365 and 512 - 518 of the principal judgment.

limits in the planning permission and the WTN itself, were in accordance with WEDG 2006. The key point however, was that compliance with the WEDG 2006 limits did not delineate the parameters of WTN nuisance in this particular case. Irrespective therefore of whether or not Ballyduff was a low noise environment, compliance with WEDG 2006 was not determinative.

109. In summary, whether or not Ballyduff was a low noise environment was a live issue at module 1 which I did not have to decide, but which I assumed *arguendo* would fall in the defendant's favour. In doing so, however, I emphasised that there was no compelling evidence which would permit me to make a finding one way or the other on the issue. This remains the case.

110. At module 1, I determined that the onus of demonstrating nuisance remained at all times on the plaintiff. However, the onus of proof in substantiating its positive defence, which at that time was that the WTN complied with its planning permission, was on the defendant. We are now at a different stage of the litigation at which the defendant must surely substantiate its positive defence, which is now that on the application of the Phase 2 penalty scheme, the WTN complies with the relevant WEDG 2006 night time limit. I am satisfied the Phase 2 penalty scheme, properly interpreted, applies higher night time penalties to low noise environments. A strong argument can therefore be made that the onus of proof on this issue is now reversed and that the defendant bears the burden of proving that Ballyduff is not a low noise environment. Indeed, this would be entirely logical as only the defendant can reliably assess background noise levels which requires turbine shut down. As the defendant has not even attempted to investigate background noise, it is hard to see how this burden could have been discharged. This would tend to suggest that the defendant has not discharged the burden placed upon it of demonstrating compliance with the Phase 2 Report/WEDG 2006 night time noise limits, as properly interpreted.

111. Having said that, I accept that the defendant's argument that low background noise was not a live issue in module 2. It was not addressed in module 2 in either parties' expert reports. The argument arises from a single observation in Mr. Stigwood's oral evidence, which I accept the defendant did not anticipate. Although I afforded the defendant an opportunity to recall Mr. Carr to deal with this issue, I accept that by that stage, it was far too late for either side to present background noise data to the court. The low background noise issue remains incompletely explored in evidence and undetermined by the court. In these unusual circumstances, irrespective of the onus of proof, I am persuaded that it would be unfair to the defendant to hold against it on this specific point.

112. I will therefore decline to place any reliance on Mr. Stigwood's low noise environment argument. It is, in any event, entirely unnecessary to do so. Even if one fully ignores this argument, the analysis outlined at paras. 73 to 101 above admits of only one conclusion: even if I had admitted the disputed new evidence, this would not disturb this court's finding on liability in module 1.

Conclusion in relation to the disputed new evidence and in relation to the application to re-visit the principal judgment.

113. The defendant's written legal submissions cite the Supreme Court decision in *Re McInerney Homes Ltd.* in which O'Donnell J. (as he then was) expressed the view that the jurisdiction to reopen a judgment arises where a trial judge has proceeded on the basis of a particular assumption of fact which has transpired to be incorrect. In such circumstances, it could be said that the hearing, and indeed the judgment, had proceeded almost on the basis of a common mistake and that justice

requires that the matter should be reconsidered. The defendant submits that there is *"strong reason to re-visit the judgment"* because new evidence has come to light (in the form of the IEC AM analysis of the 2017 NF data) which establishes that T2 is operating below the threshold set out in WEDG 2006.

114. However, this demonstrates no incorrect assumption of fact or common mistake in the hearing of module 1 or in the principal judgment. In the principal judgment, I assumed *arguendo* that the WTN noise levels did comply with the WEDG 2006 noise limits, but nonetheless found as a fact that WTN nuisance was proven on the evidence.

115. At para. 31 of their submissions, the plaintiffs state:

> *"What the Defendant says provides the full answer to the Plaintiffs' complaints and the test of acceptability for nuisance in Ireland is an unadopted measurement methodology linked to a proposed 2016 UK penalty scheme (itself apparently under revision) judged against an averaged overall decibel limit in a 2006 planning guidance."*

116. I cannot disagree with that characterisation. In *G v. A Judge of the District Court* [2023] IEHC 386[25] Simons J. noted that a judge asked to review their own judgment should have regard to the fact that, on most occasions, the appropriate avenue of redress for a person aggrieved by a judgment is to exercise their right of appeal. The parties to litigation are entitled to assume that, absent an appeal, a written judgment which has been approved by the judge and has been published, is conclusive. In the present case, the defendant has provided no credible basis for the court to exercise its rare and exceptional jurisdiction to revisit its prior judgment. Regrettably, the defendant's approach has served only to add an additional layer of delay, costs and judicial decision making to already protracted proceedings.

117. I will now turn to the proper business of module 2: the assessment of the mitigation measures trialled by the defendant and the appropriate remedy.

118. I will first set out the evidence of the parties. Although the defendant's witnesses gave evidence before the plaintiffs' witnesses, this judgment will be better understood if I reverse this order.

Plaintiffs' evidence

Evidence of Ms. Webster

119. Ms. Webster continues to live alone at HH since Mr. Rollo, co-owner of the house and her former partner, left in March 2021. On foot of the principal judgment, the plaintiffs' solicitors wrote to the defendant on 15th March 2024, proposing arrangements for mediation and asking whether, pending mediation, the defendant would mitigate the noise nuisance in response to the court's findings. The defendant did not agree to any mitigatory measures pending mediation.

120. A mediation agreement was signed on 27th June 2024,[26] which provided that the defendant would implement *"an iterative process of trial and error to achieve a restricted operation of T2 so that its operation does not give rise to excessive AM and WTN".* The defendant would trial different modes during the mitigation period of July to September 2024. The precise design of the trial was a

[25] Cited with approval by the Court of Appeal in *Gaultier*.
[26] Which it is agreed is to be read together with a letter from the plaintiffs' solicitors on 17th June 2024.

matter for the defendant and not the plaintiff. The plaintiffs agreed that the defendant could place noise monitoring equipment *"on their land"* at HH and that Ms. Webster would keep a noise diary to record the impact of the noise. It was also noted that the plaintiffs may want to place noise monitoring equipment externally and/or internally at HH and that any raw data from the plaintiffs' noise monitoring equipment would be exchanged simultaneously with the defendant's raw data.

121. The defendant's acoustic expert, Mr. Carr, placed noise monitoring equipment in the front and rear gardens of HH. In addition, Mr. Daniel Baker, Acoustic Consultant, was engaged to undertake outdoor and indoor monitoring on behalf of the plaintiff. External monitoring was carried out in the rear garden and internal monitoring was carried out in the same ground floor back bedroom as previously.

122. Ms. Webster's evidence was that the noise from the turbines was unchanged over the two month mitigation trial period. It remained most intrusive in the evenings and at night time. There was no noticeable change in the AM or in the WTN levels. Ms. Webster continues to find it difficult to enjoy her time at HH and her sleep remains disturbed. Ms. Webster's evidence was that seven and half years after her first complaint to Mr. Brazil, she continues to suffer intrusive, dominant and unreasonable WTN, which has all of the features previously found to exist by the court: *"The noise rises and falls, it's not a single instance like a car passing where it passes very quickly or a dog barking even. It's unpredictable. The intensity,... rises and falls. It can be quite thumpy, then it can go quiet, then it can go up and down and so on and so on."*

123. Aside from the fact that she views the nuisance as remaining unabated, three features of Ms. Webster's evidence bear emphasiss.

124. First, Ms. Webster is stressed and worried about the wind turbine. She has been worn down by the WTN and finds it increasingly difficult to stay in the house. She is understandably disappointed by the approach to the mitigation process in which the defendant trialled only one different operating mode as part of what was intended to be a *"trial and error exercise".*

125. I formed the impression that Ms. Webster's disappointment and frustration, justifiable though they may be, now impact her perception and tolerance levels of the WTN. An obvious example of this is Ms. Webster's approach to the issue of audibility of the WTN inside HH. During module 1, Ms. Webster was cross-examined as to whether she equated nuisance with mere audibility internally. The thrust of Ms. Webster's answers was that it was not audibility alone that disturbed her concentration, relaxation and enjoyment and caused her difficulty falling asleep. Rather, it was audibility, combined with low frequency impacts, such as vibration and a sense of pressure. Ms. Webster also relayed being woken *"bolt upright"* from her sleep by the WTN, which clearly implies a higher level of noise than mere audibility. I believe that there has been hardening in Ms. Webster's position. She now takes the view that if the turbine is audible at all indoors it is thereby a nuisance. I cannot agree. One cannot equate audibility, even internally, with nuisance.

126. Second, in cross-examination, counsel for the defendant laid great emphasis upon para. 70 of this court's judgment reciting Ms. Webster's evidence. I stated *"what primarily disturbs Ms. Webster's relaxation and sleep is when the turbine is turning "full tilt"".* The defendant relied upon Ms. Webster's use of the phrase *"full tilt"* in two ways; first it suggests that it is inconsistent with Mr. Stigwood's findings at module 2, that the worst noise intrusion occurs at moderate to higher windspeeds (but not at the highest windspeeds). Second, the defendant maintains that the phrase

"full tilt" led it to assume that mitigation was only required at the highest windspeeds, leading it to select the 1,600 mode (which only limits rotational speeds and noise at windspeeds above 7.8 m/s) for the trial and error process.

127. This was an entirely unreasonable position for the defendant to adopt. Ms Webster's use of the phrase *"full tilt"* cannot justify the defendant's conclusion that the WTN is not a nuisance at windspeeds below the maximum. Ms. Webster's complaints of intrusive WTN usually occur at night when she is in bed and is clearly not counting turbine blade rotations. Rather, her sense that the turbine is turning fast will be a general impression gained from the rhythm of the noise in her room. Even during the day, Ms. Webster would be unable to count the turbine rotations with the naked eye.

128. In any event, the defendant fails to distinguish between the court's recital of Ms. Webster's evidence at para. 70 and the court's findings. The court did not find that the WTN was most intrusive, still less that it was only intrusive, when the turbine was turning at its very fastest level. Rather, I concluded at para. 631 that whilst this would potentially need to be revisited in module 2, it was likely that the worst features of the WTN were associated with at least *"moderately higher speeds of rotation"*. Similarly, at para. 590, I found that *"at moderate to high speeds of rotation"* the impact of the WTN far exceeds masking levels and is the primary noise experienced in the environment.

129. This court's reference to moderate to high windspeeds was based in part on my finding that the WTN at the time of my site visit to the plaintiffs' houses did not give rise to nuisance. Nuisance therefore arises at windspeeds greater than 3.8 m/s to 4.8 m/s. It follows that my reference to moderate to high windspeeds may be interpreted as windspeeds above 5m/s in any event. In addition, the evidence at module 1 was that the turbine reaches its maximum speed of rotation at 9 m/s and that, beyond that, the WTN does not increase with rising wind speeds. Further, at very high windspeeds background wind noise progressively increases masking the WTN. These factors in themselves imply that any assumption that the greatest problems occur at the very highest windspeeds is misplaced. I also found that the WTN was more intrusive at night time, when ambient background levels are low and stable atmospheric conditions both enhance sound propagation and render high AM values and thump AM more prevalent.

130. Third, Ms. Webster states that on 12th July 2024, the defendant's solicitors wrote to request that audio recording equipment to be placed in her personal bedroom which she would be required to turn on and off in order to record the noise. Ms. Webster states that she was surprised to receive this additional request as it was not part of the mediation agreement which had been signed two weeks earlier. Ms. Webster considered this an intrusive and unnecessary request and did not agree to it.

131. Ms. Webster states that the defendant could have used five other bedrooms in her home for monitoring. There is a dispute between the parties as to whether or not the defendant was willing to carry out monitoring in one of the other bedrooms in the house as a proxy for Ms. Webster's bedroom and, if so, whether she was willing to permit this. The defendant's position is that Ms. Webster refused any internal monitoring. The plaintiffs' position is that internal monitoring was not ruled out, provided it was not in Ms. Webster's bedroom. One way or another, internal monitoring was not agreed at mediation and the plaintiffs were evidently not prepared to depart from the terms of the detailed mediation agreement.

132. It may have been more constructive had Ms. Webster responded to the defendant's letter of 12th July 2024, with a formal counter offer of noise monitoring in another bedroom. However, I attribute any inflexibility to Ms. Webster's increasing frustration over the defendant's general response to her complaints, no doubt copper fastened by its attempt to depart from the monitoring procedures agreed at mediation. In any event, this is largely by the by. The lack of internal monitoring by the defendant in Ms. Webster's bedroom does not prevent this court from deciding the issues which fall for resolution in this module.

Evidence of Mr. Stigwood, plaintiffs' acoustician

Misinterpretation of the principal judgment

133. Parts of Mr. Stigwood's module 2 report suggest that he interpreted the principal judgment as holding that the mere presence of high AM values and/or thump AM is sufficient to establish nuisance.

134. Much of Mr. Stigwood's module 2 report focuses on demonstrating high AM values and thump AM, without analysing how these features correlate with overall WTN levels. As a result, in much of the data that Mr. Stigwood presents, AM levels are high (and thump AM is present), but overall noise levels are quite low, particularly when compared to the data previously gathered by Ms. Large.

135. The defendant disputes Mr. Stigwood's interpretation of the principal judgment. I agree with the defendant on this point. This court's conclusion was not that the mere presence of high AM values and thump AM constitutes nuisance. Rather, high AM values are liable to create nuisance if audible at a sufficient level. Similarly, thump AM is liable to constitute nuisance if within the audible range; or if giving rise to unacceptable vibration and pressure (always bearing in mind that low frequency noise can annoy at lower levels). Thus, I found that thump AM, which is both heard and felt, as vibration or as a sense of pressure, was the most intrusive feature of the WTN.

136. However, Mr. Stigwood's testimony did not suffer from this frailty. He accepted that high AM values and thump AM are not *per se* evidence of nuisance. Overall noise levels must also be taken into account. This is consistent with the court's findings, and with the evidence of Mr. Stigwood and Ms. Large (upon whose testimony the court placed particular emphasis) in module 1.

Has the 1,600 mode abated the nuisance?

137. Mr. Stigwood's analysis of the WTN in the 1,600 mode is set out in a lengthy report running to almost 100 pages containing almost 100 different time-domain graphs and other graphs. His evidence is that the 1,600 mode, does not result in the abatement or improvement of the nuisance. Intrusive AM continues externally and internally,[27] including at nighttime, in the evenings and weekends.

138. Mr. Stigwood states that, in the 1,600 mode, high AM values are measured on the time-domain graphs and on the application of the IOA RM. Several of these time-domain graphs showed AM

[27] In oral evidence, Mr. Stigwood clarified that the outdoor/indoor noise level differential though an open window would be in the order of 10-12 decibels. For a window open only for ventilation, one would expect a slightly lower differential. This was in accordance with the evidence of both parties at the earlier module that, with a window very slightly open for ventilation purposes, one could assume a 10 dB reduction externally to internally.

values of 10 dB, the highest possible value using the IOA RM. IOA RM analysis shows that high AM values are associated with at least moderately high speeds of rotation (as opposed to the highest rotational speeds). AM values are highest at windspeeds between 5.1 and 8.7 m/s, and are maximal at 7m/s approximately.

139. Unconstrained, maximum T2 rotations are in the order of 22 or 23 rotations per minute. The 1,600 mode caps turbine rotations at 18.6 revolutions per minute. It does not therefore *"kick in"* until revolutions have reached that speed and only starts to have an effect when windspeeds are in excess of 8 m/s.

140. When visiting HH during the mitigation trial, Mr. Stigwood experienced erratic, dominant and impulsive WTN externally and internally. He correlated his experience (and that of Ms. Webster) with the raw data noise collected and with the SCADA data, and found that same concurred.

141. By listening to the WTN and correlating it with the spectrograph, Mr. Stigwood concluded that thump AM is dominant for substantial periods and is particularly prominent internally. In Mr. Stigwood's opinion, thump AM remains the primary cause of nuisance even in the 1,600 mode. This thump AM is worst under conditions of meteorological stability, which most often occurs at windspeeds below those at which the cap applies.

142. Mr. Stigwood summarises his view on the 1,600 mode as follows: *"in a short few words, the cap has not stopped the AM and its exceedance over the background, its dominance, its erraticism, its intermittency, the impulsive character, all those elements within it, its excessive AM values, it hasn't stopped any of those. So the cap has not prevented these occurring. They have continued to occur."*

143. Mr. Stigwood's uncontradicted evidence is that Mr. Carr's 2024 1,600 mode noise monitoring data demonstrates noise levels 2 to 3 dB lower than his own data. This must be taken into account in interpreting Table 3.

144. Unlike Mr. Carr, Mr. Stigwood presents a full IOA RM analysis of the WTN during the mitigation mode. Although this provides the court with some of the important data omitted from Mr. Carr's reporting, as Mr. Stigwood uses Mr. Carr's 2024 raw noise data for this IOA RM analysis, the data set is necessarily incomplete for the reasons just explained.

145. Fortunately, it is not necessary to grapple with the minutiae of this analysis in order to determine whether or not the 1,600 mode has abated the nuisance. This is because two things are common case: First, AM values and thump AM are not impacted *per se* by the 1,600 mode (or in all likelihood by any of the operation modes). Second, the impact of the 1,600 mode is to reduce WTN by a maximum of 2.1 dB at windspeeds of 9 m/s and above. At windspeeds of 3 m/s and 4 m/s, the 1,600 mode brings about no change in WTN noise levels. At 5 m/s, it actually increases WTN by slightly less than a decibel. At 6 m/s, 7 m/s and 8 m/s the 1600 mode is estimated to reduce WTN by between .8 and 1.2 dB.

146. It is common case that, from the perspective of one listening to the WTN, a noise level change of 3 dB is on the boundary of perception and that a change of 2.1 dB is either barely perceptible or imperceptible. Therefore, as the 1,600 mode has effected no improvement in AM values or thump AM and has merely reduced noise levels to an effectively imperceptible degree, it could not be expected to ameliorate the nuisance to an appreciable extent.

The IEC

147. Mr. Stigwood was unimpressed by the defendant's use of the IEC which he said had not been adopted in Ireland. He disagreed with the proposition that the IEC represented a significant change in the assessment of thump AM. The only way to differentiate between swish and thump AM is to look at the spectrum data. Mr. Stigwood was also critical of the defendant's failure to apply Appendix C of the IEC, which deals with low frequency noise evaluation.

Other evidence from Mr. Stigwood relevant to the potential abatement orders this court might make

148. Mr. Stigwood's view is that it is not for the plaintiffs to suggest mitigation measures for the wind turbine. However, in most cases of intrusive AM, turbine shut down at sensitive times is required.

149. Mr. Stigwood criticised the defendant for seizing upon Ms. Webster's comment that the turbine most disturbed her when it was spinning *"full tilt"* and then trialling a cap that only kicked in at the highest windspeeds. In his view, the blades rotate quickly at windspeeds of 6 m/s and up. Mr. Stigwood states that an observer would not visually perceive a difference between rotational speeds at, say 6 m/s and 9m/s. Both could in his view fairly be described as *"full tilt."* It is preposterous to expect an observer to reliably discriminate between turbine rotational speeds of 16.33 revolutions per minute (RPM) at windspeeds of approximately 6m/s and 18.59 RPM at windspeeds of approximately 9m/s. As there are three blades, the difference in blade passing frequency between these two windspeeds will not be apparent to the naked eye. I agree.

150. The defendant relies upon data from the turbine manufacturer, Enercon, which predicts likely reductions in WTN at different windspeeds in a range of different operational modes ("the Enercon prediction data"). Mr. Stigwood notes that the predicted noise level reductions are averaged out over all wind directions. The predicted reductions cannot therefore be assured in any particular wind direction. Further, the predictions are based on measurements taken very close to wind turbines in unstable meteorological conditions. In Mr. Stigwood's view, the predicted noise level reductions may not therefore be achieved, particularly at night when meteorological conditions are stable and wind shear is high. On the other hand, Mr. Stigwood appears to accept that the 2024 1,600 mode noise monitoring does demonstrate WTN level reduction in the broad range predicated by Enercon (when averaged over 24 hours and in all wind directions).

151. The most adverse impact of the WTN occurs when rotations are moderate to high, which he defined as windspeeds of above 6 or 7 m/s. High AM values and thump AM virtually disappear at very high windspeeds, which he defined at above 12 m/s. At windspeeds above 12m/s, WTN is a rumbling type of noise with very little character which is less intrusive, particularly in the presence of other masking noises, such as wind noise. The exception would be when there are extremely stable atmospheric conditions.

152. Generally wind direction can make a big difference to AM and WTN levels. However, Mr. Stigwood stated this was not necessarily the case on Mr. Carr's spiderweb graphs, particularly in crosswind conditions.

153. Mr. Stigwood acknowledges that restricting the operation of T2 to its lowest power mode of 1,000 KW ("the 1,000 mode") could potentially provide a noticeable difference to overall sound

levels. However, this may not ameliorate intrusive AM. I have some difficulty with this. The ETSU Review, notes a strong association between the annoyance posed by AM and the absolute sound level of the WTN. In my view, therefore, it is generally safe to assume that a noticeable reduction in noise levels will have an appreciable beneficial impact. This is of relevance in crafting fair and proportionate injunctive orders.

Evidence of Mr. Mayer, Mechanical and Automotive engineer

154. Mr. Mayer who operates as a Wind Energy Consultant advising on the execution of wind development, states that noise mitigation is well established in the wind industry due to complaints of noise nuisance caused by technical failure, inadequate distance, or irregularities in wind flow. Mr. Mayer considers that the mitigation exercise undertaken by the defendant was a poorly structured process and lacked the required professionalism and expert input. The adoption of a single alternative mode for T2 during a two month period is inadequate. Mitigation ought continue for at least six months.

155. Mr. Mayer criticised Mr. Brazil's failure to consult in detail with Enercon prior to commencing the mitigation process. If this court's judgment had been discussed with Enercon, it could have devised a tailored and effective mitigation process. The turbine can be programmed to trigger a wide range of noise reduction modes to mitigate specific noise generating constellations of wind speed and wind direction whenever they appear.

156. In addition to offering different operating modes, further mitigation could have been achieved by modalities such as trailing edge serrations, blade feathering and other mechanical or electrical interventions.

Defendant's evidence

Evidence of Mr. Brazil

157. Mr. Brazil's evidence was that the new IEC was applied to the 2017 NF data to obtain a thorough description of the sound characteristics of the WTN when operating in the 2,300 mode with a view to this data providing a starting point for mitigation purposes. In his oral evidence, Mr. Brazil referred to Mr. Carr's spiderweb graphs as derived from the 2017 NF data but not to any further data and in particular not to the Carr comparative exercise.

158. Mr. Brazil gave evidence that *"there is meaningful [noise] reductions in my opinion".* He did not, however explain how he had reached this conclusion.

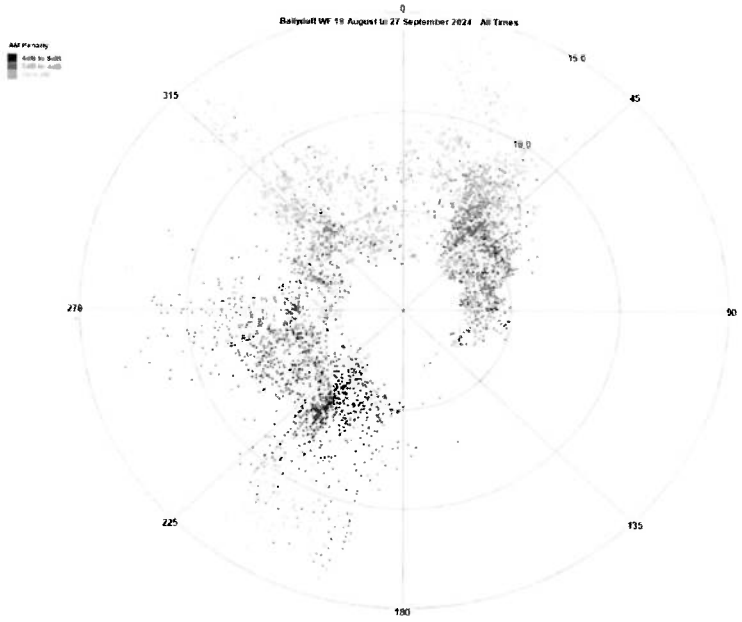
Evidence of Mr. Carr, defendant's acoustician

159. The primary purpose of Mr. Carr's report and statement was to set out his comparative exercise which he contends shows that there is no nuisance in either the 2,300 mode or the 1,600 mode and that no mitigation is required.

160. Mr. Carr carried out an AM assessment of the 2017 NF data and the 2024 1,600 mode data. He sets out the results in several graphs. As I have decided to admit only the 2024 1,600 mode data, only those graphs are relevant. Further, it is not disputed that the noise levels for the front garden are elevated as compared to the rear garden due to external sounds, I will focus on the rear garden 2024 1,600 mode data.

161. I reproduce below figures 5 and 6 of Mr. Carr's report. These are the spiderweb graphs analysing the rear garden 2024 1,600 mode data pursuant to IOA RM/IEC. Figure 5 presents results for the rear garden on a 24 hour *"all data"* basis and figure 6 presents the results for nighttime.[28]These graphs set out derived AM penalties rather than AM values per 10 minute segment, as would generally be required. Figures 5 and 6 shows a significant number of AM penalties of 4 to 5 dB, indicating AM values between 6.5 dB and 10dB and AM values above 10 dB, respectively. I also reproduce Table 3 which sets out the comparative exercise for the rear garden 2024 1,600 data at night time[29] in the downwind direction only.

Figure 5: IOA RM results – 2024 1,600 rear garden 24 hour data



[28] Mr. Carr restricts this to between the hours of 23.00 and 04.00 to avoid the dawn chorus. However, I prefer to adopt the most conservative approach and to use the spiderweb graph for the entire period of 23.00-07.00 hours.

[29] Mr. Carr restricts this to between the hours of 23.00 and 04.00 am to avoid the dawn chorus.

Figure 6: IOA RM results – 2024 1,600 mode rear garden night-time (23:00 to 07:00hrs) data

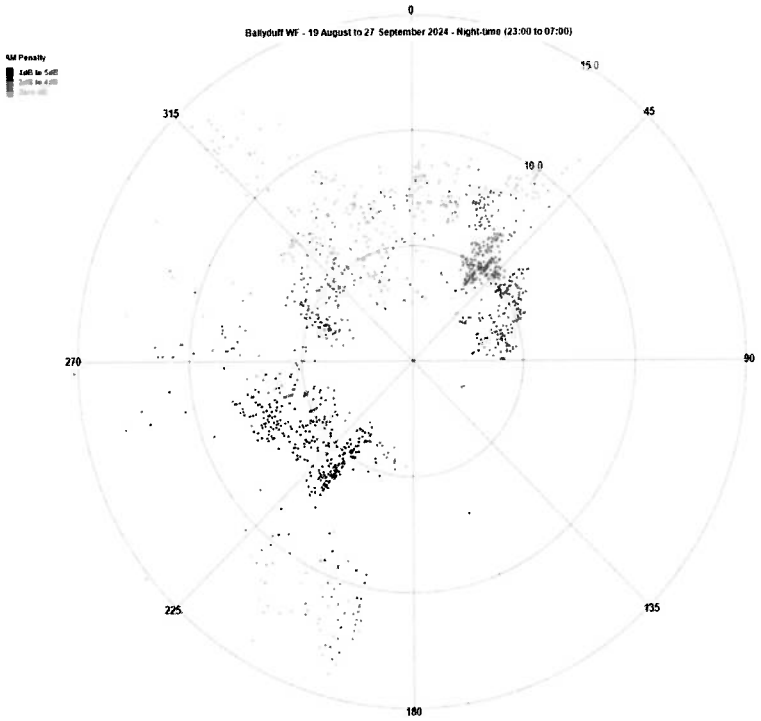


Table 3 2024 1,600 mode rear garden 23:00 to 04:00hrs data- downwind only

Wind Speed m/s	Total measured noise level L_{A90},dB	Total measured noise level L_{A90},dB + AM Penalty	Difference (dB)
4	25	29	4
5	30	34	4
6	34	38	4
7	36	40	4
8	37	41	4
9	38	41	3
10	38	41	3
11	38	41	3
12	39	41	2

162. Mr. Stigwood did not quibble with the penalties derived by Mr. Carr or with Table 3. For this reason, I will accept that, save for a potential underestimation of sound levels by 2 or 3 dB, the data summarised at Table 3 is accurate. Table 3 shows that AM values are at their highest at windspeeds of 4 to 8 m/s. AM values drop at windspeeds of 9m/s to 11 m/s and drop again at windspeeds of 12 m/s. The acoustic experts therefore agree that AM values are highest at windspeeds below the level at which the cap becomes fully operational.

163. Mr. Carr states that the downwind sector,[30] when the wind is blowing from the turbine to the receptor location, generates the loudest noise. He contends that the crosswind and upwind sectors produce lower levels of WTN at HH. He does not however present any data which would inform the court as to noise levels in the crosswind and upwind sectors.

164. This is an unfortunate and significant omission from the defendant's perspective. It means that the court can only apply the broadest discrimination between different wind directions in setting abatement measures.[31]

165. Mr. Carr's evidence is that having examined Ms. Webster's diary entries and Mr. Stigwood's report, there is no obvious pattern to any specific wind speed or direction that can be correlated with the AM complaints set out in the noise diaries.

166. In cross examination, Mr. Carr did not agree that, rather than looking at averages, nuisance is concerned with the minute by minute experience of the plaintiffs. He denied that this experience is better illustrated on the time-domain graphs than by the averages presented in his reports. He agreed however that the IOA RM cannot tell one what the noise sounds like and that it does not differentiate between swish and thump AM.

167. Mr. Carr accepted that his report omits important data which the IEC requires to be reported, such as average 10 minute AM values and the percentage of 3dB modulation depths, 6dB modulation depths and 9 dB modulation depths in the data presented. Mr. Carr's data informs the court only of average AM penalties per windspeed. I cannot know what makes up those averages. The penalty averages may be the mean of very high and very low AM penalties over 10 minute periods or they may represent the most commonly occurring penalty. This omitted information would be highly relevant in determining the specific circumstances under which high AM values may give rise to nuisance at HH. Although the defendant argues that Mr. Stigwood's *"compliant"* IOA RM analysis fills this lacuna, the lacuna is entirely unsatisfactory in the first place.

168. Both experts are agreed that because the IEC essentially adopts the IOA RM methodology, very high AM values would not be reflected in the data unless present for more than 50% of any particular 10 minute block. This inexorably means that a greater number of short, intermittent episodes of high AM values will be experienced on site than are reflected in Mr. Carr's analysis. His data is liable to significantly under-represent Ms. Webster's lived experience of high AM values on a day to day basis.

169. Mr. Carr maintains that the average modulation depth for the mitigation period was approximately 3 or 4dB. This may well be correct. However, this is an average for all windspeeds and all wind directions. Even leaving aside low frequency/thump AM, emergence, etc, this in no way

[30] Downwind would usually be considered within 45 degrees either side of the Ballyduff windfarm turbines.
[31] As to which see para. 218 below.

forecloses nuisance at times when AM values are greater than this, which the evidence shows is a common and regular occurrence.

170. Mr. Carr's opinion on whether the 1,600 mode has abated the nuisance is so inconsistent as to be meaningless. He accepted that reducing the power mode does not reduce AM values or thump AM *per se* and that effective abatement can only be achieved through overall noise reduction. He then supported the defendant's contention that the maximum noise reduction of 2.1 dB effected by the 1,600 mode was *"significant"* and not *"negligible"*. However, he also accepted that, from the point of view of one listening to the WTN (a "receiver"), a noise level reduction of 3 dB would be on the very boundary of perception. I cannot reconcile these two positions and nor, I suspect, can Mr. Carr.

Has the 1,600 mode abated the nuisance? Onus of proof

171. As the defendant submits, the burden of proof in relation to nuisance rests with the plaintiffs. In *Hanrahan v. Merck Sharp and Dohme (Ireland) Ltd* [1988] ILRM 629, the Supreme Court found that it *"would be contrary to authority"* to require the defendants to disprove that the plaintiffs had suffered the mischief complained of or that same was caused by emissions from its factory. In the present case, this burden has already been discharged in relation to the 2,300 mode and the court has ruled on liability.

172. There is a dispute between the parties as to who bears the onus of proof on the question of whether the 1,600 mode has abated the nuisance. The plaintiffs maintain that the onus of proof is on the defendant and the defendant maintains that the contrary is the case. I accept the plaintiffs' submission on this point. The plaintiffs have proved, on the balance of probabilities, that the WTN is a nuisance. It is not necessary for them to prove this again and again for each adjustment to the turbine that the defendant might choose to make. Rather, the onus is on the defendant to prove that the adjustment that it proposes, the 1,600 mode, abates the nuisance.

Findings of fact regarding the 1,600 mode

173. In the principal judgment I was satisfied that:

1. The WTN is a nuisance at night[32] and during the quiet waking hours.[33]
2. Adverse impact occurs at windspeeds in excess of those which prevailed at the time of the court's visit (i.e. at windspeeds in excess of 5m/s).
3. Albeit that it would potentially require to be re-visited in module 2, it is likely that the worst features of high AM values and thump AM are associated with at least moderately higher speeds of rotation when WTN levels are sufficient to bring these characteristics to the fore.

174. On the basis of the evidence adduced at module 2, I now make the following findings of fact:

1. Table 3 shows that in the 1,600 mode, average night time downwind AM penalties at windspeeds between 4 and 8 m/s are 4 dB. Average night time downwind AM values are therefore between approximately 6.5 and 10 dBs. However, these

[32] Between 23.00-07.00 hours on all days.

[33] Between 18.00-23.00 hours all day plus 07.00-18.00 on Sundays and 13.00-18.00 on Saturdays.

penalties are averaged over several weeks. In any event, the IOA RM only captures those high AM values which are present for more than 50% of any 10 minute period. I am therefore satisfied that there are also regular periods of higher AM values at these windspeeds.

2. In the 1,600 mode, average night time downwind AM penalties at windspeeds of between 9 m/s and 11 m/s are 3dB. Average night time downwind AM values are therefore between 3 dB and approximately 6.5 dB. However, by the same logic, I find that there are also regular periods of higher AM values at these windspeeds.
3. Thump AM continues to be a regular feature in the 1,600 mode. This has been confirmed by spectrograph analysis.
4. In the 1,600 mode, erraticism, impulsivity, unpredictability and dominance continue as before.
5. I find on the balance of probabilities that, in the 1,600 mode, the WTN continues to disturb Ms. Webster's concentration, relaxation, enjoyment of her home and sleep to an unreasonable extent.

175. As will be evident, it is not even necessary to rely on the onus of proof to conclude that the 1,600 mode does not abate the nuisance. It is common case that, from a receiver's point of view, a noise level change of 3 dB is on the boundary of perception and that a change of 2.1 dB is barely perceptible or imperceptible. It is also common case that the 1,600 mode has effected no change to AM values, thump AM and other intrusive features such as erraticism, impulsivity, unpredictability, etc. A maximum reduction in WTN of 2.1 dB will not abate WTN nuisance arising from high AM values, thump AM, erraticism, impulsivity and unpredictability, which together dominate the plaintiffs' noise environment.

176. I therefore find as a fact, on the balance of probabilities, that the 1,600 mode does not ameliorate the nuisance to any appreciable extent. The defendant suggests that it had insufficient time for the mitigation exercise. Its written submissions note that on 2nd July 2024, prior to the trial and error process commencing, senior counsel for the plaintiffs applied for a hearing date for module 2. The defendant now submits that, despite objections raised by its counsel, who argued that more time was required, this court directed a November 2024 hearing date. This is a mischaracterisation of what occurred on 2nd July 2024. The mediation agreement, which was before the court on 2nd July 2024, specifies that the mitigation exercise terminate by September 2024. The defendant did not request the plaintiffs or the court to extend the mitigation period for the purposes of trialling other potential turbine modes. Rather, counsel contended that as the mitigation exercise would not be completed until September 2024, the defendant would not be ready for the trial of module 2 until the New Year of 2025. This, I regarded as being an excessive delay.

Analysis and findings of fact relevant to the potential abatement orders this court might make

177. Citing *Lanigan. v Barry* [2016] 1 IR 656 ("*Lanigan*"), the defendant argues that there are insufficient findings of fact in the principal judgment to determine the appropriate form of injunction. This requires some explanation. In *Lanigan*, the High Court had determined that a significant increase in activity at a motor racing circuit since its grant of planning permission amounted to a material change of use, meriting an injunction pursuant to s. 160 of the Planning and Development

Act 2000. The trial judge also found that the motor racing circuit caused a noise nuisance to the plaintiff's neighboring stud farm also meriting an injunction. The trial judge granted an injunction on both grounds significantly restricting the operation of the motor circuit. The injunction was principally focused on bringing the situation back to that authorised by the planning permission as interpreted by the trial judge. On appeal, it was contended that the injunction was excessive. The Supreme Court found that the trial judge had failed to have regard to the fact that some of the intensification, held to be a material change of use, was immune from enforcement as same was statute barred. As such, the s. 160 injunction could not stand. Further, because the High Court's injunction for nuisance was simply a reproduction of the planning injunction, it was also set aside. The Supreme Court also held that it could not determine the precise form of planning injunction to be granted in the absence of clear findings of fact regarding the level of use before and after the expiry of the enforcement limitation period. Likewise, in respect of the case in nuisance, the Supreme Court determined that there were insufficient findings of fact to allow it to craft an appropriate injunction designed to do justice in all of the circumstances.

178. In remitting the matter to the High Court, Clarke J. stated at para. 48:

> *"While the findings of fact sufficient to establish that there is a nuisance cannot, therefore, be disturbed, there are, in my view, insufficient findings of fact to allow this court to craft an appropriate form of injunction designed to do justice in all the circumstances pertaining to the nuisance claim. That is not to say that some form of injunction will not, almost inevitably, follow in order to deal with the established nuisance. However, this court does not have sufficient definitive findings of fact to enable a decision to be made as to the precise form in which any such injunction should be imposed."*

179. The key point is that this lacuna arose because the trial judge had formulated the injunctive relief for nuisance largely by reference to the planning permission. There were therefore few findings of fact which could inform the appropriate injunction to grant solely in respect of nuisance.

180. The present case is distinguishable. This court has determined on the basis of extensive findings of fact that the WTN poses a nuisance to the plaintiffs at specific times of the day and night and has explained why. It stands to reason that the conditions giving rise to nuisance such as moderate to high windspeeds, stable atmospheric conditions and high windshear will occur on an intermittent basis, albeit regularly and for sustained periods during these sensitive periods. When such conditions occur, nuisance arises in the manner already described.

181. The defendant submits that *"it is not open or appropriate for this court to determine the precise form of injunction that should be granted in the absence of definitive findings of fact as to where the threshold for nuisance lies, or when and under what circumstances the nuisance occurs".* Effectively, it argues that before granting an injunction, the court must (1) prescribe the precise combination of WTN decibel level and AM value that amounts to WTN nuisance and (2) must determine the precise combination of wind speed, wind direction and metrological conditions that render the Ballyduff WTN liable to cause a nuisance. I disagree.

182. The defendant's approach is simplistic and reductive of this court's findings at module 1. The WTN nuisance is not a product only of the WTN decibel level and its AM values. All of the *"Defra* factors" considered in the principal judgment are crucial to the assessment. It is neither necessary, nor indeed even possible, for this court to adjudicate upon the scientific and acoustic *causes* of the

WTN nuisance in this case, particularly not to the level of detail insisted upon by the defendant. Naturally, WTN nuisance caused by the interaction of the blades with the atmosphere and the environment will not be constant. It will wax and wane. Nor will the impact be wholly consistent at a given windspeed and wind direction.

183. In short, because the existence and cause of the WTN nuisance in this case is multifactorial, this court cannot prescribe the precise combination of WTN decibel level and AM values at which it is or is not a nuisance. Still less can it determine the precise combination of wind speed, wind direction and metrological conditions that render the Ballyduff WTN liable to cause a nuisance.

184. However, I can and have determined that, as presently operated the WTN causes a nuisance to the plaintiffs on a regular basis, for sustained periods of time, many of which correspond with the most sensitive times of the day.

185. The defendant must bear the onus of proof in demonstrating that the WTN does not give rise to a nuisance at particular windspeeds or in particular wind directions. It is for the defendant to bring forward evidence on foot of which I can carve out particular windspeeds or particular wind directions as being unlikely, on the balance of probabilities, to cause nuisance. In so far as there is insufficient evidence to carve out particular windspeeds or particular wind directions, it is also for the defendant to bring forward evidence to demonstrate that particular mitigation measures, such as a specified reduced power mode, will reliably and consistently abate the WTN nuisance and that shut down is not necessary at those particular windspeeds or particular wind directions. Insofar as the defendant has not brought forward such evidence, the court will make such findings of fact as are open to it on foot of the other evidence in the case.

186. Bearing all of the above in mind, and on the basis of the evidence of both parties adduced at module 1 and module 2, I now make the following findings of fact of relevance to potential abatement orders:

1. The WTN is most intrusive at moderate to high windspeeds of 5m/s to 8 m/s. I draw this conclusion for a number of reasons. First, as explained at para. 129 above, the WTN does not pose a nuisance at windspeeds below 5m/s. Although high AM values and even thump AM may occur at these low windspeeds, the WTN level is low enough that such features are not liable to annoy. In the second place, Mr. Carr's 2024 1,600 mode data shows that at night time, windspeeds of 5 m/s to 8 m/s are associated with the highest AM values which is widely recognised to be intrusive if audible at a sufficient level. As it is common case that the 1,600 mode has effected no change to AM values (or indeed to thump AM, erraticism, impulsivity, unpredictability, etc), this conclusion applies equally to the 2,300 mode. In the third place, thump AM is more likely to be noticeable when combined with these high AM values. Fourth, thump AM is more prevalent under conditions of meteorological stability, which most often occur at windspeeds below 8 m/s. Fifth, at these windspeeds, background masking levels in the form of wind noise will be low when compared to higher windspeeds. I therefore find that the WTN gives rise to nuisance at windspeeds of 5m/s to 8m/s and that this occurs intermittently but commonly, and for sustained periods, throughout quiet waking hours and at night.

2. At windspeeds of 9m/s, high AM values and thump AM also occur intermittently but regularly and for sustained periods. I accept that this causes a nuisance during quiet waking hours and at night. I draw this conclusion for a number of reasons. First, Mr. Carr's Table 3 shows that at a windspeed of 9m/s, average downwind night time AM penalties are 3 dB. At 9m/s average AM values are thus between 3 and 6.5 dB. Second, in light of the limitations of averaging and given that the IOA RM analysis will not reliably capture erratic or intermittent high AM values, I find that there are also regular and sustained periods of higher AM values at windspeeds of 9m/s. Third, I accept Mr Stigwood's evidence that thump AM regularly accompanies these high AM values. Fourth, I find stable atmospheric conditions, which occur most frequently at night, further exacerbate WTN nuisance. Fifth, I accept Mr. Stigwood's uncontradicted evidence that modern thinking now considers that high AM values and thump AM are more likely to disturb sleep when occurring with rapidity, which is a feature of higher rotational blade speeds caused by higher windspeeds, such as 9m/s. Overall, at a windspeed of 9m/s, high AM values and thump AM, causing vibration and pressure, occur with frequency and rapidity (in the sense just described). There features combine with the emergence of the WTN over background noise, and its erraticism, impulsivity and unpredictability, to dominate the sound environment on an intermittent but regular basis.
3. Table 3 presents average AM penalties of 3 dB at windspeeds of 10 m/s and 11 m/s in the 1,600 mode. As it is accepted that the 1,600 mode has not impacted AM values (or thump AM), the same AM values should broadly apply to the 2,300 mode.[34] Therefore, at windspeeds of 10 m/s and 11 m/s average AM values are between 3 and 6.5 dB. Thump AM regularly accompanies these high AM values. Although, at these higher windspeeds of 10 m/s and 11 m/s, AM and thump AM will be less intrusive due to the masking effect of wind noise, in very stable atmospheric conditions, sleep will still be disturbed. This, in turn, is due to at least three factors: the rapidity of blade rotation, the fact that thump AM will be more prevalent internally than externally and the fact that masking wind noise will be less effective internally than externally. I therefore find that the WTN is liable to give rise to nuisance in the form of sleep disturbance at night and in the early morning on an intermittent but regular basis at windspeeds of 10 m/s and 11 m/s. On the other hand, I do not find nuisance is likely to arise during quiet waking hours at windspeeds of 10m/s and 11 m/s.
4. At the very highest windspeeds (which Mr. Stigwood puts at 12m/s and above), high AM values, thump AM and the other features of the WTN will be even less common. Masking wind noise will be of considerable benefit at windspeeds of 12m/s and above. However, WTN nuisance will still arise, albeit on a fairly intermittent basis in

[34] Part of the he disputed new evidence includes a Table summarising AM penalties in the 2,300 mode. This suggests that AM values are somewhat lower at these high windspeeds in the 2,300 mode than in the 1,600 mode. Neither expert has commented upon this. I will adopt the more conservative approach and assume that AM values are generally as set out in table 3.

very stable atmospheric conditions at night and in the early morning. I do not find that nuisance is likely to arise quiet waking hours at windspeeds of 12m/s and above.

5. Figure 5 shows that in the 1,600 mode, high day time AM values (i.e. AM values which would attract penalties of 3 to 5 dB) occur in all wind directions bar the 135 to 180 degree sector. Figure 6 shows that in the 1,600 mode, high night time AM values occur in all wind directions bar the 90 to 180 degree sector. This applies equally to the 2,300 mode.
6. Other than as indicated at point 6 above, high AM values can occur in all wind directions.
7. Despite the limitations of averaging and accepting that the IOA RM will not capture high AM values if present for even as much as 49% of a particular 10 minute period, it is reasonable to conclude that if figures 5 and 6 show virtually no high AM values in a given wind direction, then same are unlikely to be a substantial or regular feature of the WTN in that particular wind direction.
8. As Mr. Stigwood's evidence was that thump AM accompanies high AM values, I also conclude that, when AM values are low, thump AM is unlikely to cause a nuisance.
9. The features giving rise to WTN nuisance in this case go well beyond mere high AM values. However, I am satisfied that where the data shows no (or virtually no) high AM values in a particular wind direction, then nuisance can on the balance of probabilities be excluded in that wind direction. As such, I am satisfied that nuisance does not occur, in the 1600 mode, the 2,300 mode or in any other operational mode during quiet waking hours in the 135 to 180 wind direction or during the night in the 90 to 180 wind direction.
10. Although noise levels are generally likely to be lower in crosswind and more particularly upwind directions, the defendant has not provided any evidence on which I could determine how much lower WTN levels might be.
11. I find that, although there is clearly a margin of error, the noise level reductions that Enercon predicts for different operational modes should be broadly achievable during the day. However, due to stable meteorological conditions, such an outcome is uncertain at night. In the absence of evidence to verify that these predictions can consistently be achieved at night, I cannot be so satisfied.

Are the plaintiffs entitled to an injunction?

187. The plaintiffs submit that the appropriate remedy is an injunction restraining the operation of T2 such that it does not cause noise nuisance at HH.

188. In *Lawrence v. Fen Tigers Ltd* [2014] 2 All ER 622 at para.121, Lord Neuberger stated that once nuisance has been established *"the prima facie position is that an injunction should be granted, so the legal burden is on the defendant to show why it should not".* Likewise, in *Patterson v. Murphy* [1978] ILRM 85, Costello J. stated that when an infringement of the plaintiffs' rights and further threatened infringement have been established, the plaintiffs are *prima facie* entitled to an injunction of which they will only be deprived of *"in very exceptional circumstances".* He then stated, echoing *Shelfer v. City of London Electric Company* [1895] I Ch 287, as follows:

"If the injury to the plaintiffs' rights is small, and is one capable of being estimated in money, and is one which can be adequately compensated by a small money payment, and if the case is one in which it would be oppressive to the defendant to grant an injunction, then these are circumstances in which damages in lieu of an injunction may be granted.

The conduct of the plaintiff may be such as to disentitle him to an injunction. The conduct of the defendant may be such as to disentitle him from seeking the substitution of damages for an injunction.

The mere fact that a wrong-doer is able and willing to pay for the injury he has inflicted is not a ground for substituting damages."

189. Although it is maintaining the position that there is mitigation at 1600 mode wind speeds, it appears that the defendant is now offering no suggestion of mitigation to the court. Rather, it adopts the primary position that mitigation is not required because nuisance is not established. It appears to contemplate no further adjustment to T2 unless mandated by the court. It also maintains that the plaintiffs ought to be confined to damages *in lieu* on the application of the *Shelfer* principles. It is clear that the nuisance will therefore continue if not interrupted by an order of this court.

190. The plaintiffs contend that their injury is not *"small"* or capable of being compensated by a *"small"* award. The defendant contends that damages are *"easily quantifiable at this point".* However, perhaps because quantum of damages is not for determination in this judgment, it goes no further than that and does not actually submit that such damages would be *"small".*

191. I am satisfied that the injury to the plaintiffs is not *"small"* in the sense described above by Costello J. Ms. Webster and Mr. Rollo's home life has been very seriously impacted by the nuisance and Mr. Rollo now lives away from their home. The noise seriously intrudes on Ms. Webster's enjoyment of her home; she is deprived of the healthy and comfortable enjoyment of her home and her sleep is disrupted.

192. As regards the conduct of the parties, the defendant submits that it has at all times acted in good faith in the hope of resolving the dispute between the parties. The plaintiffs maintain that the defendant's conduct was cynical in the extreme because:

- The defendant did not engage in any serious effort at mitigation, but rather used the opportunity presented to it by the court to adduce new evidence to dispute this court's finding on liability.
- Despite only reducing nuisance by a level now acknowledged to be barely perceptible or imperceptible from a receiver's point of view, the defendant maintained that the 1,600 mode had abated the nuisance. Mr. Brazil gave evidence to this effect. The defendant robustly cross-examined Ms. Webster on this premise. Only at the conclusion of the hearing was it apparently conceded that the mitigation had *"not changed anything appreciable".*

193. I agree that aspects of the defendant's conduct are unimpressive. However, I interpret this behaviour as indicative of the defendant's deeply entrenched positions rather than as *"conduct which disentitles [it] from seeking the substitution of damages for an injunction".*

194. The defendant cites the following passage from *Lawrence & Anor v. Fen Tigers Ltd & Ors* [2014] 2 All ER 622, in which Lord Neuberger stated, *inter alia,* as follows:

> *"I would cautiously (in the light of the fact that each case turns on its facts) approve the observations of Lord MacNaghten in Colls [1904] AC 179, 193, where he said:*

... if there is really a question as to whether the obstruction is legal or not, and if the defendant has acted fairly and not in an unneighbourly spirit, I am disposed to think that the Court ought to incline to damages rather than to an injunction.."

... If, as I suspect, Lord MacNaghten was simply suggesting that, if there was no prejudice to a claimant other than the bare fact of an interference with her rights, and there was no other ground for granting an injunction, I agree with him."

195. These considerations cannot avail the defendant. Even if I were convinced that the defendant had "*acted fairly and not in an unneighbourly spirit*," which I am not, the WTN nuisance in this case involves far more than an intrusion on a bare legal right. It has, for a period of seven years, utterly deprived the plaintiffs of the enjoyment of their property.

196. The defendant submits that the potential financial implications render an injunction oppressive and disproportionate. Such a submission requires substantiation by evidence. The defendant failed to adduce any evidence to assist the court in understanding the financial implications of operating in a lower power mode or of turbine shut down at sensitive periods.

197. The defendant has failed to respond to the plaintiffs' legitimate complaints for many years. Ultimately, in response to this court's principal judgment, it has implemented a "*mitigation strategy*" that, had any thought been given to the matter, was always bound to fail.

198. I am also satisfied that this degree of intrusion on a family home may not fairly be compensated by monetary compensation alone. In *Patterson v. Murphy*, Costello J. indicated that "*the mere fact that a wrongdoer is able and willing to pay for the injury he has inflicted is not a ground for substituting damages*". To confine the plaintiffs to damages in *lieu* would be to permit substantial WTN nuisance to continue for many more years. This would not do justice between the parties. On the basis of my findings of fact above, and applying the *Shelfer* principles, the plaintiffs have made out an entitlement to an injunctive remedy.

Relevance of the public interest

199. The plaintiffs do not seek an order shutting down the turbines completely, but rather an order shutting down T2 during quiet waking hours and night hours. They submit that such an injunction would not be overly oppressive.

200. The defendant argues that, in considering what remedy to award, I ought to place weight upon the public interest in clean renewable energy. The plaintiffs do not accept that the public interest is of particular relevance to the matters falling for adjudication. They observe that the public interest is not referenced in the *Shelfer* principles. However, as noted by Lord Legatt in *Fearn and others v. Board of Trustees of the Tate Gallery* [2023] UKSC 4, ("*Fearn*"), there had been a move away from "*the strict criteria derived from of Shelfer*". Ultimately, departure from the *Shelfer* principles, on grounds of public interest or otherwise, is to be determined by the courts on a case by case basis.

201. The plaintiffs also refer to *Bellew v. Cement Ltd* [1948] IR 61 in which Maguire C.J. found (at p. 64) that the court was "*not entitled to take the public convenience into consideration when dealing with the rights of private parties*". However, I note that, in the same case, Black J. took a different view and held that although public convenience cannot affect the right of a private individual to a remedy for nuisance, it can be considered in determining which remedies should be granted. Furthermore, in *Patterson v. Murphy,* Costello J. acknowledged (pp. 99-100) that the public interest was to be taken into consideration (albeit that he found that none arose in the case before him).

202. In my principal judgment I stated:

> *"Although a plaintiff who establishes nuisance has a prima facie right to an injunction such that the defendant bears the legal burden of demonstrating that damages rather than an injunction is an appropriate remedy, the public interest must inevitably be a factor in the court's assessment of an appropriate remedy. At the very least it means that a generalised injunction ought not to be granted where a tailored injunction more suitable to the particular interference held to constitute nuisance is warranted."*

203. The plaintiffs concede that this passage is consistent with *Fearn* in which it was held that whilst public interest considerations are not relevant to liability in nuisance cases, they might be relevant to remedy.

204. I accept therefore that property rights may need to be balanced with the activity of the defendant, where that activity is in the public interest. On the other hand, because it is widely recognised that WTN may unreasonably interfere with the amenity of local residents, there is also a public interest in acknowledging and constructively addressing such problems at a national and an individual level. Devising appropriate measures to avoid WTN nuisance at the planning and development stage is clearly of critical importance to the achievement of the State's aim of substantially increasing renewable energy. However, it is also critically important that turbine operators engage constructively with genuine WTN nuisance complaints and devise appropriate abatement measures. I accept Mr. Mayer's view that acoustic experts, engineers and turbine manufacturers such as Enercon, would have a wealth of experience in such matters that the defendant could have leveraged, had it chosen to do so. It was within the defendant's purview to propose a strategy that would abate the nuisance, whilst preserving power generation as much as possible

205. The defendant's argument of public interest based on loss of the environmental benefit of renewable energy is made in the most general terms only. No specific evidence has been provided as to how much of the power produced by T2 at night is actually deployed to the national grid.

206. Notwithstanding, it cannot be denied that that restricting the power output from T2 will inevitably reduce the renewable energy it produces. Accordingly, if I can be satisfied on the balance of probabilities, that measures short of the complete shutdown of T2 during quiet waking hours and night hours would abate the nuisance, then I will fashion a remedy in those terms. Ultimately, for the reasons set out below, I am so satisfied and this court's injunction is crafted accordingly.

Crafting the injunction

207. In *Lanigan,* Clarke J. stated, that where nuisance is established, the court should adopt whatever remedy appears just in all the circumstances of the case having regard to the need to protect those who suffer by virtue of the nuisance to whatever extent might be considered just and reasonable. He emphasised that planning permission for an activity does not permit the commission of a civil wrong. The injunctive relief which may be justified for nuisance purposes may, either generally or in a specific respect, go further than that which might be justified on planning grounds. The two jurisdictions are not coextensive.

208. Because WTN nuisance will wax and wane with prevailing meteorological conditions an injunction which either shuts down or restricts the operation of T2 will unavoidably be too broad at

certain times and too narrow at others. For this reason, the parties were encouraged to investigate these issues and to proceed by trial and error. Unfortunately, this was a fruitless endeavor.

209. Before explaining how I have crafted the abatement order, it is necessary to make three preliminary observations:

210. First, the defendant's position is that that AM values and thump AM cannot be controlled or lessened by any engineering or mechanical alterations to the turbine. I am surprised that the defendant did not investigate the improvements that trailing edge serrations, blade feathering or other mechanical or electrical interventions could bring about in the WTN. I am also surprised it made no effort to investigate the meteorological conditions under which high AM values and thump AM manifest with a view to seeking Enercon's advice on how best to abate the WTN. Be that as it may, that opportunity has now passed.

211. As matters stand therefore, short of turning off T2 at sensitive times, the only potential abatement method is to reduce noise levels (at relevant windspeeds/wind directions) by a clearly noticeable degree. From a receiver's point of view, a reduction of 2.1 dB is barely perceptible or imperceptible . On the other hand, 5dB is thought to be an easily noticeable noise differential, which is why it is commonly used to limit the emergence of WTN over background noise levels. Therefore, all other things being equal (and strictly subject to the point made at para. 214 below), a 5 dB reduction in the WTN at relevant windspeeds/wind directions is likely to abate the nuisance to an appreciable extent at the windspeeds/wind directions concerned.

212. Second, I am convinced that to simply order a 5 dB reduction in the WTN would be fraught with difficultly. Such an approach would first require the assessment of background noise levels in order to isolate the WTN and discern its level at each relevant windspeeds/wind direction. This would involve extended noise monitoring. It would then be necessary to devise and trial a bespoke turbine mode to achieve the required noise level reduction at each relevant windspeed/wind direction. This is turn would require further extended monitoring to verify the noise reduction. As a matter of certainty, this would lead to further dispute and to ongoing nuisance whilst the matter is regularised. This would be entirely unjust to the plaintiffs who have long awaited a fair resolution to their complaints.

213. An order requiring a 5 dB reduction in WTN (at relevant windspeeds/wind directions) would not therefore be sufficiently clear or enforceable and would require ongoing court supervision. Instead of ordering a 5 dB reduction in WTN, I prefer to approach nuisance abatement during quiet waking hours by restricting T2 to an appropriate Enercon operating mode, provided that this is predicted by Enercon to achieve a 5dB reduction in WTN noise level at relevant windspeeds. I am of the view that, with some margin of error, this is a reasonable and fair approach to mitigation during quiet waking hours. At night time however, I accept that, for the reasons outlined by Mr. Stigwood,[35] the predicted WTN reductions are unlikely to be reliably and consistently achieved. Accordingly, I am not be satisfied that restricting T2 by operation mode only would be effective at night. Therefore, save at very high windspeeds (i.e. at 12 m/s and above), restricting T2 by operation mode only would not be a reasonable or fair approach to mitigation during night hours.

[35] See para. 149 above.

214. Third, Ms. Webster gave evidence at module 1 that what often disturbs her sleep is a sudden change in the WTN, rather than the absolute loudness or quality of the WTN at a given time. Sudden changes in windfarm noise occur as a result of high AM values, changes in the spectral content of the WTN and as a result of its erraticism, impulsivity and unpredictability. Sudden changes in the WTN would also of course occur if the turbines were to be continually switched on and off as windspeeds rise and fall. I am therefore satisfied on the balance of probabilities, that continually switching on and off the turbine with each increase or decrease in windspeed would in itself be jarring, disturb sleep and cause nuisance at night. Therefore, this should be avoided in crafting the abatement order. On the other hand, even if such jarring effect is likely to be somewhat annoying and distracting during quiet waking hours, I find that it can reasonably be tolerated and would not in itself amount to nuisance.

215. I have determined that nuisance is established but also that the public interest requires that the operation of T2 should be restricted no more than is necessary. On the basis of the findings of fact made at para. 186, I must now determine what precise operation modes ought to be directed per windspeed/wind direction in order to abate the nuisance at sensitive times and then tailor an injunction accordingly.

Windspeeds of 5 m/s to 7m/s inclusive

216. For reasons already set out, I find that the WTN is most intrusive at windspeeds of 5 m/s to 8 m/s inclusive. In line with the starting point identified at para. 211 above, and subject once again to the concern expressed at paras. 212 - 214 above, I have in the first instance considered a 5 dB noise reduction at windspeeds of 5 m/s to 8 m/s can be achieved by directing a change in the operating mode of T2. If so, this could potentially provide an effective mitigation strategy during quiet waking hours.

217. However, a 5dB reduction in noise levels at windspeeds of 5 m/s to and 7 m/s is not predicted to occur on any of operating modes presented by the defendant to the court. Even the lowest power mode, the 1,000 mode is only predicted to affect a maximum noise level reduction of 4.1 dB (at windspeeds of 7m/s only). As I am satisfied (a) that windspeeds 5 m/s to 8m/s are those of greatest adverse impact and (b) that a clearly noticeable detection in noise levels cannot be secured by adopting one of the operating modes presented, shutdown of T2 at night at windspeed of 5m/s to 7 m/s is required.

218. As regards, wind direction, some reduction in overall noise levels probably occurs in wind directions other than directly downwind. However, Mr. Carr has not addressed this in any detail in his evidence in module 2. Therefore, even if I were satisfied that some variation were appropriate in other wind directions, I am in the dark as to what that might be. This is regrettable; but it is the inexorable result of the manner in which the defendant has chosen to litigate module 2. On the other hand, I am satisfied that T2 does not cause WTN nuisance at any windspeed during quiet waking hours in the 135 to 180 wind direction or at night in the 90 to 180 wind direction. I am satisfied, on the balance of probabilities, that it is not necessary to order turbine shut down (or indeed other abatement measures) at any windspeed during quiet waking hours in the 135 to 180 wind direction or at night in the 90 to 180 wind direction.

219. Accordingly, I order shut down of T2 at windspeeds of 5m/s to 7 m/s during quiet waking hours for all wind directions save in the 135 to 180 wind direction. No restriction is necessary during quiet waking hours in the 135 to 180 wind direction. At night time, I order shut down of T2 at windspeeds of 5m/s to 7 m/s for all wind directions save in the 90 to 180 wind direction. This same wind direction limitation applies *seriatim* below.

Windspeeds of 8 m/s

220. At 8m/s, the 1,000 mode predicts an average reduction in WTN of almost 6 dB. Although this precise reduction may not be consistently achieved, I am nonetheless of the view that this measure will sufficiently abate the nuisance during quiet waking hours. I will therefore restrict T2 to the 1,000 mode during quiet waking hours at a windspeed of 8 m/s.

221. However, the position is different at night. Due to stable meteorological conditions, I am not satisfied that this deduction can be reliably or consistently achieved at night across all of the relevant wind directions between 180 and 90. As sleep disturbance is, and has always been the primary complaint , it is essential that any night time abatement measure is clear, certain in its effectiveness and enforceable. If not, a requirement for further court supervision would be inevitable. I am also satisfied that the sudden commencement and cessation of WTN as the wind increases and drops above and below 8m/s would have a jarring effect liable to disturb sleep. I therefore find that, due to a combination of high AM values, thump AM and this jarring effect, permitting the commencement of operation of T2 as the wind reaches 8m/s would cause a continuing nuisance at night. Accordingly, I order that T2 remain shut down at night at a windspeed of 8m/s.

Windspeeds of 9 m/s

222. AM values drop somewhat at 9 m/s. However, I have found that, due to a combination of relatively high AM values and thump AM, both of which are likely to occur with increasing frequency (in the sense of rapidity at this high windspeed) the WTN poses a nuisance at this windspeed.

223. I order that during quiet waking hours the turbine shall operate in the 1,200 mode at windspeeds of 9m/s. This is predicted to bring about an average 3.6 dB noise level reduction. Although this reduction is somewhat less than 5dB, I am satisfied that when balanced with the higher background masking noise levels which winds of 9m/s will provide this will sufficiently abate the nuisance during quiet waking hours. I will therefore restrict T2 to the 1,200 mode during quiet waking hours.

224. At night, the points made at para. 221 above apply with equal force. Although the masking background noise level from the wind will be higher at 9m/s, the defendant has provided no detail in this regard. No evidence has been put before me upon which I could be satisfied either that the predicted noise level reduction can be consistently and reliably achieved in stable atmospheric conditions at night or that that background wind noise would mask the jarring effect of the sudden and unpredictable commencement and cessation of operation as the wind rises to and falls below 9m/s. Accordingly, I order that T2 remain shut down at night at a windspeed of 9m/s.

Windspeeds of 10 m/s and 11 m/s

225. Table 3 shows that AM values at windspeeds of 10 m/s and 11m/s are on average the same as at 9m/s. Whilst, it is common case masking wind noise will increase at these higher windspeeds,

I have no specific data as to the extent of this increase. In stable atmospheric conditions, high AM values and thump AM are liable to disturb sleep at night and thus cause a nuisance.

226. I have carefully considered whether to permit the turbine to operate at night at these windspeeds in a reduced power mode. However, I am once again constrained by a lack of evidence as to the reliability of the predicted noise level reductions at night. I am also constrained by a lack of evidence as to the efficacy of background wind noise in masking either the WTN or the jarring effect of a sudden and unpredictable commencement and cessation of operation of T2. Without such evidence, I cannot be satisfied that operation in a lower power mode will abate the nuisance. If I were to craft a mitigation order without such evidence, it would in reality be little better than a guess. I will therefore continue to order the shut down of T2 at night at windspeeds of 10 m/s and 11 m/s.

227. By contrast, stable atmospheric conditions are unusual in the day time. In any event, the primary concern at higher windspeeds was of sleep disturbance. As such, I am satisfied that it is not necessary to restrict the operation of T2 at windspeeds of 10m/s and 11 m/s during quite waking periods.

Windspeeds of 12 m/s and above

228. At night time I will order that T2 operate in the 1,200 KW mode at windspeeds of 12 m/s and above. This is predicated to reduce WTN by between 3 and 4 dB. Even if this noise reduction is not consistently achieved over all relevant wind directions, I am satisfied that wind noise will mask turbine noise to a large extent and that this measure will abate the nuisance. I impose no restriction on the operation of T2 at windspeeds of 12 m/s and above during quiet waking hours.

Conclusion

229. I close by once more regretting the defendant's failure to engage constructively with the mitigation process. It trialled only one entirely ineffectual mitigation mode and instead devoted itself to disproving nuisance. The defendant therefore failed to adduce important evidence such as properly presented AM values, WTN levels in different wind directions, background noise levels/masking noise levels or verification of the WTN level reductions in the Enercon prediction data. Had it done so, then it would probably have been open to me to devise more nuanced abatement measures inuring to the benefit of the defendant and the public. Instead, having caused a nuisance for seven years, the defendant has squandered its opportunity to partake in any meaningful way in the design of fair, proportionate and effective abatement measures. Any difficulties that the defendant may encounter on foot of this court's order are entirely self-inflicted

THE HIGH COURT

[2025] IEHC 330

Record No.: 2018/3928P

RAYMOND BYRNE AND LORNA MOORHEAD

PLAINTIFFS

- AND -

ABO ENERGY IRELAND LIMITED, ABO ENERGY O&M IRELAND LIMITED

AND

WEXWIND LIMITED

DEFENDANTS

JUDGMENT of Mr. Justice Oisín Quinn delivered on the 5th day of June 2025

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I. Introduction

1. The defendants' wind farm causes, by means of noise, a substantial interference with the plaintiffs' day to day enjoyment and use of their home and garden in Wexford.

2. Midway during this six week trial (which ran from 25 February 2025 to 4 April 2025) the three defendants admitted liability for nuisance and partially abated the problem by switching off the relevant turbines at nighttime from 10pm to 7am.

3. At the end of the case the defendants apologised for the nuisance, and they proposed that in addition, they would switch off the turbines during the morning from 7am to 11am at weekends and on public holidays but would continue the nuisance into the future during the remaining periods of the day and they proposed paying damages for this future ongoing nuisance, together with damages for the nuisance to date, in part relying on the fact that the turbines contribute to Ireland's renewable energy needs. The defendants also made a proposal to address the plaintiffs' complaint about sporadic shadow flicker from the turbines.

4. Consequently, there are two main issues in this judgment. The first concerns the approach to the assessment of the damages for the nuisance to date and whether, as the defendants contend, this should be measured by reference to a notional capital damage to the value of the plaintiffs' property, or, as the plaintiffs contend, this should be assessed by reference to broader principles relating to the assessment of general damages focussing on the impact to each of the plaintiffs in their use and enjoyment of their home.

5. The second main issue is whether the noise nuisance should be fully abated by means of an order restraining the operation of the relevant turbines at all times or whether the defendants should be allowed pay damages for committing an ongoing nuisance into the future, that they agree substantially interferes with the plaintiffs' normal use and enjoyment of their home, in circumstances where the activity causing the unlawful interference contributes to Ireland's efforts to meet its renewable energy targets as part of the State's national Climate Change Plan.

6. In addition to the foregoing, the issues of whether to award aggravated and exemplary damages arise, together with a subsidiary question as to whether, even if the court were to order a full shutdown of the turbines, there remains a damage to the capital value of the plaintiffs' property by virtue of what the plaintiffs' expert valuer described as a stigma damage.

II. Summary of Conclusions

7. The detailed decision, and supporting reasons, on each issue are set out from para.s 303 to 399 in Section XI below. For convenience, this Section contains a summary of the conclusions reached. In regard to the first issue, I am satisfied that the plaintiffs' contentions are broadly correct. The defendants, having admitted liability for nuisance, asked the court to assess damages based on a notional capital damage to the plaintiffs' home to date, which the defendants' valuer estimated at up to approximately €150,000; the plaintiffs' valuer estimated the notional capital damage at about €394,000. For reasons described more fully later in this judgment, had I been required to evaluate this competing evidence, I would have favoured a figure closer to the plaintiffs' valuer on this issue. However, to measure the damages for the nuisance to date by reference to a notional drop in the capital value of the plaintiffs' property attaches too much significance to the capital value of the person's home in cases of this nature. As it happens, in this case the plaintiffs have a valuable home, but the true *value* of a person's home in the context of the enjoyment they get from its ordinary use and amenity, as a place of refuge, rest and relaxation, cannot necessarily be measured fairly by reference to its capital value. It is more likely to do justice in individual cases to consider and assess the effect, duration and impact on the amenity of the home from a nuisance, which causes no physical damage and is stopped, by reference to an assessment of the impact on an objectively reasonable person in the circumstances of the plaintiff. The defendants' approach, albeit well supported by English caselaw, has the risk of leading to vastly different awards that would not in general appropriately reflect the underlying constitutional rights protected by the tort of nuisance.

8. The law of nuisance, interpretated this way, is sufficient to vindicate and protect the underlying constitutional rights engaged in a case like this. However it would be unjust and potentially discriminatory if persons who endure a nuisance to their home life, such as that caused by ongoing excessive noise (which causes no physical damage to their property and is ended by order of the court), could be awarded wholly different amounts of compensation for the same type of interference primarily by reference to the capital value of their property.

9. The accepted expert evidence in this case indicated that the nuisance was "one of the worst cases of wind farm noise impact" (*per* the plaintiffs' expert, which was admitted by the defendants) and "an outlier" (*per* the defendants' expert). Consequently, for the reasons more fully set out hereunder, and having regard to the particular nature and effect of the nuisance on each plaintiff, I have decided to award general damages to each plaintiff as follows:- to the first named plaintiff €10,000 for each year of the nuisance; and to the second named plaintiff €15,000 for each year of the nuisance. As the admitted nuisance commenced in May 2013, this amounts to twelve years, bringing the award of general damages for the effect of the nuisance to date in respect of each plaintiff to €120,000 and €180,000

respectively. These awards will be made as against all three defendants jointly and severally.

10. As for the second issue, in general a defendant should not be able to pay damages to be allowed to continue to commit a nuisance that remains substantial and will continue for many years.

11. In this case the fact that the defendants' activity contributes to Ireland's renewable energy is highly significant. Ireland's Climate Action Plan requires the State to substantially increase the amount of energy generated from renewable sources, of which wind is the major one. The importance of the goal of the Climate Action Plan is the very environmental future and sustainability of the planet.

12. While the proportion of energy generated by the turbines in question constitutes a tiny percentage of the renewable energy supplied to Ireland's grid, that fact alone is not sufficient to preclude a serious consideration of whether or not the full injunction sought by the plaintiffs should be granted. Inevitably, in any individual case, the likely contribution to the grid of the wind turbines in any nuisance action will be small.

13. The evidence provided by the expert witnesses demonstrated that a multitude of different solutions short of a full shutdown are usually possible to sufficiently abate a problem of excessive noise from wind turbines (it is not an unusual problem) without having to shutdown the turbines completely.

14. At the Case Management Conference two weeks prior to this trial on 12 February 2025, the court pointed out to the defendants that they had no proposed evidence in their witness statements or expert reports which put forward any solution to abate or reduce the noise in the event that the court were to find a nuisance.

15. The defendants very belatedly appeared to contemplate that they might be unsuccessful in defending the nuisance claim. Early in the trial the defendants did then apply and were given liberty to deliver additional evidence (on foot of which they submitted an additional witness statement as to fact and an additional expert report). Nonetheless, the defendants' expert confirmed during the trial that, based on the evidence before the court, the only order that would stop the nuisance would be to order the turbines to be switched off.

16. Wind turbine noise is a recognised problem from wind farms. Addressing it in a substantial way is seen, according to the expert evidence in this trial, as critical to the future success of wind as a major source of renewable energy. The evidence adduced at this trial indicates that engineers, acoustic experts and turbine manufacturers are used to engaging with nearby residents and regulatory authorities to assess and address genuine problems. There are usually many solutions available, short of shutting down the turbines.

17. For reasons that are not entirely clear, the defendants in this case chose not to engage in any meaningful way with the genuine and substantive complaints made by the plaintiffs (which were fully conceded during the trial by the defendants). Even when they were facing having to defend a substantial High Court action they chose not to explore or develop any evidential basis for making a proper submission as to what meaningful steps might be taken to substantially reduce the nuisance or mitigate the problem. Even when Nordex, the manufacturer of the turbines, offered to the defendants to help develop a "mitigation plan" back in 2019, when the defendants were facing an Enforcement Notice from Wexford County Council, they took no action. If an evidential basis for a solution or combination of solutions had been put forward then this could have readily resulted in an order that would not have involved directing the full shutdown of the three turbines.

18. In this case, for the reasons more fully set out below, I have decided that the fair, just and appropriate outcome is to make a permanent order directing that the three turbines in question be shut off completely. That is the only order based on the evidence, in the opinion of both sides' experts, which will prevent the nuisance which the defendants admit is a serious one.

19. The option of allowing the defendants to essentially pay damages to be allowed continue the nuisance during the daytime and evenings is not appropriate in this case - notwithstanding the hugely important public interest in maintaining and increasing the supply of renewable energy to our grid – principally on the grounds that the defendants have failed to put forward any proper evidential basis for mitigation measures that might have made some meaningful impact on the noise nuisance problem and would have allowed the machines to continue to operate, notwithstanding the factual and expert evidence that this could have been done.

20. This conclusion therefore is limited to the circumstances here and including the defendants' decision to largely ignore and then to fail to engage in any meaningful way with a substantial and serious problem which they have belatedly admitted.

21. As to the question of whether aggravated and exemplary damages should be awarded, for the reasons more fully set out hereunder, I am of the view that aggravated damages are appropriate but not exemplary damages. The response and approach of the defendants for the period of twelve years prior to the trial was seriously unimpressive. They did not substantially engage with the plaintiffs' complaints and declined, without explanation, to provide requested information or properly co-operate with the legitimate investigations of the local authority. The approach of the defendants significantly aggravated and prolonged the upset, disturbance and distress experienced by the plaintiffs, and for the reasons more fully described in this judgment, I have decided to award them the additional sums of €24,000.00 and €36,000.00 respectively in aggravated damages.

22. While the defendants failed to offer much answer to the plaintiffs' claim for exemplary damages and while I am concerned at the largely unexplained failure of the defendants to properly engage with the plaintiffs' complaints at a time when the wind farm was generating substantial revenues (over €1m per year for the last four years), I am not sufficiently satisfied that this behaviour has been shown to be so bad or so clearly a conscious and deliberate violation of the plaintiffs' rights as to merit the sanction of an award of exemplary damages. While this conclusion was a relatively close run decision, it is partly informed by my consideration that when the outcome of the case is looked at in the round, I am of the view that the order for the permanent shutdown of the three machines combined with the award of compensatory damages (based in part on the duration of the nuisance) and aggravated damages is probably sufficient in this case to indicate that a failure to properly engage with substantial and bona fide complaints is to be deprecated. In addition, I have taken account of the positive manner in which the defendants behaved during the trial, including making an admission of liability in respect of the nuisance on Day 11, initiating a partial shutdown of the machines at nighttime on Day 12, and making an apology to the plaintiffs at the end of the hearing.

23. Finally, in circumstances where the court is making an order for the permanent shutdown of the machines in question, I am not persuaded, for the reasons more fully set out hereunder, to award any damages for the contended for stigma impact on the plaintiffs' property. There is a planning permission for a wind farm. The three other turbines are allowed to continue to operate. The award of damages is designed to properly compensate the plaintiffs for the duration and effect of the nuisance to date. The court's order for the full shutdown of the three relevant turbines means there will be no ongoing nuisance into the future from these turbines pursuant to the current planning permission. Accordingly I do not propose to award any sum of damages other than in respect of the awards described above in respect of the general damages for the effect of the nuisance to date and for aggravated damages.

III. Background

(a) The plaintiffs

24. In Wexford, about three and half kilometers to the northeast of Bunclody, there is a large hill called Gibbet Hill, which rises to about 315m in height. Just to the west of this hill is an area called Curragh. The hill slopes steeply down to Curragh and is partly covered by a coniferous forest owned by Coillte. In 1998 Raymond Byrne and Lorna Moorehead purchased a one-acre plot of land in Curragh with a view to building their family home.

25. Both Mr. Byrne and Ms. Moorhead had strong connections to the area. Ms. Moorehead's parents are from Bunclody, while Mr. Byrne's parents lived not too far away in Fearns where he had grown up. The family home was built by 1999, and the plaintiffs have lived there ever since raising their two sons and building a life in the local area. They had the benefit of being near their respective parents, who in turn were able to enjoy being near their grandchildren, the plaintiffs' sons.

26. The family home is reached by a narrow laneway from the nearby main road which runs to Bunclody. It is located in a very rural area and has a generous and well laid out garden. Ms. Moorhead's father helped with laying out the garden. Once the family had settled in Curragh, Ms. Moorhead became very actively involved in the local community. She became a member of both the Parents' Council and the Board of Management of the local primary school and she also joined the board of the Bunclody Community Council. She was soon asked to assume positions of responsibility on those local bodies.

27. Prior to moving to Curragh Ms. Moorhead had worked in Dublin as an international brand manager with a background in market research for a substantial international drinks company.

28. Mr. Byrne had qualified as a barrister in the early 1990s and has since pursued a successful career as a legal academic and a law lecturer. He has written a number of legal textbooks and has held positions with the Law Reform Commission as Director of Research and, from 2016 to 2021, he was the full-time Commissioner at the Law Reform Commission.

(b) The wind farm

29. In 2008 the third named defendant (Wexwind) applied for planning permission for a six-turbine wind farm at Gibbet Hill. The plan was to place four turbines at the high part of the hill overlooking Curragh and a further two turbines a little further to the east, at a second

slightly lower high point of the hill (291 meters high) which was considered to be also well exposed to wind. The turbines were to have a tower or 'hub' height of 80 meters. They would then consist of a three blade Nordex turbine with a blade length of 45 meters, giving a blade diameter of 90 meters. Five of the turbines were to have a rated energy output of 2.5 megawatts (MW) and one would be limited to 2.3MW giving a total combined output of 14.8 MW which was necessary to comply to the overall Grid Connection Capacity.

30. As part of the application, an Environment Impact Statement (EIS) was submitted. The EIS contained a predicted noise assessment which estimated the predicted noise likely to emanate from the wind turbines in downwind conditions when the wind was blowing at 10meters per second at 10 meters hub height. At Curragh, the predicted noise contribution of the turbines was estimated to be 39db(A) (decibels A-weighted, i.e. the recognized adjusted decibel measurement to more accurately correlate to the perceived noise level).

31. As it happens the plaintiffs were unaware of the application and apparently there were no objections lodged by any member of the public. On 16 November 2009 Wexford County Council granted permission for the wind farm for a period of 20 years from the date of commissioning of the facility (unless permission for a further period is granted). The permission required that within the first year of operation a report on actual noise levels and shadow flicker experienced in nearby homes would be prepared and submitted and if "abnormal results" were identified by reference to the EIS then the developer was to submit proposals to reduce these impacts by means of "mitigation measures" and/or "limiting the use of the turbines at sensitive periods".

32. Construction of the wind farm did not begin until 2012, and the facility become operational in May 2013. The facility consists of six turbines which connect to a local substation. The entire facility is designed to be unmanned, and the turbines largely operate automatically based on preprogrammed software which controls typically the directional positioning of the blades, the rotor speed, the blade pitch etc., or they are otherwise typically controlled by Nordex technicians from a Nordex engineering control room in Germany or occasionally an engineer on site using a laptop or other device.

(c) The defendants

33. The first and second named defendants (together ABO Energy Ireland) admit to being the operators of the wind farm. The ABO Energy Ireland companies are subsidiaries of ABO Energy Gmbh & Co KGaA, (ABO Energy Germany) a company based in Germany. Another ABO company, ABO Energy O&M GmbH through a contractual agreement with Wexwind was said to provide certain technical and commercial management services to Wexwind in

relation to the Gibbet Hill wind farm. ABO Energy Ireland then provides some of these services to Wexwind.

34. Wexwind is a special purpose vehicle which was set up to own the Gibbet Hill wind farm. It has one shareholder, a Luxembourg based investment fund called UniInstitutional Infrastrukter SICAV-SIF (the Luxembourg Fund).

35. The defendants called only one witness as to fact, a Mr. Spicer who is a director and employee of the second named defendant. He described his role as coordinating the activities of the various contractors to the wind farm and looking after "invoice handling". He works from an office in Cornelscourt in Dublin. He never met with or ever had any direct interactions with either plaintiff.

36. Mr. Spicer said he took his instructions from representatives of the asset managers of the Luxembourg Fund called Union Investments property Infrastructure GmbH. These representatives are based in Germany. ABO Energy Germany, Mr. Spicer explained, was still majority owned by the two persons who he described as the "founders", namely a Jochen Ahn and Matthias Bockholt. He explained that in general they build and develop wind farms and then "sell them on to investors after that". The accounts of Wexwind indicate that in recent years it has been paying down financing with payments of more than €1million per year from the income it is receiving for the energy supplied by the Gibbet Hill wind farm.

(d) General features of wind turbine noise (WTN) in a noise nuisance claim

37. Wind turbine noise (WTN) (along with shadow flicker, considered below) is one of two common and well recognised challenges with wind farms. Independent expert evidence was given on behalf of the plaintiffs about WTN and shadow flicker from an environmental health and acoustics expert, a wind energy engineer and an engineer with specialist expertise in acoustics from wind farms. The defendants called an independent acoustics expert.

38. In the context of the admitted nuisance in this case there are a number of features to noise that can typically be relevant to the degree to which WTN may constitute a nuisance. There was no substantial disagreement as between the experts with expertise in relation to WTN in that regard.

(i) Loudness

39. The first significant feature is how loud the noise is. This is measured in decibels which are typically A weighted (dbA) to give a more accurate correlation between the amount of energy represented by the sound, and how it is perceived by the human ear.

(ii) Pitch or Frequency

40. The next feature of importance is the pitch or frequency of the sound. This is measured in Hertz (Hz). WTN from the rotation of the blades of a wind turbine is typically emitted at a mid to high frequency range (500-800 Hz). However, depending on the machine in question and in particular depending on the manufacturing tolerances or operating efficiency of the gearbox, a wind turbine can also emit low frequency noise. It is now generally recognised that low frequency noise, typically in this scenario between 160 and 200 Hz, is significantly more intrusive to the human ear than mid to high frequency noise.

(iii) Amplitude Modulation

41. The third feature of WTN is whether or not the noise is modulating. This modulation, or changeability, can relate to the loudness and the frequency. Amplitude modulation (AM) is a recognized intrusive feature of WTN. This is typically caused by the movement of the blades through the air which can create a swishing or swooshing sound.

(iv) Different noises simultaneously emitting from the same sound source

42. The fourth feature of WTN that can affect the perceived intrusiveness of the sound energy emitted from a wind farm is whether or not there is an overlapping of different noises simultaneously from the same source. For example, a wind turbine can emit noise from the passing of the blades through the air which may be a mid to high frequency noise, meanwhile the gearbox contained in the nacelle of the same machine can emit a low frequency noise. In addition, depending on the positioning of various different turbines within a wind farm and the nature of the local topography (ground conditions, trees, different elevations etc.) the different towers can emit different noises depending on their position *vis. a vis.* the direction of the wind. The blades can be turning at slightly different speeds and the modulation and loudness may be different adding to the intrusiveness of the overall noise reaching the human ear.

(v) Changeability

43. The fifth feature that may be relevant is whether or not there are changes to the above features. The changes can arise in loudness due to rotator speed changing (due to changing wind speed or operating limits contained in the programming of the turbine) or to the frequency or pitch of the sound or indeed to the modulation changing. This can give the

sound a quality that indicates the machine noise is 'speeding up' or 'slowing down' or 'getting louder'. The experts indicated that this draws the attention of the listener.

(vi) Erratic or unpredictable changes

44. Sixthly, there may be an unpredictability or erratic nature or random fluctuation to the changes or sounds. This can be intrusive because the ear and attention of the human listener is drawn to uncertain or unpredictable noises.

(vii) Tonal noise

45. The seventh feature is whether or not the noise emitted has a tonal quality. This, according to the experts, is where the noise energy is largely contained within 1/3 of an octave. It is recognized, according to the experts, in the science and studies around intrusiveness of noise from wind turbines that a tonal feature to the noise can be particularly intrusive.

(viii) Duration of the noise

46. An eighth feature is the duration of the noise and whether there are gaps and breaks. In other words, an intrusive noise that only occurs for a very short period of time and only rarely or sporadically, can have a considerably smaller effect in terms of disturbing people who live nearby compared to a noise that continues for a longer and considerable period of time, for example for long periods throughout the day or night.

(ix) The timing of the noise

47. A ninth feature that can have an impact on the level of intrusion is the timing during the day of the noise. In that regard nighttime or times perceived as being associated with rest or relaxation such as the evening or at weekends are typically seen as more sensitive times when, for example, people in their own home or garden can have an expectation of peace and quiet or rest and relaxation. In addition, the timing can be relevant insofar as there may be more or less other noises or sounds which may mask or reduce the intrusiveness of the noise from the wind turbines.

(x) Wider context

48. Then a tenth factor is the wider context in which the WTN is experienced. This means that any consideration of the effect of the WTN should take account of whether the environment is typically rural and peaceful or urban, and if urban whether it is a quiet residential area or a residential area close to busy roads or other noisy activities can be relevant.

49. Included in a consideration of the wider context is a feature which one expert described as "messaging". This feature can involve the listener as experiencing more intrusion or irritation from noise when they know of and can see the source of the noise and can associate the noise with the context in which it is occurring.

50. In addition, this wider context can involve consideration of the character of the noise and whether it is natural or industrial or man-made. In that regard many natural sounds such as from rain, thunder, wind, birdsong, animals or water sources are typically recognised as being considerably less intrusive than the sounds from industrial or man-made sources.

51. In relation to the sixth feature described above, namely whether or not the changes are unpredictable or erratic or, on the other hand steady or rhythmic, this feature can be affected by local meteorological conditions and the topography of the site. While it is usual, according to the experts, that WTN as a problem is more typically associated with a person living downwind from a wind farm, both acoustics experts for each side in this case agreed that the plaintiffs in this case were experiencing an unusual feature of *upwind* amplitude modulation from this wind farm.

52. In this case the experts agreed that the amplitude modulation which is commonly described in terms of a "swish" or "whoomp" or a "thump" or a "whoosh" was occurring across a range of wind directions and was commonly both upwind and downwind. In that regard both the plaintiffs and defendants' experts agreed that "this case is unlike many others where it is normally limited most of the time to downwind conditions" (i.e. the amplitude modulation) and that, because of this unusual feature, this had a relevance and impact on the frequency and duration of the impact of the noise nuisance that was admitted.

(xi) Sensitisation and attenuation

53. Finally, the experts alluded to a number of features that can occur when a person is exposed to a noise nuisance over a prolonged period of time. The first feature is sensitisation. In this scenario a person who is regularly exposed to a particularly irritating noise becomes - and it is commonly acknowledged that this can occur - sensitised to the noise. In other words they are more attuned to noticing the noise and finding it irritating. This is, as it were, in contradistinction to habituation, where the person may get used to a noise that is regular, steady and predictable.

54. The other concept relevant to considering the impact and amount of interference being caused by noise is the concept of attenuation. This relates to the impact on the noise of moving from outdoors to an indoor setting (the effect of the noise energy moving through walls or windows). Typically moving indoors will lead to a drop in the energy levels of mid to high frequency noises, which can include the sounds of nature such as birdsong or wind and the rustling of nearby trees and so on. When these sounds reduce due to attenuation, the human ear can then more readily notice a low frequency man-made tonal noise such as can be emitted from wind turbines.

55. As can be readily appreciated from the foregoing therefore, in considering whether or not the sounds emitted from a wind farm can objectively and reasonably be considered to constitute a nuisance, it is clear from the evidence of the experts on both sides in this case that it is not simply a question of assessing the loudness of the noise or, accordingly, therefore the precise distance of the person from the wind farm.

(e) Shadow flicker

56. Shadow flicker is recognised as a potential intrusive feature for nearby residents from a wind farm. Shadow flicker occurs when, depending on the position of the sun *vis a vis* the wind turbines, a rapid flickering of light is experienced by nearby residents.

57. In this case the defendants conceded that shadow flicker was a problem at particular times of the day during particular times of the year for the plaintiffs. This problem is well recognised and given the ease with which it can be predicted it is very easy to ameliorate the effect of shadow flicker without any substantial impact on the energy production generated by the wind farm. In other words, at any given time for the particular periods during the year it is possible for the owner and operator of a wind farm to identify when shadow flicker will be a particular problem and it will only arise at any particular moment from one particular turbine. This problem can be ameliorated by making adjustments to the software that controls the turbines and the defendant agreed to implement such a measure and this was identified and proposed by the defendants towards the end of the case.

IV. THE NATURE OF THE NUISANCE EXPERIENCED BY THE PLAINTIFFS

(a) Introduction

58. The nuisance experienced by the plaintiffs was particularised in some detail in the pleadings delivered on their behalf and was then elaborated upon in the witness statements prepared and delivered on behalf of the plaintiffs. The plaintiffs then gave evidence on Days 2, 3 and 4 of the trial. No objection was made on behalf of the defendants that either of the plaintiffs'

evidence had extended outside the ambit of the pleaded claim. Then on Day 11 all three defendants admitted liability for nuisance in respect of the entirety of the plaintiffs' pleaded claim for nuisance. As a consequence, the plaintiffs dropped their claim that the wind farm was operating in breach of its planning conditions. Accordingly, there is no issue of fact arising in relation to the evidence given by the plaintiffs as to their experience of the nuisance.

59. The plaintiffs explained that they had chosen to build their home and live in a quiet and peaceful rural area to raise their children. They explained that this decision was in part informed by the fact that they had grown up in the area and both of their parents were alive at the time and they wished for their children and their grandparents to enjoy each other's company for as long as possible.

60. Each of the plaintiffs had both enjoyed their own childhoods in nearby Fearns and Bunclody respectively. As a result, their home is extremely precious to them and is naturally full of rich memories of their children growing up, spending time as a family and with their grandparents.

61. The plaintiffs gave evidence how the first turbine became operational in May 2013. The plaintiffs' home is approximately 1,050 meters from the nearest turbine on Gibbet Hill. While the overall experience of each plaintiff was similar, the noise nuisance did affect them in different ways.

(b) The first plaintiff's experience

62. Initially in May 2013 the operation seemed to involve the testing of individual turbines but Mr. Byrne gave evidence that almost immediately he found himself disturbed by both the loudness and the nature of the noise from the turbines.

63. He said he realised he was experiencing what the experts acknowledged to be a feature of wind turbine noise namely amplitude modulation (AM). He said that this has been a regular and persistent feature of the wind turbines since 2013 and he described the AM sound as a whoop or whoosh noise and sometimes a thump.

64. However, he also described hearing what he said was a distinctive humming noise. This was the low frequency noise that was identified by the independent experts. He described this noise as an intrusive base tonal sound which was not predictable and was, he felt, competing

in an a-rhythmical fashion with the mid to high frequency noise. He said he found this very disruptive. He said he found the low frequency tonal sound particularly disturbing when he was inside the house and at night. This was supported by the expert evidence in relation to the phenomenon of attenuation described above.

65. He said that during the first few months of the following year he also noticed the shadow flicker problem. He described this as a rapid flickering shadow that falls across the property and comes through into the house. Videos were shown by the plaintiffs during the trial of this phenomenon and it can best be described as having a strobe-like effect which is extremely distracting and intrusive. Mr. Byrne said it was impossible to avoid it. Nonetheless it was of relatively short duration, lasting on average roughly 10 minutes or so and only during particular months of the year.

66. The plaintiffs gave evidence that as a result of the efforts they were making to engage with the defendant and then due to subsequent requests from the acoustic engineer from the local authority (which was considering and ultimately did serve enforcement notices on the defendants) that they were asked to keep noise diaries and logs.

67. Mr. Byrne described the area in which their home was built as a very quiet uplands area. There would be occasional noise at harvest time or early morning traffic however he said the local road was a quiet road. He said that since the wind farm became operational the noise environment is now highly intrusive and pervasive. He said it was especially intrusive late in the evening and he described the WTN as a pervasive, invasive and intrusive noise. He described the noise from the blades as being a whooshing or swishing sound but that when the rotor blade speed increases it can become a whoop sound. He said it was particularly difficult to get to sleep.

68. In relation to enjoying the garden outside the house he said that before 2013 he very much enjoyed being out in the garden and doing gardening work but that when the turbines are operating fast it takes the joy out of being outside. He said that when he has to do gardening work, he puts on ear pods and plays a podcast to drown out the intrusive noise, but even with the volume up loud he explained that it does not always drown out the noise from the turbines. In addition to the swish sound or the whoop when the blades are moving faster, he described also hearing a hum or droning noise which he said had the character of a mechanical noise.

69. Mr. Byrne described that when the blades are moving very fast that he could feel a kind of pressure occasionally and that he had to pop his ears.

70. Mr. Byrne explained that his study is in the front of the house where the house faces Gibbet Hill and the turbines. His study is on the ground floor and even when he is in his study with the window closed and the turbines are rotating quickly, he can hear the whoosh and the thump and also the hum sound. He said that the sound can break his concentration and then he will hear the hum sound so that he rarely has the windows open now.

71. In relation to the sleep disturbance, he said that this began at the beginning in May / June 2013. He said initially it was a shock as the noise intruded into the plaintiffs' bedroom. He found it difficult to get to sleep straight away so initially he would listen to the news on the radio to try to help mask the noise. However, he explained that this only sometimes worked. Accordingly, he said he began to work late so that he would go to bed feeling really tired. Usually, he had retired to bed at 11:00pm but due to the noise he had begun to work later and sometimes would not go up to bed until 1:00am so that he might fall asleep due to tiredness.

72. He described how both he and his wife used podcasts with a familiar voice that they had listened to before to try to mask out the noise. As a result, he said he was getting approximately only five hours sleep from approximately 2:00am to 7:00am. He described however that his wife would sometimes wake up during the night and this might wake him up. He described how she would go downstairs to watch news stations on the television at a loud volume.

73. He described how his work practices changed over the years from 2013 due to changes in his working role and then due to the COVID pandemic. Initially from 2013 he was commuting to Dublin and would leave the house shortly after 7am and he would drive up to get the Dart from Greystones. His working day meant he did not get home until after 7:00pm. However, after a number of years he was getting increasingly more tired and began to take the bus from Fearns so he could sleep on the bus.

74. He had been the Director of Research at the Law Reform Commission and then the full time Commissioner from 2016. He described how his wife was diagnosed with a serious illness in 2017. From the evidence, it was clear that both plaintiffs have busy lives and were significantly and substantially struggling as a result of the effect and intrusion of the noise on their home.

75. Mr. Byrne described that as he became more sensitised to the noise that he was able to discern that the three particular turbines near to the plaintiffs' home were not operating identically. This was confirmed by the independent expert who analyzed the SCADA data made available from the defendants on discovery.

76. Mr. Byrne described the impact when he was out in the garden that he would not be able to have the peace and comfort that he had enjoyed prior to the wind farm operating in 2013. This was something that he had really valued. He said the noise impacted on him when working in his study and particularly at nighttime and he described this. The disturbance to his sleep was something that really started to impact him over time. He described the effect as unrelenting and that there was no escape from it.

77. Based on his evidence, it was clear that one of the features that added to the distress was that Mr. Byrne felt there was essentially no escape from the noise either outside or inside, whether he was trying to work or whether he was trying to read a book or relax. Then in particular there was no escape at nighttime.

78. He described as intrusive the character of the whooping sound which he had come to understand was the phenomenon recognised by the experts as amplitude modulation. He was also aware of the hum which he described as like a kind of low drone.

79. During the course of the hearing the court attended, at the request of and with the agreement of the parties, a sound studio where various samples of the noise emanating from the wind farm as recorded by the plaintiffs' independent expert were played to the court. One of these recordings indicated the tonal droning noise which had a frequency of 160Hz. The noise recording of this sound had been made internally and had a decibel level of 43.2dB.

80. It could be clearly heard that the tonal noise was modulating. In addition, some of the sound samples clearly contained an identifiable swoosh of the blades *and* also a tonal drone that to the courts ear was modulating as well. This observation which was indicated by me during the sound recording was confirmed by the expert. In other words, it was possible to hear both a separate swoosh noise from the blades but also a modulating low tonal drone.

81. Mr. Dietrich Meyer, another independent expert of the plaintiffs (whose evidence is discussed in more detail below), explained that the lower frequency tonal drone noise was in all probability emanating from the gearbox within the nacelle of the wind turbine and that it had a modulating effect because the sound was radiating out through the rotating blades.

82. Mr. Byrne described the whooping sound when the blade speed increases to 15 rotations or more per minute which amounts to 45 blade passes (each turbine has three blades) as creating a whomping sound nearly every second, which he described as being impossible to avoid. He then pointed out that this thumping noise could be competing with the hum. He said it was impossible to try to read on the patio or at times even in the study and his coping mechanisms became news radio and familiar history podcasts. He pointed out however that even while listening to the radio or to a podcast with the headphones on, that it was still possible to detect the noise from the wind turbines. These features, and the fact that the plaintiffs found the noise intrusive in this manner, was confirmed by the independent experts as objectively likely based on the known effects of these types of sounds and based on the experts' independent sound recordings.

83. He also pointed out that the noise was not predictable and that it was erratic and could change not only from one day to the next but during the day. As a result, he found it very difficult to concentrate, to relax, to read or to get to sleep.

84. He described being able to detect both the whomping sound and the hum in between the whoops of the blades and that this was like listening to a "terrible competition".

85. He indicated that it was not the visual impact of the turbines or simply the loudness that was disturbing, but it was rather the strange character of the noise and the erratic and unpredictable nature of it.

86. The plaintiffs described how they had moved a mattress into the back of the house and at one stage tried moving their bedroom to the back of the house into a smaller room that had been used initially as one of the children's bedrooms when he was a baby and then subsequently as essentially a walk-in wardrobe. However shortly after this they realised that the noise was permeating into this room as well and that this move gave no relief.

87. One of the experts explained how low frequency noise can be more discernible indoors due to the phenomenon of attenuation described above. In other words, there are other masking mid to higher frequency noises from nature that can be heard outside but these noises are

less intrusive and are lost indoors, leaving the ear only to detect the mechanical low frequency tonal noise. After a few months accordingly, the plaintiffs moved back to their bedroom at the front of the house.

88. As Mr. Byrne explained to the court on Day 3 (page 33 line 7) *"judge this is our home, we want to stay in our home, we have for 11 years asked ABO and Wexwind please allow us to stay in our home, please stop this AM and hum in our house, please come and talk to us please listen to what we're listening to, we want to stay here and we think you can do something about that. We want to stay here."*

89. Mr. Byrne explained how a home is far more than simply a capital asset. On Day 3, page 34, he explained how their home carried with it both joyful and painful memories associated with the life he and the second named plaintiff had shared there. He explained that:-

> *"these are all things that are part of that home that is not just bricks and mortar it is full of memories it is full of strength it is full of all those things that are indescribable in any other terms than being all about life. Life is about those joyful times those terrible times but that's I think some of the things that give us the greatest resilience as human beings the strength as human beings to say please to ABO and Wexwind, please come to our home experience what we experience. We will tell you all about the joy, we will tell you why it is so important, we will bring you around, we will show you all of the things that we put into this in terms of all of the wonderful things that are, there's structure but also these memories that we want to hold on to and will you please come and talk to us at some point."*

90. Mr. Byrne explained that he has been largely working from home since he retired from the Law Reform Commission in 2021 and therefore his study in the house is also his workplace.

91. Mr. Byrne explained that towards the end of 2017 the plaintiffs were worn down and that was when they had to make a decision to hand the matter over to their legal team and then in 2018 the litigation commenced.

(c) The second plaintiff's experience

92. Ms. Moorhead experienced similar noise intrusion to that described by her husband. She noticed and was aware of the tonality or hum noise and the amplitude modulation and she described the low frequency noise being occasionally felt as a vibration or pressure. She also found the unpredictable and changing nature of the noise as intrusive and that despite using coping mechanisms she was unable to acclimatise to the noise.

93. She explained that by the summer of 2017 she was unwell having been diagnosed with a serious illness which required treatment but exposed her to experience increased fatigue and tiredness. At this time on occasion, she felt an overwhelming sense of despair when she was trying to rest at home. It was clear from her evidence that she found the failure of the defendants to meaningfully engage in a significant way aggravated her feelings of helplessness, frustration and caused her additional aggravation and upset.

94. Overall, she described the noise from the wind turbines as one that can pervade the house, is intrusive and disturbing, and on occasion can be associated with vibration. She explained that in her experience the AM varies in terms of loudness and can occur on its own or occasionally is associated with the tone and low frequency noise which fades in and out.

95. She explained that the modulating tone is constantly ramping up and down in volume and therefore repeatedly catches her attention. She explained that on many nights she had to get up and goes downstairs and watch the television at a loud volume. She described the tonal noise as if someone is standing in the corner of the bedroom striking a tuning fork with varying force so that the resonance is constantly changing and fluctuating.

96. In 2004 the second plaintiff had been diagnosed with vestibular migraine and suffers occasional bouts of vertigo. She explained that the prolonged impact of the wind turbine noise on her sleep was unhelpful to these conditions.

97. She explained that she also used to get great enjoyment from gardening and reading outdoors but that at certain times with the noise from the relevant turbines she is only able to spend time outdoors with on-ear headphones. She also described how the noise outdoors has impacted on the family's use of the garden for social occasions.

98. She expressed the view that she was perplexed at the failure of the defendants to properly engage with the complaints and she pointed out that the first time anyone was sent on behalf of the defendants to conduct a noise monitoring exercise was in August and September 2024 in preparation for the court hearing.

99. Ms. Moorhead's evidence clearly conveyed her awareness of the intrusion of the fluctuating hum and the rise and fall in volume and the fact that the noise fades in and out and in

addition she indicated she was aware of and her attention was drawn to the tone within the hum. This description was backed up by the independent acoustics expert evidence.

100. In terms of watching television she explained that normally the television is set to volume 15, whereas when she goes down during the night and turns on CNN or Sky News she puts the volume up to 50 to try to mask out the noise from the wind turbines.

101. At times the second plaintiff became visibly upset during the giving of her evidence. She conveyed that she had endeavoured to remain calm and to constantly carry on but she explained that the wind turbine noise was tapping into her reserves and her resilience.

(d) Site visit on 4 March 2025

102. By agreement between and at the request of the parties, I visited the plaintiffs' home on 4 March 2025 (the parties were represented, and the stenographer made a transcript of the visit). On the day of my visit there was a mild light breeze coming from the south. Outside the house a clear but gentle 'whoosh' of the blades could be heard, the blades were turning at about 18 rotations per minute. There was also a low rumble to be heard. Initially, to the unsensitised ear, it sounded as if an aircraft might be flying overhead. To my ear, the noise on the day was moderately intrusive. Ms. Moorhead in evidence subsequent to the site visit said that she would have rated the conditions as a '1' in terms of her noise logs (10 being the most severe). Having said that, this was based on the conditions just before I arrived and it was indicated by Counsel that the wind had increased somewhat during the visit (this observation was based on a counting of the turbine blade rotations per minute).

(e) Overall impression of the plaintiffs' evidence

103. The first plaintiff was cross examined for two hours on Day 3. Nothing of substance was put in terms of contradictory evidence. It was not suggested he was oversensitive or being unreasonable. It was not suggested that his recollections or diary entries were inconsistent with any of the data collected by the experts.

104. He was measured and reliable. He described highly intrusive whoomp, AM and droning/tonal hum which interferes with sleep and interfere with the normal use and enjoyment of the home, especially at times that would be associated with rest (the evenings, nighttime and the weekends). The level of disruption is substantially in excess of what an ordinary reasonable person should have to endure. It effects his sleep, work, rest and enjoyment of his home.

105. He described moving bedrooms, waking in the night, going to bed extremely late so as to be tired, wearing headphones, being unable to enjoy his garden, listening to talk radio and podcasts at nighttime to try to drown out/minimise the noise. He described it as intrusive and attention grabbing. His evidence was supported by the emails and correspondence, by the data recorded by the acousticians and by contemporaneous diary entries.

106. The second plaintiff gave clear and cogent evidence. She is a person clearly very well regarded in her local community and is involved in lots of community groups. She is clearly well respected and trusted by her neighbours and peers. Her evidence was supported by diaries and logs. While these were snapshots they indicate a clear pattern of highly intrusive WTN. The tonal hum and the whoomp clearly intrude and disrupt rest and relaxing time, gardening, evening time and sleep. Her sleep has been substantially and regularly disturbed.

107. Based on her evidence it is clear that the shadow flicker is also highly intrusive. It is like an alien form of light pulse. Watched on a screen (as it was shown to the court) it resembles the screen pulsing or flickering as if resetting. In the natural environment it is clearly highly visually intrusive.

108. The plaintiffs' evidence was clear and coherent and was supported by their logs and noise diaries. These Diaries indicated for example instances where the plaintiffs' children and their friends no longer wanted to play outside in the garden because of the turbine noise.

109. In addition, the particular features of the noise described by the plaintiffs were supported by the independent experts who made sound measurements. Furthermore, certain sound recordings were played to the court and these supported the descriptions given of the noise intrusion by the plaintiffs.

110. The cross examination of the plaintiffs was careful and appropriate and it was not suggested at any stage that the plaintiffs' descriptions of the noise were inconsistent with any of the independent or objective data or recordings or notes or records.

(f) The Plaintiffs' accounts were supported by the independent experts

111. The plaintiffs obtained reports from independent experts which supported their case in objective terms.

112. It should be a observed at this stage that when both plaintiffs gave their evidence and referred to their logs and the diaries that these demonstrated firstly a consistency with the independent measurements taken by the acoustics experts but also indicated that the plaintiffs were able to identify levels of noise that on occasion they did not consider intrusive and these attracted low scores in the ratings system they have been asked to adopt by the County Council.

(i) Mr. Stigwood

113. Mr. Stigwood's evidence, commenced on Day 6 and was helpful to the plaintiffs' case in relation to establishing nuisance. He reviewed Ms. Large's first report and then he was taken to his own reports. In reviewing Ms. Large's first report he explained the various findings which showed the following combination of features:-

i. as part of the noise emanating from the wind turbines firstly there is amplitude modulation namely a rising and falling of the loudness at a medium 500 Hz frequency;

ii. this is caused by the movement of the rotor blades of the turbines through the wind;

iii. this is typical AM noise from wind turbines and is accepted by the defendants' expert as occurring in this case;

iv. however, in addition there is also a low hum noise that is also modulating;

v. this tonal or droning noise is at approximately 160 Hertz frequency;

vi. this low frequency tonal noise is also modulating;

vii. Mr. Stigwood explained that this may be due to the fact that it is emanating from the motor or hub contained within the nacelle and is then radiating out through the rotor blades – this explanation was endorsed as the likely cause of the modulating low frequency tone by Mr. Meyer;

viii. as a result, there are two modulating frequencies: one at approximately 160 Hz and a second one at 500 Hz;

ix. in addition, the changing noises emanating from the wind turbines is affected by the fact that there are three turbines and depending on the wind and the precise alignment of the rotors which are adjusted mechanically to face the wind and allowing for the fact that the wind can be moving in different directions and at different speeds in different positions due to the topography of the site (this surprising account was confirmed by the defendants' SCADA data from the turbines), then on occasion the noise data recorded by Ms. Large and as analysed and explained by Mr. Stigwood appears to contain overlapping noises where the peaks

and troughs are accentuated by virtue of the fact that the sound wave is arriving simultaneously thereby accentuating the peak and the trough;

x. this is occurring at both the low and the medium frequency, but then on occasion the waves can detach or desynchronize which gives the effect to the listener that the pulsing noise or the modulating noise is speeding up but in effect what is happening is that the peaks and troughs from the two or three different wind turbines are arriving at slightly separate times;

xi. they can then re synchronize again depending on the conditions;

xii. as a result of all of the foregoing when there is amplitude modulation which can occur in particular in either upwind or downward conditions, and unusually here it can occur in upwind conditions, the noise level - the decibel level - and the modulation can change and fluctuate and these changes and fluctuations draw the attention of the listener.

114. Mr. Stigwood explained that low frequency noise is considered more intrusive. He referred to the UK Defra NANR guidelines which place a limit for modulating indoor noise at the 160 Hertz frequency and he explained based on Ms. Large's data how this has been exceeded in several of the monitoring samples by a considerable degree. In particular he referred to one data set which showed that on one occasion the amount of noise at the 160 Hertz frequency which was modulating indoors was at approximately 43dB (the limit is 34dB). He said this would be a considerable and substantial amount above the Defra limit which is considered to be the limit of what is tolerable.

115. He also explained that the WHO guideline of 42dB as the threshold for nighttime noise which would cause disturbance from traffic or cause somebody to awaken was also breached.

116. On Day 7 Mr. Stigwood gave specific descriptions of data recordings which confirmed or supported the accounts given by the plaintiffs of the noise intrusion from the wind turbine noise.

117. His analysis of the data indicated that the wind turbine noise has a significant AM feature. This AM fluctuates in terms of the peaks and troughs and also fluctuates in terms of how quickly the modulations occur.

118. He explained that his data also indicated that low frequency noise in the one third octave around 160Hz is a significant component of this wind turbine noise. This is heard by the

human ear as a tonal noise. He confirmed that when the low frequency noise was isolated, the data indicated that the low frequency noise itself is modulating.

119. He explained on Day 7 how low frequency noise can be more intrusive indoors because while the noise passing through walls or windows, or open windows, reduces but in particular the higher frequency noise reduces - this makes the low frequency component which remains more noticeable and intrusive.

120. He stated that the SCADA data, when analysed indicated quite dramatically the different wind conditions at each of the three turbines which face towards the plaintiff's home. This analysis demonstrated the unpredictable and turbulent nature of the wind conditions on the top of Gibbet Hill from the perspective of the plaintiffs' home.

121. He explained that in most wind conditions there was some level of noise intrusion and that accordingly there was little are no respite to be had, save when there was essentially no wind blowing.

122. Mr. Stigwood also referred to the various planning standards and statutory nuisance standards that have been adopted and / or are developing in the United Kingdom. These indicated, in his opinion, that over time there has been an increasing awareness and acceptance that amplitude modulation and low frequency noise are particularly intrusive. There are recommendations for noise penalties where wind turbine noise contains substantial amplitude modulation and more recently a recommendation that where the amplitude modulation increases in frequency that this would also lead to a corresponding increase in the noise penalty. The practical effect of an increase in noise penalty is to add the decibel penalty to the existing overall loudness which can push the loudness over a limit in the planning condition, this means that an operator will have to reduce the operation of the turbine to reduce the overall decibel level (sound energy) being produced by the turbines. These types of arrangements are far more specific than the basic decibel level limit contained in the 2009 permission for this wind farm. In addition, however, this evidence was referred to by Mr. Stigwood to demonstrate the growing acceptance of the unacceptable intrusiveness of both AM and low frequency noise.

123. Mr. Stigwood explained that in the context of a nuisance assessment one should look at a multiplicity of factors from the perspective of the neighbour who claims that their home is being unreasonably intruded by wind turbine noise.

124. In his opinion, this case he said was extreme and one of the worst cases of wind turbine noise he had come across for a number of reasons. Firstly, there is a high component of low frequency noise. Secondly, the low frequency noise component is itself modulating. Thirdly the low frequency noise is intrusive and is very noticeable indoors and is above the Defra NANR45 recommended threshold for low frequency noise of 160Hz, which is at 34dB on the reference curve.

125. He regularly measured low frequency noise at the 160 Hertz frequency indoors that was substantially above this threshold and he explained that this would be intolerable; would be intrusive to sleep; and would be disruptive and cause interference and he said the likely effect of this type of noise correlated with the accounts of the intrusion given by the plaintiffs.

126. This case was unusual and exceptional he said and one of the worst he had ever come across. He explained that the standards are a touchstone of what is objectively considered intrusive and they indicate that amplitude modulation and low frequency noise above the threshold and increased speed of modulation are all features that are reasonably to be considered more intrusive (see his evidence on Day 7 from 15:00 onwards).

127. In summary the evidence gathered by Mr. Stigwood and his colleague Ms. Large demonstrated that there was amplitude modulation from the wind farm which was measured inside the plaintiffs' home which exceeded the low frequency criteria for unacceptable noise. In addition, this noise was exacerbated in its intrusiveness by virtue of the fact that it was highly modulating. In addition, the measurements indicate that the noise exhibits a tonal droning beat. The measurements referred to in evidence by Mr. Stigwood showed fluctuations well in excess of 10dB and sometimes of the order of 15dB. This is a highly noticeable level of modulation. According to Mr. Stigwood he recorded average levels of low frequency noise well above the 34dB limit recommended by the guidelines. He recorded average levels of low frequency noise in or around 160Hz, with a tonal quality where the noise is within 1/3 of an octave, and with decibel values in the order of 38dB to 41dB. He described these as exceedances which are substantial. In his opinion these noise levels would produce considerable disturbance especially when recipients are exposed over a long period of time. He said the distinct droning or tonal character measured on a second-by-second basis adds notably to the intrusiveness.

128. His conclusions were sent out in his report in relation to this issue in paragraphs 4.25 to 4.28 as follows:-

> *"4.25 In my experience such high levels of exceedance of the NANR45 criteria are consistent with unreasonable intrusion and exceed any point of acceptability*

by a substantial margin. This is where the noise intrusion is absent of cumulative impact from other elements of disturbance from the source of noise. In other words where the low frequency content occurs on its own. These other impacts include the turbine amplitude modulation noise within mid and high frequencies, tonal / droning modulations and the general rumbling sound generated. These additional elements exacerbate noise that is appropriately judged highly unreasonable due to the low frequency constituents in isolation.

4.26 Unfortunately the nature and character of low frequency noise disturbance and human reaction to it is not sufficiently understood to evaluate cumulative impacts from a range of noises and how one type exacerbates another. What is reasonably concluded is the combined impact means unreasonable intrusion occurs with lower sound energy levels and less frequency in the number of periods of disturbance.

4.27 In this case exceedance of low frequency noise criteria is sufficient to conclude this element is unreasonable, exceptional and intolerable to the normal reasonable person in isolation of the other characteristics. Its measurement and observations of occurrence are consistent with the resident's complaints of it.

4.28 The DEFRA Report on wind farm noise nuisance NANR277 specifically references the NANR45 criterion curve and states: "Should local authorities consider that low frequency noise is a substantial element of any complaint, they may wish to consider incorporating the advice of the Salford University Contract NANR45 procedure for the assessment of low frequency noise into their investigation."

129. At paragraph 7.41 Mr. Stigwood states:-

"7.41 This combination of unreasonable and intrusive constituents to the noise renders it one of the worst wind farm noise intrusion experiences I have observed in my career in a neighboring house. The LHS inset graph in Figure 24 shows a point in time where the fluctuating low frequency tone / drone exceeds the adjacent bands by 15-18dB which means the character is all the more intrusive than the average value indicates."

130. At paragraph 10.8 Mr. Stigwood states:-

"10.8 My independent analysis and the objective observations during 2024 confirms what I consider to be overwhelming evidence of unreasonable noise intrusion in this case. The complaints are strongly supported and normal

limits of tolerance by people are exceeded by a significant margin. In general in my career I am struggling to recall wind farm noise impact worse than experienced in this case. In some cases there are higher peaks or average sound energy levels experienced but the low frequency content and tonal / droning seriously exacerbate the already intrusive impact in this case."

131. At paragraph 10.12 Mr. Stigwood states:-

> *"10.12 In my expert opinion and experience the objective evidence is consistent with the residents' complaints. The noise is unreasonable and exceptional especially comparatively with other environmental and industrial sources. It exceeds normal boundaries of acceptability and expected intrusion by a substantial margin. This is one of the worst cases of wind farm noise impact that I have witnessed in my career, not due to the decibel levels but the cumulative intrusive factors of low frequency nose noise, tonal / droning content, amplitude modulation and occurrence over a wide range of wind directions."*

(ii) Mr. McKeown

132. As will be described later in more detail, Wexford County Council served an enforcement notice and commenced an enforcement process against the defendants. These enforcement notices were based on the investigations and findings of a Mr. Eugene McKeown of RPS, who were independent experts retained by the Council.

133. Mr. McKeown was called as an independent witness by the plaintiffs on Day 14. His evidence is also discussed below in the context of the approach that he said the defendants were taking to the problem (of which he was critical). Mr. McKeown is a member of the Institute of Acoustics and a member of the Acoustical Society of America and he has a master's degree in applied acoustics. He is also a chartered engineer and a fellow of the Institute of Engineers of Ireland. At the time he was giving evidence in this trial he was working in Galway University doing research funded by the Environmental Protection Agency looking at noise from offshore wind farms and studying the effects on the soundscape of offshore wind farms and coastal sites. He explained that in the early years of the wind farm industry in the 1990s amplitude modulation was not seen as an issue because the turbines were smaller at that point in time. He explained that it was critical for the industry to have and maintain public support to ensure the ability of the industry to roll out and install wind energy.

134. In the context of the substance of the plaintiffs' complaints, he said his data supported their concerns. Mr. McKeown's evidence during the early part of Day 14 indicated that his measurements demonstrated considerable substantial low frequency noise with a prominent tonal quality and significant low frequency noise in the 165 Hertz region. His evidence also confirmed that his recordings indicated that 75% of the time they were recording significant levels of amplitude modulation. He said on Day 14 at page 61 line 19 that the:-

> *"outstanding feature from my perspective is the amplitude modulation and I felt that the amplitude modulation was such that that was the important issue. The total penalties, we had detected some, we had detected some at high levels. I had, you know, listened to tones when I was down there under attended measurements. But in terms of Wexford County Council, for the want of a better term, pursuing the wind farm for non-compliance, tonal noise on the basis of our measurements, wouldn't have presented a strong case, whereas amplitude modulation did. But I just qualify that by referring to what I said previously, that we were measuring externally and in those circumstances masking noise is likely to be higher -- if the tonal level is here, the masking level is likely to be here, whereas if you filter it as in you're inside a structure or building, it is likely to be lower and the tones more prominent"*

135. Mr. McKeown also gave evidence by referring to his field notes which showed amplitude modulation, plus humming, and he confirmed tonal noise with amplitude modulation and overall, he confirmed the plaintiffs' description of tonal noise, low frequency noise and amplitude modulation.

136. Mr. McKeown confirmed that even with the three relevant turbines turned off there might still be some noise from the 4th turbine T4 but he offered the view that the level of noise from this turbine would not in his opinion constitute a nuisance. There is no application in these proceedings (and nor would there be a basis for same) to restrict the operation of this fourth turbine, or indeed the two other turbines further to the east.

137. In Mr. McKeown's report he called this 4th turbine T5 (he had a different numbering system for the turbines). Mr. McKeown also confirmed the plaintiffs' account about low frequency noise. He explained that with low frequency noise, which he had measured outdoors, that if you step indoors what happens is a lot of the masking noise is reduced so low frequency tones become more prominent and amplitude modulation becomes much more prominent.

(iii) Mr. Meyer

138. Mr. Mr. Meyer is a mechanical engineer and an automotive engineer who had spent 35 years working in the renewable energy industry mainly with wind turbines in Germany. He worked as a partner in a company that manufactured wind turbines for seven years and headed various project development companies as managing director. He also worked in research on the reduction of wind turbine noise by sound decoupling, variable rotor speed operation and airfoil optimization. He was involved in that research beginning in the early 1990s. In addition, he worked for a German manufacturer before becoming a manufacturer himself and was involved in developing wind turbines in Germany. His experience has involved him in the development of approximately one hundred and fifty wind farm projects across the world including eight in Ireland. Mr. Meyer's evidence both corroborated and explained the science behind what the plaintiffs described on the one hand, and also outlined the variety of potential causes of and solutions to the problems identified, on the other. In this part of the judgment, I summarise those portions of his evidence that tended to corroborate and explain what the plaintiffs had described. Later, this judgment will return to his evidence on the potential to mitigate the noise from wind turbines without having to turn them off as this becomes relevant to the issue around what kind of injunction to grant.

139. Firstly, it is useful to quickly set out some of the factual context for his evidence. The plaintiffs' house is largely due west of the wind farm. As the prevailing wind is from the west, the plaintiffs' house is quite often upwind of the wind farm. Nonetheless for reasons that were explained by the expert evidence on both sides, unusually the plaintiffs in this case were experiencing considerable noise intrusion even when upwind of the turbines. In that regard the EIS and the approach to the planning assessment was based simply on a downwind analysis and the only condition placed on the operation in terms of noise was a simple decibel level. As explained above, the experts in this case agreed that unlike many other cases the amplitude modulation here was being experienced in both upwind and downwind conditions.

140. As Mr. Meyer explained, the software controlling the turbines takes readings from a wind gauge and adjusts the position of the turbines and the blades automatically through motors so that they face into the wind. This is to maximize energy production. In other words when the wind is coming from the west and the plaintiffs' house is accordingly upwind of the turbine, the turbines and the blades turn to face towards the plaintiffs' home.

141. Mr. Meyer explained how the local topography may be contributing to this unusual effect where amplitude modulation is heard in these upwind conditions. He described how he had visited the plaintiffs' site in March 2022. He explained that the three turbines in question T6 was 1127 meters from the plaintiffs' home, T3 was 1050 meters and T5 was 1288 meters. He explained that on visiting the site he was struck by the fact that the turbines were visible

and the sound emitted by the turbines hits the plaintiffs' house without a natural barrier. He said that when he first saw the turbines, he was about two kilometers away in his car. He stopped and got out of his car and that even from this position the operating noise of the wind turbines was clearly audible. He then said that arriving at the house the operating noise was louder than on the approach even though the wind flow was from the southwest and the rotors were not facing the house on the day of his visit. He said he could hear the low frequency noise and the low frequency noise that was audible was in his opinion generated from the gearbox and showed a strong tonality.

142. The wind coming from the west travels on the down slope as it passes the plaintiffs' house, but then as it enters the valley this lower wind or air is pushed upwards by the steep facing slope of Gibbet Hill. This air then passes through a forest on this facing slope of Gibbet Hill which adds to the turbulent nature of this air, which then, as it arrives at the three facing turbines, mixes with the air travelling at the height of the turbines thus creating a potentially turbulent set of air conditions which in turn can affect each of the three wind turbines facing the plaintiffs homes slightly differently and causing additional noise problems.

143. Mr. Meyer explained that when he was at the plaintiffs' home, he described how turbine T6 stopped but he said that the noise from turbine T3 was still clearly audible. He explained that when the house is upwind from the turbines the wind has to climb the hill which leads to an acceleration of the wind flow in the layers close to the ground and that in addition the wind has to flow over a forest which causes turbulence. He explained in his evidence on Day 15 at 12:08 that the mixture of the two results in a very unsteady air flow to the wind turbine rotors and thus creates high aerodynamic and mechanical loads. He said that in such a situation the rotor blades cause more noise due to oblique flow and turbulence and the gearboxes, which in his opinion generated a strong single tone, radiate this tone via the rotor to which they are mechanically connected. He explained that this can create a modulating effect for the low frequency noise, which is in addition to the modulating effect of the noise from the blades themselves.

144. As to the impact of the amplitude modulation being a change of loudness of the same tone, he described this as being:-

> *"the problem that makes people crazy, because if you listen to a tone which always has the same sound and the same volume, you ignore it after a while. Now, if that changes constantly, you go mad. And like if the sound is transferred from gearbox into the blades and there is - say the wind is changing, there is more or less load on the turbine, then you have a change in the - not in the frequency, but in the power, yeah, that - in the power with which the sound is emitted. And the rotor is an ideal vehicle to propagate it"*; see Day 15, pages 102-103.

(iv) Mr. Corr

145. Next, and somewhat unusually perhaps, the substantial nature of the plaintiffs' experience was reflected in the manner in which one of the defendants' experts altered his view as to the level of the impact of the noise nuisance on the capital value of their home. Mr. Corr, a valuer, was called by the defendants to offer an expert opinion on the question of the impact of the nuisance on the capital value of the plaintiffs' home.

146. Leaving aside for the moment the question as to what weight to attach to his evidence in that regard (it will be considered later), Mr. Corr's evidence was nonetheless stark and instructive in relation, at least in one respect, to how extreme this wind turbine noise nuisance is.

147. Mr. Corr gave evidence on Day 18. He explained in his evidence that he had initially formed the view in his expert report that the wind turbine noise would have an impact of only 1% on the capital value of the plaintiffs' home. He felt the total impact of the wind farm on the capital value of the plaintiffs' home was 4%, comprising 2% for the visual impact (about which complaint is not made) and then 1% for the shadow flicker and a further 1% only in respect of the noise.

148. Mr. Corr explained how he had initially been sent a huge amount of documents by the solicitors for the defendants who were instructing him to prepare his report. On Day 18 page 94 he very candidly conceded: "*to be honest with you I didn't actually read them because I thought there was a possibility that the case might settle and that effectively I'd have read potentially hundreds of pages that in a settlement scenario might not be relevant.*"

149. He then explained that prior to giving his evidence he had been sent the plaintiffs witness statements and the transcripts from Days 2, 3 and 4 when the plaintiffs gave evidence, together with some transcripts from Mr. Stigwood, the plaintiffs primary acoustics expert. He then candidly explained that having read *this* material his view had completely changed. Having reviewed this material, he felt that the case was an outlier and that his estimate of the potential impact of the noise nuisance on the value of the plaintiffs' home had increased massively, potentially up to seventeen times, so that now he was of the opinion that the impact of the noise from wind farm on the capital value of the plaintiffs' home was up to 20%, with 17% (17 times more than his original assessment) being due to the effect of the noise.

150. In real terms this meant that his pretrial view (which was, on his own admission, made without really reading the papers) was that the impact of the noise on the value of the plaintiffs' home should be worth about €8,440.00 (this was based in part on studies that he felt showed that over time the impact of a nearby wind farm on the capital value of a property *decreases*) and now, having read their witness statements and transcripts of their evidence and that of their expert, it had jumped to €143,480.00 (or €151,920.00 including the 1% damage for the shadow flicker).

151. He agreed in cross-examination that the plaintiffs' house is dramatically affected by wind turbine noise intrusion and he reiterated that essentially the position was so bad in his revised opinion to make it an outlier. It is to be noted that this was the reaction of an independent person briefed to offer an opinion on behalf of the defendants.

(v) Mr. Carr

152. Mr. Shane Carr of Irwin Carr was retained as the defendants' acoustics expert in 2017 and he gave evidence on Day 17. However, he had worked with ABO prior to that on other sites. Prior to the commencement of the trial, he had prepared six reports between 2018 and 2025, although he only ever first engaged in any substantial analysis of the noise at the plaintiffs' home during August and September 2024. During the trial the defendants were giving liberty to deliver an additional report of Mr. Carr dated 7 March 2025. This report was also prepared prior to the admission of liability.

153. In addition to those seven reports, Mr. Carr prepared a joint statement (the "Acousticians' Joint Statement") with Mr. Stigwood in late February 2025, shortly before the commencement of the trial. This joint statement was prepared following the Case Management Conference of the 12 February 2025 when the Court had directed the parties to arrange for a joint report from the acousticians.

154. In his first five reports prepared 2018 and 2019 there was no substantive engagement with the plaintiffs' complaints. Rather Mr. Carr's approach was largely focused on the planning permission issues and the Enforcement Notices that had been served by the Council. In his sixth report of 16 January 2025, Mr. Carr continued to focus on the question of compliance with the planning permission and, in addition, he made technical criticisms of the approach of the plaintiffs' experts. In his seventh report of 7 March 2025, he explained that any mitigation of the noise, short of turning off the turbines, would involve a significant period of trial and error, possibly a year or more. However, none of his suggestions were put to the plaintiffs' experts and no submission on behalf of the defendants was made relying on any of the suggestions mooted by Mr. Carr, other than turning off the machines.

155. Following the admission of liability for nuisance and the consequential abandonment of the plaintiffs' application for a planning injunction, Mr. Carr's role in the case become more limited. Even though the defendants admitted liability in respect of the noise nuisance, including in relation to the low frequency tonal noise, Mr. Carr's January 2025 report did not identify low frequency noise as a problem. Mr. Carr offered no explanation for his failure to identify the substantial problems experienced by the plaintiffs consistently for many years. Nor did he explain why he failed to hear, record, or measure the noise nuisance being experienced at the plaintiffs' home that had been heard, recorded and verified by Mr. Stigwood and his colleague Ms. Large, by Mr. McKeown of RPS (after he was retained by the Council) and then by Mr. Meyer. If this failure troubled him, it was clear he had not dwelled on it.

156. In the Acousticians Joint Statement, Mr. Carr had stated that the IEC TS 61400 Standard (a standard published by the International Electrotechnical Commission in relation to wind turbines) stated that it was "impossible to accurately measure low frequency noise from wind farms". This statement was not agreed to by Mr. Stigwood. During cross-examination, Mr. Carr accepted that this was an incorrect description of the relevant standard. Mr. Carr went on to say that in his opinion based on the guidance, that the appropriate way to measure for low frequency noise indoors, was not to actually measure it indoors at the location, but rather it should be estimated using predicted levels of LFN based of the manufacturer's trials of the same type of turbines in Scotland and Denmark. Despite the fact that the wording of the Institute of Acousticians standard which he referred to applies to the necessarily predictive exercise required at a planning stage when a Noise Impact Assessment (NIA) is required (NIAs are required during the planning process in the UK, i.e. *before* the facility is built), Mr. Carr explained that he had spoken to one of his colleagues who sat on a body along with the chairperson of the energy body in the Institute of Acousticians, and he understood that this person shared his view as to what he thought the standard meant. In this case the uncontradicted expert evidence was that low frequency tonal noise problems can be caused due to problems in the gearbox (a view that is consistent with the communications to the defendants from Nordex in 2019 referred to below in Section VI). Consequently, the opinion of Mr. Carr that complaints of low frequency noise from these particular turbines in Wexford should be assessed by relying on predicted low frequency noise levels based on tests by the manufacturer carried out in wind farms in Denmark and Scotland was unconvincing irrespective of his interpretation of the standard.

157. While Mr. Carr did not assist the court with an understanding of the extent or causes or potential methods of ameliorating the admitted low frequency noise, he did indicate, in his evidence and through the Acousticians Joint Statement delivered just before the trial began, that he agreed with Mr. Stigwood that amplitude modulation was occurring in this case under

a range of wind directions "commonly both upwind and downwind" and that "this case is unlike any others where it is normally limited most of the time to downwind conditions. This is relevant to the frequency and duration of impact."

158. Finally, during his evidence on Day 17, Mr. Carr was asked by the Court (page 100, line 13) "what order would the Court have to make to stop the daytime nuisance that the defendant says it is committing?" and Mr. Carr replied "In the evidence that you've [been] given, as this is agreed, it would be switching them off" (Day 17, page 100, line 16).

V. INTERACTION BETWEEN THE PLAINTIFFS AND THE DEFNDANTS AND WEXFORD COUNTY COUNCIL

159. Both plaintiffs gave evidence of their efforts to interact with the defendants in the hope that their complaints would be taken seriously and that the defendants would carry out some proper substantive analysis of the problem and engage with them in an effort to mitigate or ameliorate the noise intrusion. Those efforts were unsuccessful.

160. Ms. Moorhead described how after a particularly bad night of noise at the beginning in June 2013, where she found it impossible to sleep, she had sent an email to ABO asking them to take some action to mitigate the noise. She received a response from a Mr. Egan stating that the defendants' staff had not identified any untypical noise. Mr. Egan's email of the 19 June 2013 also indicated that ABO would be organising an independent noise monitoring program.

161. Ms. Moorhead described how she had written a number of initial letters to the defendants in 2013. However, the defendants did not indicate they would engage in any substantive testing of the wind turbines but rather their initial replies were in general based on an approach that assumed their legal obligations to nearby residents were limited to complying with the conditions of the planning permission. As a result, the plaintiffs then got in touch with Wexford County Council.

162. On 5 July 2013 Wexford County Council informed the plaintiffs that they had opened an enforcement file in respect of the Gibbet Hill wind farm and they asked the plaintiffs to keep a noise diary. The Council's engineer, Mr. Cooney, carried out some external noise monitoring at the plaintiffs' home but for reasons that are not clear that data was subsequently lost. Meanwhile a firm called Hayes McKenzie was retained by the defendants. Their instructions appear to have been largely limited to assessing whether or not the defendants were operating the wind farm in accordance with the planning permission. In view of the admission of liability, the proposed witness from Hayes McKenzie was not called

by the defendants. In any event the Hayes McKenzie monitoring did not include attending at the plaintiffs' property and it appears to have been solely limited to addressing the position from the point of view of the planning permission.

163. On 13 February 2014 Wexford County Council wrote to Mr Spicer of ABO and in this letter they indicated that:

> *"On the recommendation of our Senior Executive Scientist, it is recommended that an investigation should be carried out to ascertain the source of noise and if breach in limits are due to the Wind Farm, that you submit remediation measures to bring the Wind Farm into compliance. The investigation should include a further noise survey, both during and post investigation, to indicate subsequent compliance."*

This was accompanied by a formal warning letter from the County Council to ABO.

164. Subsequent to this on 3 November 2014 Mr Cooney sent an email to Mr Egan in the following terms:

> *"Hi Emmet,*
>
> *Regarding the Gibbet Hill wind farm, we have been carrying out a noise survey to premises to the south of the wind farm from 11 August to 24 October 2014 [it was not disputed that this was in fact the plaintiffs' premises].*
>
> *In order to progress our investigation and ascertain the veracity of the complaint that it is the wind farm which the origin of the noise, can you forward the following SCADA details, so that I can cross-reference it to the noise data collected.*
>
> *Wind speed,*
>
> *Wind direction*
>
> *For the wind turbine marked with a yellow square below,*
>
> *Kind regards,*
>
> *Brendan Cooney." (sic)*

165. Mr. Spicer was involved in this and passed the request on to, amongst others, a René Werner of Union Investment and a Martin Gromus, also of Union Investment, the advisers for the Luxembourg Fund that owns Wexwind. On 7 November 2014 Mr. Spicer wrote:-

> *"Hi Rene,*
>
> *Please see below request from the council.*

Can you please advise if you would like this data released to them or not.

Regards

Robert"

Later that same day Mr Werner replied as follows:

"Hi Robert

Martin and I decided to not provide any information.

Kind regards

Rene"

This was relayed by Mr Egan to Mr Cooney on 10 November 2014:

"Hi Brendan

We have to ask the owners of the wind farm for permission where requests for data to be released are made; unfortunately they did not agree to it on this occasion.

Regards emmet" (sic)

166. These documents were made available on discovery and despite the specific pleas that the defendants had failed to engage properly with the plaintiffs, the defendants chose not to call any evidence to address this nor did they seek to explain this refusal. During the re-examination of Mr Spicer, an attempt was made to suggest to Mr. Spicer that in fact this request had been responded to positively and he agreed. However, this answer was incorrect and Mr. Spicer was actually referring to an earlier email exchange. There was no evidence that the defendants changed their approach. In addition, it was clear from Mr Spicer's evidence that he was unfamiliar with the documents.

167. There had been various delays in the Council carrying out noise surveys including in one instance where data was lost and secondly when a procurement process had to be carried out. Eventually in 2016 the plaintiffs were told by Wexford County Council that a consultancy firm RPS had been appointed to undertake an assessment. Mr. Eugene McKeown of RPS was the relevant expert and he gave evidence in this case as a witness called by the plaintiffs.

168. Mr. McKeown gave evidence on Day 14 of the trial; his evidence in so far as it corroborated the accounts of the plaintiffs is largely described above. However, he also gave relevant evidence in relation to the issue of the nature of the interaction with the defendants which is relevant to the claims for aggravated and exemplary damages (and will be discussed

further in Section XI(4). Mr. McKeown pointed out that the defendant had not provided him with all the SCADA data; Day 14 page 97. Mr. McKeown's evidence on Day 14 page 100 made it clear that the defendants' level of cooperation was not satisfactory. He explained that short term switch offs which was all that the defendants ever offered was not practical. According to his evidence, in terms of his experience he explained (on Day 14 page 101) that the defendant "had been dragged kicking and screaming to facilitate anything". This was to be contrasted with other wind farms where "things were sorted out with a phone call an e-mail or a cup of coffee". Nothing of substance was put to Mr. McKeown to challenge this and no evidence of any substance was called by the defendants to contradict this.

169. By the time of the trial Mr. McKeown was no longer working for RPS. He explained that his earlier report carried out for RPS was designed to establish whether there was compliance with the planning conditions. On the 26 June 2017 RPS issued a report which concluded that the noise levels at the plaintiffs' house were such as to render the Gibbet Hill wind farm non-compliant with the grant planning permission. This ultimately led on 29 November 2017 to the first Enforcement Notice issuing from the Council regarding non-compliance with the noise limits and requesting the defendants to submit proposals within four weeks to reduce the noise impact.

170. When the formal initiating letter of 6 March 2018 was sent to Wexwind indicating a claim in nuisance, the defendants failed to take this seriously or engage in any substantive way. Indeed without having undertaken any substantive tests in relation to the plaintiffs' claim of nuisance, the defendants' solicitors issued a blanket denial that the wind farm's operations were causing a nuisance. No evidence was adduced by the defendants to justify sending this letter. The only explanation that Mr. Spicer could give for this approach was that the defendants had been focused on the planning issue. On Day 16 page 137 in reply to a question from the Court, Mr. Spicer stated, "*I would agree that ABO and the defendants were very much focused on the planning side of things and did not focus as much on the nuisance aspect*".

171. Mr. McKeown gave evidence of a meeting with representatives of the Council and ABO and he referred to the minutes of the meeting; Trial Book 8A, page 253. ABO were represented at this meeting by Mr. Shane Carr and he took a technical approach by arguing that the matter should only be examined by looking at data in a downwind direction only. This meeting took place on the 22 May 2018 at ABO's offices. Mr. Carr did not want to look at the wider picture but made a technical argument based on the ETSU standard that only downwind measurements should be looked at. At this stage ABO did not, according to the

evidence, have any substantive data of its own in relation to the noise impact from the wind farm on the plaintiffs' home.

172. Mr. McKeown explained that he had followed the correct guidelines when carrying out his assessment of the noise nuisance. He was not challenged about this in cross-examination. Mr. McKeown's detailed analysis as to why Mr. Carr's approach was incorrect both substantively and from a technical point of view was set out in detail in the letter he wrote to Mr. Cooney (the Council engineer) dated the 24 May 2018. The substance of this was not seriously disputed on behalf of the defendants.

173. Ultimately after a significant period of time, during which various technical reports were exchanged, the Council withdrew the first Enforcement Notice and issued a second Enforcement Notice. In addition the Council requested the defendant to investigate the incidence of shadow flicker. That request was made on 25 January 2019. On 28 August 2020 the Council decided that it was no longer proceeding with the Enforcement Notice.

174. Overall, the evidence of Mr. McKeown, together with the correspondence of the defendants and their own internal emails demonstrates that the defendants were not willing to properly cooperate with the Council in its investigation. In addition the evidence demonstrated that the defendants were not interested in carrying out any substantive analysis of the merits of the plaintiffs' complaints. The evidence in this regard indicated a continuing pattern of the defendants to not engage in any substantive way with the complaints being made but to rely on technical and, based on the evidence of Mr. McKeown, frequently incorrect technical arguments that served only to avoid substantive engagement. These findings are relevant to my decision in relation to the plaintiffs' application for aggravated damages.

175. While this was occurring, the defendants had decided to contact Nordex, the manufacturers of the turbines. Those contacts are best understood in the context of a consideration of the expert evidence that related to the actual potential to mitigate the noise nuisance by taking steps that would ameliorate the problem while continuing to facilitate the turbines operating.

VI. THE POTENTIAL TO MITIGATE NOISE NUISANCE FROM WIND FARMS

176. It was notable that in advance of the trial the defendant had not proposed to call any evidence either from a factual witness or an expert as to how the noise from the wind farm might be mitigated or ameliorated.

177. While the defendant was given liberty to and did adduce additional evidence, they were still not in a position to make any proposal to mitigate the noise nuisance other than turning off the machines and the defendants' only expert on this issue, Mr. Carr, accepted that based on the evidence, turning off the machines was the only way to abate the noise nuisance (see above in Section IV).

178. It is important however to note that the expert evidence before the court indicated that there is usually an abundance of solutions short of turning off the wind turbines that can be tested and adopted in cases like this. These solutions typically require a substantial willingness on the part of the wind farm operator to engage wholeheartedly with genuine concerns, to investigate them properly and to then devote some time to testing potential solutions and indeed spending some resources potentially on making adjustments or upgrades to the equipment.

179. In keeping with the overall lack of engagement by the defendants with the issues in the case, the defendants did not retain or adduce any evidence from an engineer, either an engineer employed by the defendants or by Nordex who maintain the machines, or alternatively an independent engineer. The plaintiffs on the other hand called evidence from Mr. Dietrich Meyer. As described earlier in this judgment (in Section IV), he gave evidence corroborating the account of the plaintiffs. He also gave evidence indicating the likely causes of the problems and outlining potential solutions.

180. Mr. Meyer explained how the topography of the site near Gibbet Hill was likely to be contributing to the noise nuisance problem at the plaintiffs' house. He had an illustration in his report which he discussed on Day 15 which demonstrated how the prevailing wind from the west passes over the plaintiffs' house and then briefly down into a valley before rising up the facing slope of Gibbet Hill and passing through and over a forest. This air then impacts with air travelling at the height of the turbines creating a turbulent air flow and he explained that these "flow irregularities" can disturb the flow of air around the rotors thus contributing to the noise being emitted from the wind turbines.

181. He explained that the noise from turbines can come from the rotor blades, the generator, the gearbox, the hydraulic pump, or the yaw brake or the cooling fans; although the latter three sources he said were not relevant in this case. Here, he felt the most likely source of the noise was the blades, the generator and the gearbox. He said the gearbox was most probably the cause of the low frequency noise; see Day 15 from pages 16 onwards to page 21, and in particular page 21 answer 40. He also explained that the topography was likely contributing to the problem; see Day 15, page 25-27.

182. He explained that studies around the world had emphasised the effect of low frequency noise and amplitude modulation. He explained that amplitude modulation, because it contains periodic loudness fluctuations, is a "carrier of information" to the human ear and that therefore the human ear is especially sensitive to this noise characteristic. He said that the science now recognised that low frequency noise had negative effects on human beings. He also indicated that as well as the wind direction and the turbulence factor, that the technical condition of the components of the turbines and the maintenance condition could also be relevant factors.

183. He then gave evidence about the potential for the operator to reduce these problems. He explained that wind turbines have different operational modes and these are used to optimize the performance of the turbine but can also be used to reduce the sound emission. He said in general the rotational speed of the rotor must be reduced as noise emission from the blade tips is amongst the most powerful sources of noise. He explained that the rotator speed can be reduced by either pitching the blades or by increasing the torque. In this latter scenario, by increasing the torque in the generator this will reduce rotator speed but will not reduce power or energy generation.

184. His report however explained that the downside of this operational mode is that the load on the generator and gearbox increases which can result in heat and vibration which is audible by increased humming and a strong single tone. He explained that the manufacturing quality and material quality of the gearbox and the generator would be relevant in this context.

185. As described earlier, Mr. Meyer had described that when he visited the plaintiffs' home, he was struck by the fact that the turbines were visible and the sound emitted by the turbines hits the plaintiffs' house without a natural barrier.

186. He gave evidence as to the turbine manufacturer figures from Nordex (the manufacturer of these turbines) and he said from his impression the tonality at the site was out of range of the manufacturer's figures; see Day 15 at p41-42.

187. He then said "*in my opinion either the gearboxes used in these turbines are of a high tolerance class which means that mechanical tolerances of the gear wheels are at the upper limit, resulting in higher sound emission of the gearbox or the gear boxes are worn out or damaged*"; see Day 15, page 42. This evidence was not challenged by the defendants. As discussed above, see Section IV(f)(v), this evidence (which preceded the evidence of the

defendants' acoustics expert Mr. Carr) undermines the rationality of Mr. Carr's evidence when he stated that the correct way to assess the low frequency noise at the site was not to measure the low frequency noise at the site but rather to use data from the manufacturer's facilities in Scotland and Denmark.

188. Mr. Meyer explained that a number of things can be done to ameliorate these problems. First of all, a full check of the condition of the rotor blades should be carried out to check whether they are damaged, polluted, dirty or requiring some repair. He said, secondly it was important to make sure the blade angles are correctly adjusted so that they will work with the same angle to the wind and then he said changes can be made to the operational speed or to change the load conditions of the system. In general, he said that every manufacturer has their own way to do it depending on the problem but that there were ways to do it and it needs some time to implement these solutions.

189. He explained on Day 15, page 100 that the speed can be reduced by reducing the uplift of the blades, although this will lead to less power being generated and he explained that this could be done with the Nordex machines from the control room and he then explained that the second method was to increase the torque in the generator.

190. Mr. Meyer explained that the proper operation of the gearbox could be assessed by the carrying out of an endoscopy which enables you to look into the gearbox and to look at the gear wheel.

191. Mr. Meyer explained that with a low tolerance gearbox there is very little 'play' (loose movement) between the gear wheel teeth and this reduces noise but is more expensive. The defendant did not engage with this evidence and did not call any engineering evidence to indicate with any precision or detail as to precisely what checks had been carried out and what the outcome of those checks were, or what the tolerance levels were for these machines.

192. While the defendants and their acoustics expert Mr. Carr did not engage with these possibilities during the trial, they were not unknown to the defendants. The documents which the plaintiffs obtained on discovery and introduced in evidence, demonstrated that at the time when the defendants were at risk of prosecution after the service of the Enforcement Notices, they were actually advised by Nordex of a range of possibilities to solve the problems.

193. On 4 March 2019 Mr. Timm Greinig of Union Investment (the corporate advisers to the Luxembourg Fund that owns Wexwind) sent an email to Mr Spicer in relation to the Enforcement Notice asking as follows:

> *"Hi Robert*
>
> *Does it make sense to check out technical options for the worst case scenario? I don't know if Nordex offers trailing edge serration retrofits for N90 turbines, but I guess there are at least some alternative operating modes available*
>
> *Regards,*
>
> *Timm"*

On the 11 March 2019 Mr Spicer sent an email in Nordex as follows:

> *"Can you provide details of noise optimisation modes available for the turbines in Gibbet Hill.*
>
> *Can you also advise on possible retrofits to reduce the noise/increase the power output such as trailing edge's serrations?"*

On the 11th March 2019 a representative of Nordex sent an email to Mr Spicer in relation to this issue as follows:

> *"Hi Robert*
>
> *I should be able to pick up on this for you. I have attached a document outlining the noise power modes available from the N90/2500 Gamma turbines. This should provide some details on what is available.*
>
> *In terms of retrofits there are no official upgrades which we can offer however we have had success with softer elastomer bearings for tonal noise. If the noise issues seem to be in that area we can provide more details.*
>
> *Have there been noise studies carried out you may be willing to share? If we have access to results we may be able to assist with a mitigation plan" (underlined for emphasis).*

Mr Spicer then sent an email to Mr Greinig on 19 March 2019 in relation to this issue as follows:

> *"Hi Timm,*
>
> *As just discussed, see attached latest info from Nordex on various operation modes.*
>
> *Nordex confirmed that there are no official upgrades (including trailing edge serrations) available however Nordex have had some success with softer elastomer bearings for tonal noise.*
>
> *Below are the conclusions from the RPS report for tonal noise"*

There was then an email from Nordex to Mr Spicer on 19 March 2019 at 13:05 on the subject of noise operating modes which states as follows:

> *"Hi Robert,*
>
> *Unfortunately the specification document I have is in German however it is attached for review in case that helps.*
>
> *Essentially the retrofit exchanges softer elastomer bearing rubber components which assists in deadening the gearbox vibration noise. We have had some success on another site with this retrofit so it may be an option you would like to consider.*
>
> *One thing to note is that as they are softer components Nordex cannot give a guaranteed operational life of new elastomer bearings. Any replacement required during the turbine life will be at ABO cost. We will need to include visual check at each Type 3 service." (underlined for emphasis).*

194. Notably therefore, the evidence demonstrated that there was an indication in these communications from Nordex during 2019, who are the manufacturers of the turbines, of:-

- a willingness to engage in relation to developing a potential "*mitigation plan*";
- a clear awareness of the potential issue of "*tonal noise*" (which was not something that was related to the planning permission or its conditions);
- an indication that the machines had different "*noise power modes available*" already on the machines;
- an indication of retrofits involving softer elastomer bearings with which Nordex had already "*had success with*" but which would have some costs if replacements were required; and
- a request for "*noise studies carried out*".

195. Despite this engagement from Nordex, the defendants decided not to pursue *any* of these options. Nor did they give any explanation for why they did nothing in this regard. Essentially in terms of the evidence nothing happened thereafter.

196. However these interactions and in particular the evidence of Mr Meyer, indicates that there were a range of potential solutions to address the concerns such as those being raised by the plaintiffs. Mr Meyer, in an updated report, indicated that a range of potential mitigation measures were available which would in general require to be evaluated over periods of between six and twelve weeks and then could take potentially up to fifteen months to test.

197. Some of the proposed measures involved dealing with the gearbox, the generator and the rotor blades and could involve potentially making upgrades and adjustments to the machines and some involved potential adjustments to the software operating the machines.

198. The defendants did not indicate any willingness to carry out such a process and the only curtailment option offered by them was the shutting down of the machines during nighttime and in the mornings at weekends, but otherwise operating the machines as they are currently operating and paying damages for this ongoing future nuisance.

199. The significance of this will be discussed further below, in the context of the issue of whether to grant a full injunction or to accede to the defendants' request to allow them to continue with the nuisance and to pay damages for the future impact of the interference caused to the plaintiffs.

VII. THE ISSUES

200. Accordingly, the issues that arise in this case are as follows:

(1) How much damages should be awarded for the effect of the nuisance from May 2013 to date? Related to this issue, is question as to the *basis* by which the damages should be assessed.

(2) Allied to the damages issue, is the claim by the plaintiffs that the defendants' operation of the wind farm amounts to an infringement of their constitutional rights, separate from the claim in nuisance.

(3) Should the court grant an injunction to fully restrain the operation of the three relevant turbines or alternatively should the court allow the turbines to operate during the daytime (7am to 10pm) and from 11:00am to 10:00pm on weekends and public holidays, and thereafter award damages to the plaintiffs for the future ongoing nuisance? In this context, the issue arises as to what weight should be given to the public interest in energy generated from wind.

(4) Should the court award aggravated damages for the manner in which the defendants engaged with the plaintiffs' complaints and the claim?

(5) Should the court award punitive/exemplary damages on the basis of the plaintiffs' claim that the defendants deliberately declined to engage with their complaints while continuing to generate substantial revenues from the wind farm?

VIII. THE PLAINTIFFS SUBMISSIONS

201. I propose to outline a summary of the main submissions on behalf of the plaintiffs on these five issues.

(1) The assessment of damages for nuisance to date

201. In relation to the assessment of damages, the plaintiffs submit that they should each be awarded general damages for the period of the nuisance from May 2013 to date. It was submitted that the amount of damages must be meaningful and should reflect the almost totally continuous nature of the ongoing nuisance and the substantial effect it had on the plaintiffs enjoyment of the property, in particular by reference to the nature of the intrusion, the sense of being intruded upon, the lack of sleep, the stress and the anxiety.

202. It was submitted that this was a claim relating to the plaintiffs' property rights. Reference was made to the interference with the ability of the plaintiffs to work in their home and to enjoy their home and to enjoy their garden.

203. The essential principle was submitted to be that of *restitutio in integrum*.

204. The plaintiffs referred to *Patterson v Murphy* [1978] ILRM 85, *Hanrahan v Merck Sharpe & Dohme* [1988] ILRM 629 and to *Webster and Rollo v. Meenacloghspar (Wind) Ltd* [2024] IEHC 136 (*Webster (No.1)*). In *Patterson,* Costello J. states at p99 in the context of a noise nuisance case that general damages are payable to each of the plaintiffs separately for annoyance, discomfort, inconvenience and mental distress. This is also referred to be Egan J. in *Webster (No.1)* at para.s 643 and 644 who refers to the fact that general damages were payable to each plaintiff separately for the nuisance in *Patterson.*

205. Counsel for the plaintiff submitted that the law of nuisance was grounded in the protection of property and that accordingly it would not be appropriate to take account of or to make any comparison with the guidelines issued in relation to personal injuries cases.

206. It was submitted that the injury in this case was injury to the quiet and peaceful enjoyment of the plaintiffs' property. In addition the nuisance, even if fully injuncted now, had, according to one of the plaintiffs' experts, caused a permanent "stigma" damage to the capital value of the plaintiffs' property that should be compensated for.

(2) The constitutional claims pursuant to Articles 40.3 and 40.5

207. It was submitted that the plaintiffs' property rights under Articles 40.3 and 40.5 of the Constitution had been violated.

208. Reference was made to the interference with the use of the plaintiffs' home and garden. In summary it was submitted that the operation of the wind farm constituted a violation of the dwelling of the plaintiffs so as to engage Article 40.5 of the Constitution which provides: "*the dwelling of every citizen is inviolable and shall not be forcibly entered save in accordance with law.*"

(3) Whether to grant a full injunction or a partial injunction & damages

209. It was submitted that the defendants had not engaged in a way that would entitle them to avail of damages *in lieu* of an injunction. They had not behaved in a neighbourly way. They had not given any advance notice that they would make this argument. It was submitted that the injury to the plaintiffs' rights was not small and could not be adequately compensated by a small money payment. Furthermore, the fact that the defendants might be able or willing to pay for the future nuisance was not an appropriate ground to substitute damages. Overall, it was submitted that this was not an appropriate case for an order allowing the nuisance to continue.

210. It was submitted that the plaintiffs are *prima facie* entitled to an injunction and while there was a broad discretion there were no significant factors that would disentitle the plaintiffs to an injunction to fully restrain the nuisance.

211. Without prejudice to those arguments, it was submitted that if the nuisance was to be allowed to continue in part and damages awarded, then these damages should take into account the profits that the defendant makes by continuing the nuisance, as this was an indicator of what the defendants might consider reasonable to pay to acquire the plaintiffs' property right. At a minimum, the damages in this scenario should take account of the reduction in capital value of the plaintiffs home.

212. In addition, it was submitted that if the nuisance in part was to be allowed continue then the plaintiffs would have to give serious consideration to moving from their home. In that scenario, the plaintiffs should be awarded a sufficient sum to enable them to buy an equivalent site and rebuild a home to the equivalent standard of their current home; in other words, reinstatement value.

213. Attention was drawn to some of the English cases and the judgments therein, in particular Lord Mance who in *Lawrence v Fen Tigers Ltd* [2014] 2 AER 622 expresses the view that the right to enjoy ones home without disturbance *"is one which I would believe that many, indeed most, people value for reasons largely if not entirely independent of money"*; see page 664, para. 68.

214. In addition attention was drawn to the authorities (for example *AIB v Diamond* [2012] 3 IR 549, Clarke J. at p590) that point out that even if a value can be put on the loss of a property right that in general a defendant should not be entitled to pay damages to be allowed infringe a person's property rights.

(4) Aggravated damages

215. It was submitted that the defendants approach to the complaints of the plaintiffs and their lack of substantive engagement and their failure to make any efforts to ameliorate the nuisance had caused additional hurt and distress to the plaintiffs and therefore merited an award of aggravated damages.

(5) Punitive / Exemplary damages

216. It was submitted that the pleaded case in relation to punitive / exemplary damages had not been answered substantially by the defendants. The evidence adduced was not contradicted and this evidence indicated that substantial revenues were being generated from the wind farm and the defendants had made a number of identifiable decisions to simply ignore, or not engage in any substantial way, with the plaintiffs' complaints. This merited, it was submitted, punitive/exemplary damages.

IX. THE DEFENDANTS' SUBMISSIONS

217. I propose to outline a summary of the main submissions on behalf of the defendants on these five issues.

(1) The assessment of damages for nuisance to date

218. The defendants submit that, based principally on the English caselaw (see *Hunter v Canary Wharf* [1997] AC 655 and *Dobson v Thames Water* [2009] 3 AER 319), the damages for the nuisance to date should be measured by estimating the notional impact on the capital value of the plaintiffs' property. According to the defendants' expert this was in a range of 13% up to 18% (being 17% for the noise and 1% for the shadow flicker) of the agreed value of €844,000.00.

219. The defendants' figure for the damages for the nuisance to date is, using this approach, therefore up to €151,920. On the other hand, using this approach, the plaintiffs' valuer estimated that the reduction in the capital value was €394,000 (the plaintiffs' expert estimated that the house was only worth €450,000 due to the nuisance). According to this approach, separate awards are not to be assessed for each plaintiff and nor is the amount of the damage to be based on the duration of the nuisance (save to the extent that same might influence the estimated drop in capital value) nor the amount of people living in the house; see *Hunter* and *Dobson*.

220. It was submitted that any comparison with the damages regime for personal injuries would not be appropriate; reference was made to *Hunter v Canary Wharf*.

221. That said, the defendants submitted that damages are a flexible remedy and should be flexible enough to ensure justice in each case and that accordingly, the court was not "hide bound by any particular rule". The defendants referred to *Munnelly v Calcon* [1978] IR 387 where Kenny J. states at p405*: "The dominant rule of law in assessing damages is the principle of restitutio in integrum and subsidiary rules can be justified only if they give effect to that dominant rule."*

(2) The constitutional claims pursuant to Articles 40.3 and 40.5

222. It was submitted that there was no basis for considering any claims under the Constitution as the tort of nuisance adequately protected the relevant rights and interests of the plaintiffs; reference was made to *Hanrahan* and *Clarke v O'Gorman* [2014] 3 IR 340, where it is well established that a plaintiff may only rely on constitutional torts where the ordinary law of tort is insufficient to protect the rights asserted.

(3) Whether to grant a full injunction or a partial injunction & damages

223. The defendants accepted that the threshold for granting an injunction had been passed and that the only issue in this regard was the extent of the injunction.

224. They submitted that the court had an undoubted wide discretion as to whether to grant the full injunction or, whether instead, to grant a partial injunction combined with an award of damages for the future nuisance that the defendants admitted they would be committing.

225. They referred to the fact that the proposed shutdowns would address the most sensitive times of intrusion on the plaintiffs. Based on the defendants' proposal of nighttime shutdowns (10pm to 7am) and shutdowns during the morning at weekends and on public holidays (7am to 11am), the defendants' valuer estimated that the damage to the capital value of the plaintiffs' home would be approximately half his estimate for the damage to date, in other words up to €71,740 (it is to be assumed that the shadow flicker is sorted out, so the "half" is actually half of a range of 12-17%). This would be, it was submitted, the quantification of the damages for allowing the defendants to continue the nuisance outside of those hours. This was said to be based on a timeframe of eight years (i.e. up to 2033) when the planning permission will expire. The total award of damages then to the plaintiffs would, *according to the defendants*, be up to €223,660. This figure would be higher again if the court leaned more towards the values expressed by the plaintiffs' valuer.

226. The defendants submitted that the damages for future nuisance should not be assessed on the basis of the re-instatement cost of the plaintiffs' home as this measure of damage was reserved for cases where there is physical damage to the property.

227. The defendants accepted that they could not meet the *Shelfer* test (*Shelfer v City of London Electric Company* [1895] 1 Ch 287), not least because on their own analysis, the damages that should be awarded to the plaintiffs are substantial. Even on their figures, the damages for past and future nuisance (with a partial shutdown of the facility) are €223,660 and could not be described as 'small'. Rather, they submitted that this was no longer fatal and they relied on English authorities for this argument, such as *Lawrence v Fen Tigers* [2014] 2 AER 622, which view the *Shelfer* test as just one, rather than the only, pathway towards avoiding an injunction and being allowed pay damages instead.

228. They said that the public interest was relevant to the remedy and they referred extensively to Ireland's legal and international commitments to climate action and developing renewable energy and to the decision in *Coolglass v An Bord Pleanala* [2025] IEHC 1 and to *Webster (No. 1)* at para 42 and to the existence of the planning permission for the wind farm.

229. They referred to the discretion to award damages instead of an injunction as stemming from Lord Cairns Act (section 2 of the Chancery Amendment Act, 1858) and they said this was still law in Ireland. The defendants contended that Lord Cairns Act along with the common law principles of nuisance, should be interpreted and applied where possible in a manner consistent with Ireland's EU and ECHR climate obligations. Overall though, it was accepted that the public interest was not a 'trump card' in this case but was a factor to be weighed in the exercise of the court's discretion.

230. They also submitted that to order a full shutdown would be excessively oppressive to the defendants and would cause Wexwind to become insolvent. In their submission, their own proposal of partial shutdowns would bring the wind farm close to the edge of viability and would, it was submitted, require re-financing.

(4) Aggravated damages

231. The defendants referred to the fact that liability had been admitted on Day 11 and an apology had been made on Day 19 and they submitted that *"latterly, at the very least, the Defendants have behaved appropriately before the Court."*

(5) Punitive / exemplary damages

232. The defendants submitted that these types of damages would not be appropriate and are only for exceptional cases such as where the defendants behaviour is, as in *Crofter Properties v Genport (No.2)* [2005] 4 IR 28, *"...quite beyond the bounds of normal civilised behaviour and quite outside accepted commercial relationships to gain benefit for the plaintiff. Such an award should not be excessive but should be sufficient to punish the behaviour on behalf of the plaintiff to intentionally publish defamatory matter of the defendant".*

X. RELEVANT LEGAL PRINCIPLES

233. The relevant legal principles will now be discussed in the context of each of the aforementioned issues.

(1) The assessment of damages for nuisance to date

234. Firstly the legal test for the tort of nuisance has recently been comprehensively considered by the High Court in the judgment of Ms. Justice Egan of 8 March 2024 in *Webster (No.1)*; see paragraphs 28 et seq. Both sides adopted the analysis of Egan J. as to the approach to

be taken to assessing a noise nuisance from a wind farm. As indicated by Egan J. in *Webster (No.1)* the relevant legal principles are described by the Supreme Court in *Hanrahan* where Henchy J. identified the legal basis of the tort of nuisance as follows:

> *"To provide a basis for the award of damages for the private nuisance relied on, the plaintiffs have to show that they been interfered with, over a substantial period of time, in the use and enjoyment of their farm, as result of the way the defendants conduct their operations in the factory..."*

Later in *Hanrahan* Henchy J. states:-

> *"The case for damages in nuisance... is made out if the interference is so pronounced and prolonged or repeated that a person of normal or average sensibilities should not be expected to put up with it.... It is enough if it can be said that a reasonable person in the plaintiff's circumstances should not be expected to tolerate the smell without requiring the defendants to make financial amends".*

235. As Egan J. states in *Webster (No.1)* *"to succeed in a claim for nuisance the plaintiff must show interference with the ordinary use, enjoyment and comfort of their property ... nuisance is always assessed by reference to the character of the particular locality"*, see para.s 30 and 346 of *Webster (No.1).*

236. As indicated above in Sections VIII and IX there was some divergence between the parties as to the approach to be taken to measuring and assessing the damages for the nuisance to date. While the defendants urged that the matter should be approached on the basis of a notional decrease in the capital value of the plaintiffs' property, they nonetheless conceded that damages is a sufficiently flexible remedy to ensure that justice is done in the case and the court is not hidebound by any particular rule or dictum.

237. In *Webster (No.1)* at paragraph 640, Egan J. refers to the approach adopted in England as set out in the case of *Hunter v. Canary Wharf* [1997] AC 655 where Lord Hoffman indicated that the correct approach was to consider the injury to the amenity of the land and not to the persons thereon. Consequently, as was found in *Hunter,* the damages are not therefore increased by there being more than one occupier. At para. 643 Egan J states as follows:

> *"It appears this not been the approach taken in this jurisdiction. In Patterson v. Murphy [1978] ILRM 85 blasting on the defendant's land caused physical harm to the plaintiff's residence. The plaintiffs were awarded damages for the repair of the property, <u>but it was also held that general damages were payable to each of the plaintiff separately for annoyance, discomfort, inconvenience and mental distress.</u>" (underlined for emphasis).*

238. In *Patterson* Costello J at page 99 states that "*general damages are payable to each of the plaintiffs separately for annoyance, discomfort, inconvenience and mental stress*". *Patterson* included a claim for damages for nuisance as a result of, amongst other things, the noise being generated by the blasting operations taking place at the defendant's quarry.

239. At page 99 Costello J states as follows in relation to general damages:

> *"General damages are payable to each of the plaintiffs separately for annoyance, discomfort, inconvenience and mental distress. In measuring the sums payable I have taken into account not just the conditions at Shillelagh Lodge from the summer of last year until 12 December [Note: a period of approximately six months, from early summer to 12 December of 1977] but also the fact that the plaintiffs had to move to rented accommodation with all the inconvenience thereby resulting. Whilst it may be that Mrs Paterson suffered more acutely than Mr Patterson from the nuisance it must be borne in mind that Mr Patterson had an additional strain associated with his professional career as he was most particularly affected by the lack of proper facilities for his practice in the rented accommodation. I conclude that a sum of £500 should be paid to each under this general heading and that both defendants are jointly liable for these payments."*

240. In *Hanrahan v. Merck Sharp & Dohme (Ireland) Ltd* [1988] ILRM 629 the Supreme Court had to consider a case involving a claim for damages for, inter alia, discomfort caused by smells from the defendant's nearby factory. The Supreme Court treated the claim as one in nuisance. The evidence in the High Court was that the plaintiffs complained of intense and frequent objectionable smells from the defendant's factory and that these were so frequent, pronounced and prolonged that each of the plaintiffs had made out a case for damages in nuisance for offensive smells from the factory. At page 640 Henchy J. states as follows:

> *"As I have pointed out earlier in this judgment, by reference to the cited passage from the judgment of Gannon J. in Halpin v. Tara Mines, where the conduct relied on as constituting a nuisance is said to be an interference with the plaintiffs comfort in the enjoyment of his property, the test is whether the interference is beyond what an objectively reasonable person should have to put up with in the circumstances of the case. The plaintiff is not entitled to insist that his personal nicety of taste or fastidiousness of requirements should be treated as inviolable. The case for damages in nuisance - we are not concerned here with the question of an injunction - is made out if the interference is so pronounced and prolonged or repeated that a person of normal or average sensibilities should not be expected to put up with it. It is not necessary that an interference by objectionable smell should be so odious or damaging that it affects the plaintiffs' health. It is enough if it can be said that a*

reasonable person in the plaintiffs' circumstances should not be expected to tolerate the smell without requiring the defendants, to make financial amends. I consider that the plaintiffs have made out such a case.

I would hold that each of the three plaintiffs has made out a case for damages for nuisance caused by offensive smells from the defendants" factory." (underlined for emphasis)

241. The matter was then remitted to the High Court for the assessment of those damages. Nonetheless, the precise basis upon which those general damages for nuisance caused by offensive smells might be assessed does not appear to have been argued or considered in *Hanrahan.* Accordingly, it is worth turning to some of the underlying principles by which general damages should be assessed.

242. There are well accepted general principles in relation to any assessment of general damages. For example in *MN v SM* [2005] 4 IR 461 at para 38 Denham J. states *"the three elements, fairness to the plaintiff, fairness to the defendant and proportionality to the general scheme of damages awarded by a court, fall to be balanced, weighed and determined".*

243. These principles underlie the Court's jurisdiction when it comes to general damages. These principles require awards of damages to be fair and reasonable to both claimant and defendant. The award must be proportionate to the level and nature of the injury or damage sustained and must also be proportionate when viewed in the context of awards of damages commonly made in cases involving injuries of a greater or lesser magnitude, *per* Denham J. in *MN v. SM* and Clarke C.J. in *Morrissey v. HSE* [2024] 1 IR 103.

244. In addition, further helpful general principles are set out in the case of *Munnelly v Calcon Ltd* [1978] IR 387 where Henchy J. considers the principle of *restitutio in integrum* which underpins the law of damages in cases such as this. *Munnelly* was a case dealing with a claim for damages for negligence. Part of the plaintiff's house collapsed as a result of the alleged negligence of the defendants who were building a house next door. At p. 399 Henchy J. states:

> *"In my view the particular measure of damages allowed should be objectively chosen by the court as being that which is best calculated, in all the circumstances of the particular case, to put the plaintiff fairly and reasonably in the position in which he was before the damage occurred, so far as a pecuniary award can do so".*

245. *Munnelly* was dealing with the particular issue of a claim for reinstatement costs. The judgment of Henchy J. contains helpful *dicta* in relation to some of the underpinning principles to a court's assessment of damages. Henchy J. cites from May J.'s judgment in *C.R. Taylor Ltd v. Hepworths Ltd* [1977] 1 WLR 659 at page 667 where May J. states:

> *"The various decided cases on each side of the line to which my attention has been drawn, and to some of which I have referred in this judgment, show in my opinion merely the application in them of two basic principles of law to the facts of those various cases. These two basic principles are, first, that whenever damages are to be awarded against a tortfeasor or against a man who has broken a contract, then those damages shall be such as will, so far as money can, put the plaintiff in the same position as he would have been had the tort or breach of contract not occurred. But secondly, the damages to be awarded are to be reasonable, reasonable that is as between the plaintiff on the one hand and the defendant on the other."*

246. Henchy J. then states at p.400:-

> *"I accept those two principles as being basic to, although not necessarily exhaustive of, the concept of restitutio in integrum, on which the law of damages rests in cases such as this. It is in the application of those principles that difficulty may arise, for a court, in endeavouring to award a sum which will be both compensatory and reasonable, will be called on to give consideration, with emphasis varying from case to case, to matters such as the nature of the property, the plaintiff's relation to it, the nature of the wrongful act causing the damage, the conduct of the parties subsequent to the wrongful act, and the pecuniary, economic or other relevant implications or consequences of reinstatement damages as compared with diminished-value damages. The reported cases, therefore, require to be viewed primarily as exemplifications of the application to special facts of the two principles to which I have referred.*

247. In *Munnelly*, Kenny J. states at p.405:

> *"The dominant rule of law in assessing damages is the principle of restitutio in integrum and subsidiary rules can be justified only if they give effect to that dominant rule."*

248. As indicated above in Section IX, the submissions made on behalf of the defendants were that the court should follow the approach set out in the English cases and in particular in *Hunter* and in *Dobson v. Thames Water Utilities Ltd and another* [2009] EWCA civ. 28.

249. The Court of Appeal in *Dobson* indicated that the issue of damages in the context of a nuisance was normally to be assessed by means of the damage to the value of the property.

250. In *Hunter,* Lord Hoffman states on page 706:-

> *"[I]nconvenience annoyance or even illness suffered by persons on land as a result of smells or dust are not damage consequential upon the injury to the land. It is rather the other way about: the injury to the amenity of the land consists in the fact that the persons upon it are liable to suffer inconvenience, annoyance or illness.*
>
> *It follows that damage for nuisance recoverable by the possessor or occupier may be affected by the size, commodiousness and value of his property but cannot be increased merely because more people are in occupation and therefore suffer greater collective discomfort. If more than one person has an interest in the property, the damages will have to be divided among them."*

251. In *Dobson*, Waller LJ, commenting on the case of *Bone v Seale*, which dealt with nuisance caused by smells from a pigsty, stated at page 331:

> *"it seems to me that the value of the right to occupy a house which smells of pigs must be less than the value of the occupation of an equivalent house which does not. In the case of a transitory nuisance, the capital value of the property will seldom be reduced. But the owner or occupier is entitled to compensation for the diminution in the amenity value of the property during the period for which the nuisance persisted. To some extent this involves placing a value on intangibles. But estate agents do this all the time. The law of the damage is sufficiently flexible to be able to do justice in such a case."*

252. Commenting on the judgments of the House of Lords in *Hunter v. Canary Wharf* Waller LJ at p333 in *Dobson* states as follows at para. 31:

> *"31. The speeches of the majority thus clearly establish that damages in nuisance are for injury to the property and not to the sensibilities of the occupiers. That is so, as much for the case of the transitory nuisance interfering with the comfort and enjoyment of the land as it is for the case of the nuisance which occasions permanent injury to the land and to its capital value, or other pecuniary loss."*

253. In the context of how to assess damages Waller L.J. refers again to *Hunter* at para. 32 and states:

"Lord Hoffmann contemplated estate agents valuing the difference between the right to occupy a house without the nuisance and the right to occupy one with it that is to say valuing in the loss of (notional) rental value."

254. Then at para. 35, Waller L.J. in *Dobson* states:

"It follows that the actual impact upon the occupiers of the land, although not formally the measure of common law damages for loss of amenity, will in practice be relevant to the assessment of such damages in many cases, including such as the present where a family home is in question and no physical injury to the property loss, of capital value, loss of rent or other pecuniary damage, arises."

255. In the Australian case of *Uren v. Bald Hills Wind Farm* [2022] VSC 145, Ms. Justice Richards, then in the High Court, in the context of a noise nuisance claim from wind turbines awarded both the plaintiffs damages for past loss of amenity by means of general damages in particular amounts of AUD$12,000.00 each, per year of the nuisance.

256. Richards J. then considers the legal principles relating to the assessment of damages for the future nuisance and indicates that, had she decided to award damages for future nuisance, that she would have approached the matter by assessing the decline in value of the plaintiff's property, see para 373 of *Uren*.

257. On the assessment of damages *Binchy* Law of Torts 4th Edition at para. 24.73 state as follows: –

"The Irish courts have addressed this issue after Hunter. In RDS v. Yeats, Shanley J. having referred to the Hunter restrictions, observed that in Hanrahan "a different and more flexible approach appears to have been taken on the issue of who has the right to sue". In the instant case, the plaintiff was not just the occupier of the lands but also their owner and was entitled to their exclusive possession. Since on any view it had the right to sue for private nuisance, Shanley J. found it unnecessary to consider the difference of approach that appeared to have emerged between the Supreme Court and the House of Lords."

258. While this commentary refers to a divergence with the approach in England as to who could sue, in so far as the underpinning principles referred to in the English cases may have had a limiting effect on who could sue, I am also satisfied that the approach identified in *Hunter* and *Dobson* places too much emphasis on the capital value of the property in the context of assessing damages for what may be a transitory nuisance such as from noise or smells.

259. Overall, I am satisfied that the dicta referred to in the Irish cases sets out the appropriate guiding principles for assessing the damages in this case. *Hanrahan, Patterson* and *Webster (No.1)* confirm that general damages can be awarded to each of the plaintiffs in this case for the effect of the nuisance to date. The implications of this analysis will be discussed further in Section XI below.

(2) The constitutional claims pursuant to Articles 40.3 and 40.5

260. In *Sullivan v. Boylan (No.2)* [2013] IHEC 104 Hogan J considers the plaintiffs claim pursuant to Article 40.5 of the Constitution rather than the tort of nuisance and he relied on both Article 40.3 and Article 40.5. The court granted relief for the plaintiff against a defendant who was effectively watching and besetting the plaintiff's home in circumstances where the court felt that the tort of nuisance might not be adequate to address the situation. In relation to Article 40.5 the court held that the rights of the residents of a dwelling to security and protection against all comers and privacy were all necessary features of the inviolability of the dwelling and were rights enjoyed by all who resided in the dwelling and not simply by those who had legal title to the property. This case indicates the ability of the court to rely on the Constitution if there is some deficiency, or limitation, to the existing torts that might otherwise normally apply.

261. In general however, the law is clear, that there is no need to invoke a constitutional right where an existing common law remedy applies. In *Hanrahan* Henchy J. at page 635-636 states as follows:

> *"The plaintiffs have also invoked the Constitution in support of their argument as to the onus of proof. They contend that the tort relied on by them in support of their claims is but a reflection of the duty imposed on the State by Art. 40.3 of the Constitution in regard to their personal rights and property rights. The relevant constitutional provisions are:*
>
> > *"The state guarantees in its laws to respect, and, as far as practicable, by its laws to defend and vindicate the personal rights of the citizen" (Art. 40.3.1).*
> >
> > *"The State shall, in particular, by its laws protect as best it may from unjust attack and in the case of injustice done, vindicate the life, person, good name, and property rights of every citizen" (Art. 40.3.2).*
>
> *I agree that the tort of nuisance relied on in this case may be said to be an implementation of the State's duties under those provisions as to the personal rights and property rights of the plaintiffs as citizens. The particular duty pointed to by the*

plaintiffs is the duty to vindicate the personal right to bodily integrity and the property right to their land and livestock. They say that the vindication of those rights under the constitutional guarantee is not properly effective by leaving them to their rights as plaintiffs in an action for nuisance and that the vindication they are guaranteed requires that once they show that they have been damnified in their person or property as alleged, it should be for the defendants to show that emissions from their factory were not the cause. So far as I am aware, the constitutional provisions relied on have never been used in the courts to shape the form of any existing tort or to change the normal onus of proof."

262. Henchy J. says that it must be shown that the tort of nuisance is *"plainly inadequate to effectuate the constitutional guarantee in question"* and he continues on page 636 *"... but when he founds his action on an existing tort he is normally confined to the limitations of that tort. It might be different if it could be shown that the tort in question is basically ineffective to protect his constitutional right".*

263. In *Hanrahan*, the court was dealing with was an argument that the onus of proof should be reversed and the Supreme Court upheld the High Court's rejection of that argument.

264. The question is dealt with further in the case of *Clarke v. O'Gorman* [2014] 3 I.R. 340. The Supreme Court held that it is only where it could be shown that the existing law did not adequately protect the constitutional rights of the plaintiff that a separate claim for breach of constitutional rights could be invoked. O'Donnell J. (as he then was) at page 359 addresses this question in further detail where he states at paragraph 34:

"The intersection between claims for damages for breach constitutional rights and claims in tort was discussed in Hanrahan v. Merck Sharp & Dohme. The effect of that decision is that the existing torts and other causes of action known to common law are to be considered the method by which the State performs its obligation to vindicate the constitutional rights of the citizen. <u>It is only therefore if it can be shown that the existing law does not adequately protect the constitutional rights of the citizen that a separate claim for breach of constitutional rights can be invoked</u>." (underlined for emphasis).

265. In addition, the plaintiff in this case invited the court to rely on Article 40.5 of the Constitution which provides:

"The dwelling of every citizen is inviolable and shall not be forcibly entered save in accordance with law".

266. Article 40.5 of the Constitution has some overlap with Article 8.1 of the European Convention on Human Rights which provides as follows:

> *"Article 8.1 Everyone has the right to respect for his private and family life, his home and his correspondence."*

267. The ECtHR considered Article 8 in the context of the climate crisis in the case of *Verein Klimaseniorinnen Schweiz and Others v. Switzerland, Application Number 53600/20,* ECtHR, Grand Chamber judgment of the Court, Ms. Justice Síofra O'Leary President, 9 April 2024. The case involved applicants who were older women in Switzerland and who had been exposed, by virtue of climate change, to the increasing occurrence and intensity of heat waves in their homes. The ECtHR considered the degree to which environmental nuisances could come within the scope of Article 8 of the ECHR. At para. 514 the European Court of Human Rights state as follows:

> *"514. According to the existing case-law, in order to fall within the scope of Article 8 of the Convention, complaints relating to environmental nuisances have to show, first, that there was an "actual interference" with the applicant's enjoyment of his or her private or family life or home, and, secondly that a certain level of severity was attained. In other words, they have to show that the alleged environmental nuisance was serious enough to affect adversely, to a sufficient extent, the applicants' enjoyment of their right to respect for their private and family life and their home."*

268. The resonances between this analysis of the interaction between Article 8 of the ECHR in relation to environmental nuisances (in that case excessive heat waves) and the common law development of the law of nuisance are readily apparent.

269. The judgment of the Court (O'Leary P.), went on to conclude that the applicant's Article 8 rights had been violated by Switzerland's failure, amongst other things, to quantify adequately through carbon budgets national Greenhouse Gas emissions limitations.

270. The question raised therefore from the foregoing principles are the degree to which the plaintiffs here have rights engaged pursuant to Article 40.3 and Article 40.5 and whether the existing tort of nuisance can be said to *"not adequately protect the constitutional rights of the citizen"* such *"that a separate claim for breach of constitutional rights can be invoked".*

(3) The issue of whether to grant a full injunction or a partial injunction & damages

271. The parties referred extensively to the UK Supreme Court decision in *Lawrence v. Fen Tigers Ltd* [2014] 2 AER 622 and *Fearn v. Tate Gallery* [2023] 2 AER 1, where Leggatt J. helpfully discusses *Lawrence*.

272. *Lawrence* concerned a claim for damages and an injunction in the context of a noise nuisance from a motor racing stadium and motocross circuit.

273. The lead judgment was delivered by the President of the Court, Lord Neuberger. This judgment points out how the grant of planning permission for a particular use can be relevant to a nuisance claim in potentially two ways. Firstly the planning permission can permit the very noise complained of and secondly it facilitates the defendant making an argument that the character of the locality has been altered as a result of the permission. At para. 100 on page 649 Lord Neuberger addresses the question of awarding damages instead of an injunction in considerable detail. At paragraph 101 Lord Neuberger refers to Lord Cairns Act and discusses the question as to what principles govern the exercise of the court's jurisdiction to award damages instead of an injunction. The 19th century decision of *Shelfer* mentioned above is referred to in considerable detail. At paragraph 105 he refers to the decision of Lord McNaughton in *Colls v. Home and Colonial Store Ltd* [1904] AC 179 who at page 193 refers to the question of whether "the defendant has acted fairly and not in an unneighbourly spirit". The judgment discusses how during the 20th century there had been considerable discussion as to the *Shelfer* approach and he concludes at para. 123 on p. 655 as follows:

> *"Where does that leave A L Smith LJ's four tests? While the application of any such series of tests cannot be mechanical, I would adopt a modified version of the view expressed by Romer LJ in Fishenden v. Higgs and Hill Ltd [1935] AER 435 at 448. First, the application of the four tests must not be such as to be fetter on the exercise of the court's discretion. Secondly, it would, in the absence of additional relevant circumstances pointing the other way, normally be right to refuse an injunction if those four tests were satisfied. Thirdly, the fact that those tests are not all satisfied does not mean that an injunction should be granted."*

274. This judgment also addresses whether or not the court should take account of the public interest and he concludes that it is difficult to envisage any circumstances in which the public interest arises that it could not as a matter of law be a relevant factor. Neuberger P. also states at paragraph 124 as follows:

> *"The fact that the defendant's business may have to shutdown if the injunction is granted should, it seems to me, obviously be a relevant fact, and it is hard to see*

why relevance should not extend to the fact that a number of the defendant's employees would lose their livelihood, although in many cases that may well not be sufficient to justify the refusal of an injunction".

275. He also concludes that planning permission for the activity is relevant. At para. 125 he states:

> *"Accordingly, the existence of a planning permission which expressly or inherently authorises carrying on an activity in such way as to cause a nuisance by noise or the like, can be a factor in favour of refusing an injunction compensating the claimant in damages. This factor would have real force in cases where it was clear that the planning authority have been reasonably and fairly influenced by the public benefit of the activity where the activity cannot be carried out without causing the nuisance complained of. However even in such cases the court would have to weigh up all the competing factors."*

276. Lord Neuberger also agrees with Lord Mance (who in turn agrees with "Lord Neuberger's nuanced approach") and with the statement at paragraph 168 in particular, where Lord Mance states as follows:

> *"I would only add in relation to remedy that the right to enjoy one's home without disturbance is one which I would believe that many, indeed most, people value for reasons largely if not entirely independent of money".*

277. Lord Neuberger refers to proportionality in para. 126 in this context:

> *"In some such cases, the court may well be impressed by a defendant's argument that an injunction would involve a loss to the public or a waste of resources on account of what may be a single claimant, or that the financial implications of an injunction for the defendant would be disproportionate to the damage done to the claimant if she was left to her claim in damages. In many such cases, particularly where an injunction would in fact stop the defendant from pursuing the activities, an injunction may well not be the appropriate remedy."*

278. In relation the process of assessing damages in lieu of an injunction in the context of awarding damages for what will be a future nuisance, Lord Neuberger observed the following paragraph 128:

> *"A final point which it is right to mention on this issue is the measure of damages, where a judge decides to award damages instead of an injunction. It seems to me at least arguable that where a claimant has a prima facia right to an injunction to*

restrain a nuisance, and the court decides to award damages instead, those damages should not always be limited to the value of the consequent reduction in the value of the claimant's property. While double counting must be avoided, the damages might well, at least where it was appropriate, also include the loss of the claimant's ability to enforce her rights which may often be assessed by reference to the benefit to the defendant of not suffering an injunction."

279. This approach gets support from the reasoning of Bingham MR in *Jaggard v. Sawyer* [1995] 2 AER 189. The same approach was supported by Millett LJ in *Jaggard*:

> *"... there is no reason why compensatory damages for future trespassers and continuing breaches of covenant should not reflect the value of the rights which she has lost, or why such damages should not be measured by the amount which she could reasonably have expected to receive for their release."*

280. *Fearn* was a case involving nuisance whereby it was claimed that members of the public visiting the Tate could view directly into the apartments of the plaintiffs from a viewing gallery walkway that had been added to the Tate Gallery. In *Fearn* the UK Supreme Court emphasised that the law of private nuisance was concerned with maintaining a balance between the conflicting rights of neighbouring landowners and that therefore not every interference with the persons use and enjoyment of their land was actually nuisance. The Supreme Court also pointed out that it was not a defence that the activity carried on by the defendant was for a public benefit. In deciding whether one party's use had infringed the others rights, the public utility of the conflicting uses was not relevant. The public benefit of the use causing the nuisance was, however, relevant to remedy. The Court held that the public interest might sometimes justify awarding damages rather than granting an injunction to restrain the defendant's harmful activity but it could not justify denying the victim any remedy at all.

281. Lord Leggatt gives the key speech for the majority and in his judgment from para. 9 onwards he discusses the scope of private nuisance. He states at para. 11:

> *"It follows from the nature of the tort of private nuisance that the harm from which the law protects the claimant is diminution in the utility and amenity value of the claimant's land, and not personal discomfort to the persons who are occupying it".*

282. Lord Leggatt addresses the concept of reciprocity in the context of the law of nuisance on page 15 of his judgment stating at para. 34:

"The underlying justification for those 'well-settled' tests was spelt out by Lord Millett in Southwark when he explained ([1999] 4 AER 449 at 464) that:

> *"The governing principle is good neighbourliness and this involves reciprocity. A landowner must have the same consideration for his neighbours as he would expect his neighbour to show for him."*

283. In relation to the public interest, Lord Leggatt states at para. 114 on page 36 that the public interest is relevant to the remedy but not to liability, and he explains why this is so from para. 121 *et seq*. At para. 127 *et seq* Lord Leggatt discusses the question of damages in lieu of an injunction and he refers to Lord Cairns Act and the seminal decision in *Shelfer*.

284. At paragraph 129 he turns to discuss the decision mentioned of the UK Supreme Court in *Lawrence,* discussed above. He states as follows:

> *"All the members of the court agreed that, in the words of Lord Carnworth at para [239], 'the opportunity should be taken to signal a move away from the strict criteria derived from Shelfer'. Different opinions were expressed, however, about how far this move should go. Lord Sumption saw "much to be said for the view that damages are ordinarily an adequate remedy for nuisance and that an injunction should not usually be granted in case where it is likely that conflicting interests are engaged other than the parties' interests". This drew a protest from Lord Mance, who emphasised that "the right to enjoy ones' home without disturbance is one which I would believe that many, indeed most, people value for reasons largely if not entirely independent of money". The majority agreed with Lord Nueberger, for whom the court's power to award damages in lieu of an injunction 'involves a classic exercise of discretion, which should not as a matter of principle, be fettered'. Lord Neuberger recognised that nevertheless 'it is appropriate to give as much guidance as possible so as to ensure that, while the discretion is not fettered, its manner of exercise is as predictable as possible'."*

285. Lord Leggatt continues however in para. 129 as follows:

> *"I think it is fair to say that - perhaps because of the divergent opinion of the Justices - there is little in the way of such guidance to be gleaned from his judgment. Lord Neuberger ended his discussion of this issue by acknowledging that 'we are at risk of introducing a degree of uncertainty into the law' but said that 'insofar as there can be clearer or more precise principles, they would have to be worked out in the way familiar to the common law, namely on a case-by-case basis'."*

286. In deciding to remit the matter to the High Court, Lord Leggatt states as follows at para 132:

> *"In the circumstances, if the parties cannot reach agreement on a solution, a further hearing will be required to address the question of remedy which should take place before a judge of the Chancery Division. Without constraining the matters on which the court may choose to hear argument, they may need to include:-*
>
> *(i) whether there is a public interest in maintaining the gallery with a 360° view capable of overriding the claimants' prima facie remedy of an injunction;*
>
> *(ii) whether any remedial measures which the Tate may propose are sufficient to avoid an injunction or damages;*
>
> *(iii) the scope of any injunction; and*
>
> *(iv) questions of quantification of any award of damages."*

287. The above guidance from Leggatt J. is useful as an approach to consider to this issue in this case. As it happens there was sufficient evidence adduced in this case to enable an analysis of similar questions.

288. Lord Cairns Act and the role of the Courts of Chancery are discussed in *Kirwan* Injunctions Law in Practice 3rd Edition at para.1 -17 et seq. *Kirwan* traces the origin of the Courts of Chancery at para. 1-18 and he describes how originally, as the Lord Chancellor's courts, they developed into a distinct judicial system retaining, from the period prior to the Reformation, concepts imported from the Ecclesiastical Courts and from Canon Law such as "conscience"; see para 1-19.

289. *Kirwan* also refers to the seminal decision of the Earl of Selbourne L.C. in *Ewing* v *Orr Ewing* (1883) 9 Appeal Cases 34 who states at p40:

> *"The courts of Equity in England are, and always have been courts of conscience, operating in personam and not in rem; and in the exercise of this personal jurisdiction they have always been accustomed to compel the performance of contracts and trusts as to subjects which were not either locally or ratione domicilii within their jurisdiction".*

290. On one view, Lord Cairns Act and the Judicature Act are essentially administrative in nature, so that for example, the provision we are concerned with here, section 2 of Lord Cairns Act enabled the Courts of Chancery to award damages in addition to or in substitution for an injunction. Equally in section 28 (11) of the Supreme Court of Judicature Act Ireland 1877

it provided that where there was a conflict between the rules of equity and the common law, then equity was to prevail; see Jessel MR in *Walsh v. Lonsdale* (1882) 21 Ch.D 9 at 14 and paragraph 1-39 of *Kirwan*.

291. *Kirwan* then discusses the *Shelfer* principles in light of the UK Supreme Court decision in *Lawrence*, discussed above. *Kirwan* contends "it is arguable that the approach in the *Lawrence* case is less dramatic than might at first appear; the fact that the principles in *Shelfer* were already approached as being working rules and no more than that is evident from the comments of Millett LJ in *Jaggard v Sawyer*". This analysis appears correct and gets recent support from the judgment of Egan J. in *Webster (No. 2)* [2025] IEHC 300 at para 200:-

> *"[A]s noted by Lord Legatt in Fearn and others v. Board of Trustees of the Tate Gallery [2023] UKSC 4, ("Fearn"), there had been a move away from "the strict criteria derived from of Shelfer". Ultimately, departure from the Shelfer principles, on grounds of public interest or otherwise, is to be determined by the courts on a case by case basis."*

292. Reference was to the decision of *Bellew v. Irish Cement Limited* [1948] I.R. 61 where the Supreme Court took the view that the court should not take the public interest into account in dealing with the rights of private parties in the context of an application for an interlocutory injunction to restrain a nuisance from a cement quarry, that was producing most of the cement, it was claimed, needed for the State's then public housing programme. As to whether this still remains good law is questioned in *McMahon and Binchy* Law of Torts 4th Edition at p1694 and in *Kirwan* at paras 4-143 to 4-148. In any event it is to be observed that *Bellew* was a decision in relation to an application for an interlocutory injunction and is therefore not strictly applicable to the scenario here. In addition, Egan J. in *Webster (No.2)* states as follows on this topic at para 201:-

> *"However, I note that, in the same case, Black J. took a different view [Black J. delivered a robust dissent] and held that although public convenience cannot affect the right of a private individual to a remedy for nuisance, it can be considered in determining which remedies should be granted. Furthermore, in Patterson v. Murphy, Costello J. acknowledged (pp. 99-100) that the public interest was to be taken into consideration (albeit that he found that none arose in the case before him)."*

293. There were a number of matters in relation to this issue that were not in dispute as between the parties. In the context of the admitted nuisance here which is ongoing, it is agreed that *prima facia* the plaintiffs are entitled to an injunction. The defendants agreed that the

Court's discretion is wide. In *Halpin v. Tara Mines* [1976/7] ILRM 28 Gannon J. (in a judgment that was approved of by the Supreme Court in *Hanrahan*) at page 30 states as follows:

> *"As a general proposition I take it to be the law that an occupier of land, or of premises thereon, who embarks on operations or activities out of the ordinary must not cause or permit, inter alia, noises or vibrations to pass into his neighbour's property in such a way as materially to interfere with the ordinary comfort of the occupier of such property or in such a way as to cause physical damage to the property of his neighbour. Where such interference or such damage is shown to be a matter of some continuity, repetition, or persistence it founds an action for nuisance for which the appropriate remedy would be an order of the court restraining the harmful activities or operations whether accompanied or not by an award of damages by way of recompense".*

294. In *Patterson v. Murphy* Costello J. at page 99 addressed the question of an injunction and states as follows:

> *"The defendants have submitted that even if an infringement of the plaintiffs' rights has been established the court has the discretion to award damages in lieu of an injunction and that it should do so in this case. I agree that relief by way of an injunction is a discretionary remedy. There are, however, well established principles on which the court exercises this discretion. The relevant ones for the purposes of this case can be summarised as follows:*
>
> 1. *When an infringement of the plaintiffs' right and a threatened further infringement to a material extent has been established the plaintiff is prima facie entitled to an injunction. There may be circumstances however depriving the plaintiff of this prima facia right but generally speaking the plaintiff will only be deprived of an injunction in very exceptional circumstances.*
> 2. *If the injury to the plaintiffs' rights is small, and is one capable of being estimated in money, and is one which can be adequately compensated by a small money payment, and if the case is one in which it would be oppressive to the defendant to grant an injunction, then there are circumstances in which damages in lieu of an injunction may be granted.*
> 3. *The conduct of the plaintiff may be such as to disentitle him to an injunction. The conduct of the defendant may be such as to disentitle him from seeking the substitution of damages for an injunction.*
> 4. *The mere fact that the wrong-doer is able and willing to pay for the injury he has inflicted is not a ground for substituting damages.*

In the foregoing dicta, Costello J was largely adopting the approach outlined in the case of *Shelfer v. City of London Electric Companies* [1895] 1 CH 287.

295. In *Patterson*, at page 100 Costello J. then continues:

> *"In the present case there are no circumstances which can deprive the plaintiffs of the relief to which they are prima facie entitled. The infringement of their rights is a most serious one; the injury which they have suffered and will suffer if the nuisance is permitted to continue has been and will be a considerable one; damages would not adequately compensate them. I should add that whilst I am conscious of the financial consequences for the defendants of the granting of an injunction I do not think bearing in mind that the sale to the plaintiffs took place at a time when Mr. Murphy was aware of the possibility that quarrying operations in the adjoining field might take place, and bearing in mind that both defendants must have fully appreciated the great inconvenience to the plaintiffs which the quarrying operations would cause, that relief by way of an injunction could be termed oppressive."*

296. Both parties referred to Lord Cairns Act, namely the Chancery Amendment Act 1858 and section 2 thereof which appears to be still in force:

> *"Section 2. In all cases in which the Court of Chancery has jurisdiction to entertain an application for an injunction against a breach of any covenant, contract, or agreement, or against the commission or continuance of any wrongful act, or for the specific performance of any covenant, contract, or agreement, it shall be lawful to the same court, if it shall think fit, to award damages to the party injured, either in addition to or in substitution for such injunction or specific performance; such damages may be assessed in such manner as the court shall direct."*

297. Finally, further useful factors, such as the "behaviour and attitude" of both sides and whether notice of such an application for damages in lieu has been given by the defendant, are identified by Lord Neuberger at para 149 in *Lawrence*, where he states as follows:

> *"The final point is whether the judge should have awarded damages rather than an injunction ... The decision whether to award damages instead of an injunction can be dependent on a number of issues, including the behaviour and attitude of the parties. It is therefore a matter on which the trial judge is particularly well positioned to assess in a case such as this, where there was substantial oral evidence. Further, a defendant who wishes to argue that the court should damages rather than an injunction should make it clear that he wishes to do so well in advance of the hearing, not least because the claimant may wish to adduce documentary or oral evidence on that issue which she would not otherwise consider relevant."*

298. The foregoing principles will be considered further in the context of the decision on this issue set out below.

(4) Aggravated damages

299. There was no significant dispute as to the legal principles relating to awarding aggravated damages. These are set out in *Conway v INTO* [1991] 2 IR 305; see the judgment of Finlay C.J. at page 317 who describes them thus:-

> *"2. Aggravated damages, being compensatory damages increased by reason of*
>
> *(a) the manner in which the wrong was committed, involving such elements as oppressiveness, arrogance or outrage, or*
>
> *(b) the conduct of the wrongdoer after the commission of the wrong, such as a refusal to apologise or to ameliorate the harm done or the making of threats to repeat the wrong, or*
>
> *(c) conduct of the wrongdoer and/or his representatives in the defence of the claim of the wronged plaintiff, up to and including the trial of the action.*
>
> *Such a list of the circumstances which may aggravate compensatory damages until they can properly be classified as aggravated damages is not intended to be in any way finite or complete. Furthermore, the circumstances which may properly form an aggravating feature in the measurement of compensatory damages must, in many instances, be in part a recognition of the added hurt or insult to a plaintiff who has been wronged, and in part also a recognition of the cavalier or outrageous conduct of the defendant."*

300. The *Uren* case provides a good example of how a court dealt with the issue of aggravated damages in a noise nuisance claim involving a wind farm. At para. 387 the Ms. Justice Richards noted that "a reasonable neighbour would have tried to reduce the noise; Bald Hills has not". Richards J. noted there that the operator had disputed the complaints with the local authority and concluded that it would have been better directed to finding a solution to "the gearbox tonality issue". Richards J. concluded that the defendant had not dealt properly with the plaintiff's reasonable legitimate complaints and that this "*at least doubled the impact of the loss of amenity each of them suffered at their homes*".

(5) Punitive / exemplary damages

301. The plaintiff relied on the authorities of *McIntyre v Lewis* [1991] 1 IR 121 and *Conway v INTO* [1991] 2 IR 305. In *McIntyre v Lewis* McCarthy J states that it is inconsistent with the dynamism of the common law to delimit in any restrictive way the nature of the development

of awards of aggravated or exemplary damages. These authorities point out that exemplary damages must refer to the conduct of the defendant. In *Conway*, Griffin J. at page 323 refers to whether or not the actions are a "deliberate and conscious disregard of the constitutional rights of the plaintiff".

302. In *Conway* at page 321 Finlay C.J. indicates that any award should be considered in the context of the outcome of the case as a whole and states as follows:-

> *"Bearing in mind the reasons for the existence of a right to award exemplary damages and the purposes which in my opinion a court must be seeking to achieve in making an award of exemplary damages, as a general principle they should not be awarded if in the opinion of the court the amount necessarily payable by the wrongdoer in the form of compensatory damages constituted a sufficient public disapproval of and punishment for the particular form of his wrongdoing. The reference by the learned trial judge in his judgment in this case to the approximate total or aggregate sum by way of exemplary damages which the defendants might have to pay in the multiple actions which they were facing seems to me to constitute a clear recognition by him of this general proposition, bearing in mind that he was at the same time as assessing these exemplary damages, assessing in the individual case compensatory damages as well."*

XI. DECISION

The decision on each issue and the reasons for them, are now set out hereunder.

(1) The amount of damages for the effect of the nuisance to date

303. As indicated above, the defendants admitted liability for the nuisance as pleaded by the plaintiffs on Day 11 of the trial. Counsel for the defendants confirmed that there was no issue taken that any part of the plaintiffs' evidence exceeded the boundaries of the pleaded claim. The details and nature of the interference which the wind turbine noise caused to the plaintiffs use, comfort and enjoyment of their home is described in great detail earlier in this judgment in Section IV where there is a detailed summary of the experience of each plaintiff set out, followed by a summary of the independent descriptions and assessment of the level of the interference by the independent experts who gave evidence in the case.

304. Based on the decisions in *Patterson*, *Hanrahan* and *Webster (No.1)* referred to earlier in Section X (Relevant legal Principles), I am satisfied that it is appropriate to award each of the plaintiffs' general damages for the annoyance, discomfort, inconvenience and distress suffered as a result of the nuisance admitted by the defendants.

305. Those legal principles indicate that the amount to be awarded must be fair and reasonable to both sides; *MN v SN, Morrissey v HSE*. I am satisfied that the assessment must take account of the full duration of the nuisance and that the most straightforward manner in which to assess the damages in this case (where the nuisance and level of interference broadly continued in a similar manner from when it started) is to consider a sum appropriate to each plaintiff for each year of interference.

306. In that regard, in respect of each plaintiff the full account of their experience is set out above in Section IV. In particular, there are a number of particular features to the level of the interference which the nuisance caused. It interfered with their general ability to experience and enjoy their home as a place of refuge, rest and relaxation. There was no real escape from the noise for the reasons described earlier and explained by the experts. Secondly, the interference was particularly acute in terms of the sleep disturbance experienced by both plaintiffs. Next, they both experienced the loss of substantial enjoyment of their garden as a place to rest and relax and to carry out the ordinary tasks of maintaining and enjoying a sizeable garden in a rural location. The position for Ms. Moorhead was in general appreciably worse. She was in the home, in general, more than Mr. Byrne. Her depths of resilience and ability to cope were already stretched for the reasons described earlier in Section IV. Finally, both Mr. Byrne (usually in the evenings) and Ms. Moorhead worked in the home. Their ability to do this was also interfered with.

307. It is important to approach the assessment of damages through an objective lens. The experience and accounts of the interference by each plaintiff were supported by the independent experts. In terms of gauging where on the range of potential levels of interference these claims sit, Mr. Stigwood described the case as "extreme" and "one of the worst cases of wind turbine noise" he had come across. The international standards now recognise that amplitude modulation and low frequency noise have a deleterious effect on the wellbeing of people. The levels in this case often exceeded the levels considered tolerable. Mr. Corr, the defendants' valuer, described the case as an "outlier" and increased his original assessment of the value of the impact seventeen fold having considered the transcripts of the plaintiffs' evidence and that of Mr. Stigwood.

308. The tort of nuisance protects a property right and it permits of a remedy of general damages and permits of an award that is reasonable and fair to both sides. In this case, the common law remedy is protecting constitutional rights. Where there is substantial interference in the ordinary use and enjoyment of a person's home for a sustained period of time, I accept the plaintiffs' submission that such damages should be meaningful.

309. On the defendants' approach, the court would award a single sum for damages to date based on the evidence of the expert valuers as to the notional reduction in the capital value of the plaintiffs' home. The expert valuers agreed that, absent the wind farm, the capital value of the plaintiffs' property is €844,000.00. As referred to above in Section IV(f)(iv), the defendants' expert estimates that the damage done to the agreed capital value of the home by the wind farm is between 15-20%, although 2% of this is for the visual impact about which complaint is not made. That means his estimate of the notional capital damage is between 13-18% of the agreed sum of €844,000.00, in other words between €109,720 and €151,920 (this range has a midpoint of €130,820). It will be recalled from Section IV(f)(iv) above, that Mr. Corr felt this case was an "outlier" in terms of how bad it was and he had initially only assessed the noise impact on the capital value of the home at 1% of its value.

310. The plaintiffs' expert in this regard was Mr. Anthony O'Regan, an experienced estate agent. He agreed the sum of €844,000.00 with Mr. Corr, as the value of the plaintiffs' property without the wind farm. In his view, the effect of the wind farm was more significant and he estimated that the value of the home was only €450,000.00 due to the nuisance, in other words a drop of €394,000.00.

311. On the defendants approach, the court would assess the damages for the nuisance to date by weighing the competing evidence of these two valuers and, based on that exercise, assessing damages at either somewhere in the range of the defendants' expert (€130,820.00 being the midpoint of Mr. Corr's range) or €394,000.00 or somewhere in between (as a reference point for example, €262,410.00 being the midpoint of the two valuers).

312. The defendants' submissions in this regard were carefully made and, correctly anchored in weighty English authorities. However, I am not satisfied that this is the correct approach in this case. It places too much weight on the capital value of the person's home in the circumstances of a noise nuisance which will be restrained by the Court and where the house (which itself sustained no physical damage) has not been sold as a result of the nuisance. The defendants' approach could lead to drastically different awards of general damages in cases where neighbours might have experienced very similar interferences with the use and enjoyment of their homes. For example, the interference with sleep, rest or relaxation in a garden reading a book, will in general be similar irrespective of the value of a person's home. There is an underlying constitutional right involved here and the approach to assessing damages must take account of the principles of equality that underpins any consideration of compensation for breach of a constitutional right. As it happens the Court is assessing those damages pursuant to the principles that govern the tort of nuisance but that remedy is sufficiently flexible to ensure a just approach and damages for the same wrong should be coherent whether looked through the prism of the common law or the Constitution.

313. In addition, the defendants' suggested approach in a case of this sort does not readily reflect the duration of the experience of the plaintiffs. In that regard, the defendant's valuer indicated that based on his research and the research referred to in his report, it was his opinion that there was academic evidence to suggest that in some studies the impact on the capital value of a property near a wind farm *reduced* over time. In other words, the longer a nuisance went on, the less damages a plaintiff would get. It was not clear if these studies differentiated significantly between homes where the residents were experiencing a substantial interference in their ordinary use and enjoyment of their home on the one hand, and properties which were simply near a wind farm, on the other. In any event, his evidence as to the notional impact on the capital value of the plaintiffs' home was not particularly anchored in the duration of the nuisance and indeed his report suggested that the impact on the capital value of a home near a wind farm *decreased* proportionality to the duration of exposure to the wind farm; see para 9.2(f) of Mr. Corr's report where he states "any negative impacts [on the capital value] dissipate with passage of time after the construction phase of the wind farm" and at para 9.1.5 Mr. Corr referred to research which he said supports the view that "the price effect decays over time". In this type of case, I am not satisfied that an approach should be adopted that does not appropriately reflect the duration of the exposure endured by each plaintiff. Indeed, it would be a curious outcome if the plaintiffs could have been awarded a higher amount of general damages for nuisance to date had the case been considered as one involving an exposure to six years of nuisance for example, rather than twelve. The position of course might be different in a case where the plaintiffs have decided to move and sell their home due to the nuisance; in those circumstances the impact of the noise nuisance on the capital value of their home might well loom more significantly as the key factor in assessing the amount of damages according to the general principles. However, by virtue of the outcome of this case it is not necessary for the plaintiffs to sell their home to escape the nuisance. In those circumstances, for the avoidance of doubt, this is not a case where the plaintiffs should be awarded both general damages and damages for the notional drop in the capital value of their home. I am not satisfied that this would be appropriate. As a result of the full injunction there will be no ongoing nuisance. In those circumstances, it would not be reasonable or appropriate where general damages are to be awarded to also award the plaintiffs an additional sum for the notional drop in capital value estimated by the valuers.

314. Turning then to the assessment of an appropriate sum for general damages, it should first be observed that there is little guidance in either *Paterson* or *Hanrahan* as to *how* that should be done. A starting point therefore is the underlying principles. These are discussed above in Section X. Firstly, *Hanrahan, Patterson* and *Webster (No.1)* confirm that general damages can be awarded to *each* of the plaintiffs for the effect of the nuisance to date. The starting principles for assessing those general are those described above in *MN v SN* and then in

Munnelly. The sum should be fair to both sides, objectively reasonable and proportionate to the wrong done.

315. The principle of *restitutio in integrum* looms large in the cases referred to; see *Munnelly* discussed above in particular. While restoring, by means of pecuniary award, a plaintiff to the position he or she was in, prior to the nuisance, is less clear as a guide in a case involving discomfort caused by noise or smells (compared to a physically damaged building), the cases nonetheless helpfully establish the following general propositions:-

(i) the law of private nuisance protects a person's property right, namely the entitlement to the ordinary use, enjoyment and comfort of the person's property without substantial interference from their neighbour;

(ii) the assessment of whether the interference is substantial is considered from the perspective of an objectively reasonable person and the interference should be pronounced and prolonged or repeated;

(iii) a plaintiff who suffers such a nuisance so that it causes them upset, inconvenience or distress - even where these fall short of the level that would constitute a personal injury - due to for example noise or smells, is entitled to general damages;

(iv) the general purpose of those general damages is to compensate the plaintiff by restoring them fairly and reasonably to the position they were in prior to the nuisance;

(v) in the assessment of those general damages in such a case, the measure of the damages should be fair and reasonable to both sides and proportionate with the wrong sustained and with the general approach of the courts to awards in analogous cases;

(vi) the court should consider all the relevant factors in the particular case, including the nature of the plaintiff's property, the plaintiff's relation to it, the nature of the wrongful act causing the nuisance, the conduct of the parties subsequent to the wrongful act, and the pecuniary, economic or other relevant implications or consequences of the wrongful act complained of;

(vii) as the tort of private nuisance protects a property right, it may well be helpful to consider whether the nuisance complained of has caused a notional damage to the capital value or income generating value of the property. Whether this is appropriate will depend on all the circumstances of the case;

(viii) as the tort of private nuisance also protects a person's property rights under the Constitution, general damages should not be assessed in a manner that

would be discriminatory or produce unjust results in the context of persons who experience similar or equivalent levels of discomfort, inconvenience or distress as a result of a nuisance. Every person is entitled to the ordinary use, enjoyment and comfort of their home irrespective of the value of the property and general damages for nuisance should seek to reflect that entitlement equally. For example, a plaintiff whose enjoyment of his garden is disrupted by a noise nuisance from a nearby factory should not be treated substantially differently in the measurement of general damages to his neighbour who suffers the same nuisance, but who may happen to have a considerably more valuable garden.

316. Here the full effect of the interference is described above. It has been substantial for a period of twelve years from May 2013. While I am not minded, for the reasons set out earlier, to assess damages based on the notional impact on the capital value of the plaintiffs' property, the defendants' valuer has estimated that the effect of the nuisance as having a substantial effect, is in the order of €150,000. Using the defendants' approach, the amount would be €394,000.00 based on the plaintiffs' valuers opinion. The defendants accept therefore, that based on the principles as they see them (and they did not suggest those principles were in anyway irrational) that a sum in the range of the valuers' estimates would be "fair". In addition, the conduct of the defendants has been such as to allow the nuisance to continue for many years. This adds to the reasons for assessing the damages for each plaintiff based on an amount that reflects the duration of the nuisance and this is most straightforwardly done by an appropriate amount for each year of the interference. The nature of the interference has been described by the experts as "extreme", "one of the worst cases" and "an outlier". Both sides submitted that the court should not have regard to amounts awarded for personal injuries claims. Neither side wished to submit a figure for general damages and there are few enough precedents for this scenario and such precedents as exist are obviously very different. The amount of general damages awarded in *Patterson* for approximately six months noise nuisance in 1978 was IR£500 for each plaintiff (equivalent to €3,855 today according to the CSO inflation calculator, or €7,710 for a year – but a considerably higher sum if the inflation is tracked to property inflation). In Australia in *Uren,* decided in March 2022, each plaintiff was awarded the sum of AUD$12,000 (equivalent to €7,618 today) per year for noise nuisance from a nearby wind farm. Although that sum was then doubled for each plaintiff, due to the aggravation.

317. The level of interference in this case was extreme and therefore must be at the serious end of any appropriate range of damages. The interference seriously disrupted each plaintiffs ability to enjoy their home, their place of rest and relaxation, a place which they enjoyed with their children and their own parents, a place from which they did not feel they could or wish to move from, a place where they both also worked. The level of interference tested

their resilience, their reserves and their ability to cope. This level of interference was objectively supported by independent experts and recorded sound data. The nature of the noise, in particular the amplitude modulation and low frequency tonal noise, regularly passed limits recognised internationally as being the limit of what is considered tolerable. The behaviour and response of the plaintiffs was reasonable, patient and one which was seeking to engage with the defendants and the local authority to achieve a solution. The general response of the defendants was exceedingly poor. While they admitted liability during this trial, for twelve years they avoided engaging properly or substantively with the plaintiffs' complaints. Accordingly, taking all of the foregoing into account, and taking account of the different level of effect on each plaintiff and allowing for the fact that both sides experts viewed the case as "extreme" and an "outlier", I propose to measure the general damages per year for Mr. Byrne at €10,000.00 and at €15,000.00 for Ms. Moorhead. This means that Mr. Byrne will be awarded general damages to date for the nuisance in the sum of €120,000.00 and Ms. Moorhead's award is €180,000.00.

Stigma Damages

318. I do not propose to make an award of stigma damages or some additional award for a notional impact on the capital value of the property. For the reasons set out below, I propose to grant a full injunction directing the shutdown of the three turbines at all times. The defendants had in any event also indicated that they would implement a full adjustment of the software controlling the three turbines to remove the problem of shadow flicker. Therefore, there will be no ongoing nuisance. Such noise as emanates from the fourth turbine, near the three turbines complained of, does not generate enough noise to constitute a nuisance, based on the evidence of Mr. Meyer and, in addition and consequently, the plaintiffs do not seek and have not sought an order in relation to this turbine. There is therefore an operating wind farm nearby. It will have three remaining turbines that are not affected by the Court Order. While Mr. O'Regan gave evidence that in his opinion the house would still, even in this scenario, suffer a damage to its capital value, which was called a stigma damage, I am not persuaded that the weight of his evidence on this point was sufficient to satisfy me of this. Firstly, he had no examples of it actually happening. Second, he equated it to what he called a "haunted house" syndrome. In that regard, he may well be correct that there could be some future purchaser of this house (if and when it might ever be on the market) who will discount their offer based on the noise nuisance history (even though it will be fully abated by the result of this action) but that is not, in itself, sufficient to ground an award of damages. In my view it is too speculative. In that regard on Day 18 (page 22 at line 14) Mr. O'Regan in his direct evidence said in response to a question about the value of the house even if the turbines are "turned off completely", answered "*I would put it akin to – I mean, it might be – I don't know, I have no proof of this, but I would compare it to maybe a haunted house*". Mr. Corr the defendants' expert, did not agree with this. Mr. O'Regan's view was that the house might be worth €650,000 rather than €844,000 due to this stigma damage. I am not persuaded of this for the

foregoing reasons. It is too speculative and is lacking in supportive examples. In addition, there is a sense in which it would not be reasonable to impose such damages on the defendants where the nuisance, as a result of the orders made, will have been fully abated.

319. Finally, if I am wrong in this approach of not following the defendants submissions that the damages to date should be assessed based on the notional damage to the capital value of the house, and if the defendants submissions (based on the English cases discussed above) are correct, then I propose to indicate how I would have resolved the factual dispute between the two valuers, Mr. O'Regan for the plaintiffs and Mr. Corr for the defendants.

320. As indicated earlier, Mr. O'Regan assessed the notional impact on the capital value of the house at €394,000.00 (€844,000 less a remaining value of €450,000). Mr. Corr assessed the noise impact at between 13-18%, being a range of between €109,720 and €151,920 (this range has a midpoint of €130,820). Overall, I was slightly more persuaded of the evidence of the plaintiffs' valuer on this point. He had extensive and substantial experience of buying and selling properties for many decades. On the other hand, Mr. Corr's approach was more research and academic based. In each case, both expert opinions were in themselves estimates without many examples. In addition, Mr. Corr had initially significantly underestimated the degree of impact and his revision (based on a review of the actual evidence) indicates that overall Mr. O'Regan's view that the impact was serious is correct. Overall, therefore Mr. O'Regan had substantially more experience of working in the residential property market, his approach to valuation was more rooted in real life experiences of sales, Mr. Corr's approach was more academic and research based, Mr. Corr's revised valuation indicates that Mr. O'Regan's view and approach was more correct. While reaching a figure in these circumstances involves some degree of estimation I would have estimated the impact on the capital value of the plaintiffs' property as more probably a little closer to the estimate put forward by the plaintiffs' expert for the foregoing reasons and I would have awarded a sum of €275,000. Based on the approach contended for by the defendants, this sum would then be the entirety of the award to the plaintiffs jointly between them for the nuisance to date, as opposed to the plaintiffs each getting a separate award; see *Hunter* and *Dobson*.

(2) The constitutional claims pursuant to Articles 40.3 and 40.5 of the Constitution

321. Applying the dicta of O'Donnell J. (as he then was) in the Supreme Court in *Clarke* I am satisfied that the overarching consideration with respect to this issue is first to consider whether or not the common law tort of nuisance is in some way deficient. As O'Donnell J. states *"It is only if it can be shown that the existing law does not adequately protect the constitutional rights of the citizen that a separate claim for breach of constitutional rights can be invoked."*

322. That consideration is made in a context where, based on the legal principles described earlier in Section X, the conduct of the defendants on its face engages with the plaintiffs' Article 40.3 and 40.5 rights. The admitted nuisance amounted to a substantial interference for a protracted period with the ability of the plaintiffs to enjoy the ordinary use of their home and in a manner which caused them substantial annoyance, discomfort, inconvenience and mental distress. In addition, the nature of this interference and its level of severity, as attested to by the experts and as supported independently by the recordings and data collected by the experts, reaches the level of severity to fall within the scope of Article 8 of the ECHR; see the discussion in the context of environmental nuisances in *Verein Klimaseniorinnen Schweiz* decision of ECtHR. It also, for similar reasons, would appear therefore to engage the plaintiffs' Article 40.5 rights. The tort of nuisance is designed to protect a person's property rights and the admitted nuisance here unquestionably engages the plaintiffs' Article 40.3 property rights.

323. However, I am satisfied that the existing law of the tort of nuisance is adequate to protect the plaintiffs' constitutional rights in this scenario. As explained above, I have decided that the appropriate way to compensate the plaintiffs for the effect of the nuisance to date is by means of an award of general damages that reflects the effect of the nuisance on each plaintiff in a meaningful way and that takes account of the duration of the nuisance, the nature of it and the context in which it occurred.

324. This approach is, for the reasons explained above, consistent with the Irish authorities to date on the matter, albeit that part of the reasoning therein, in particular for not following the approach indicated by the English authorities, is informed by an understanding that the rights protected here are constitutional rights, including pursuant to Article 40.5.

325. In addition, for the reasons more fully described hereunder, I am satisfied that the established principles that govern the discretion of the court to consider awarding damages for a future nuisance, rather than granting a full injunction, are also adequate to protect the plaintiffs' constitutional rights. Again, for the reasons explained below, part of that reasoning is informed by an understanding that the rights protected here are constitutional rights. Accordingly, I do not propose to make any separate finding or grant any specific relief for a breach of constitutional rights.

(3) Whether to grant a full injunction or a partial injunction and award damages for an ongoing nuisance

326. The plaintiffs explained how they wish to stay in their home irrespective of the outcome of the case.

327. As described above in Section X, the authorities (see for example Lord MacNaughton in *Colls* and Neuberger P. in *Lawrence)* make it clear that a court can consider whether or not a defendant who requests to pay damages for an ongoing nuisance to avoid an injunction has acted in a neighbourly spirit. Lord Leggatt in *Fearn*, called it the "concept of reciprocity", stating at para. 34:

> *"The underlying justification for those 'well-settled' tests was spelt out by Lord Millett in Southwark when he explained ([1999] 4 AER 449 at 464) that:*
>
> *"The governing principle is good neighbourliness and this involves reciprocity. A landowner must have the same consideration for his neighbours as he would expect his neighbour to show for him."*

328. This is relatively uncontroversial. For example, in *Larkin v Joosub* [2007] 1 IR 521, Finlay Geoghegan J. held that the owner of a neighbouring property owed a duty to his neighbour to take reasonable care to prevent his property becoming dangerous or a nuisance, to carry out periodic inspections and repairs as necessary and was liable for a nuisance once aware of it and had a duty to bring a nuisance to end or would otherwise be liable for the continuance of the nuisance.

329. This duty to act in a neighbourly spirit or to have regard to the concept of "reciprocity" (in the context of seeking permission to pay damages in lieu of stopping an ongoing nuisance – not in the context of any liability analysis) would seem in practice to reasonably involve taking account of the following factors in a case such as this:

i. it would involve the putative defendant, on receipt of a complaint, engaging with the person who has made the complaint and investigating whether the complaint has any substance;

ii. the next initial stage would involve, if the complaint appears to be genuine and to have some substance, some initial engagement on reasonable steps that can be taken, that may, during this initial phase, not be unduly burdensome, to address the concerns of the neighbour;

iii. finally, if the full investigation of the complaint leads to a conclusion that there is substance to the complaint, then the putative defendant should wholeheartedly engage in efforts to mitigate the nuisance complained of, informing and collaborating with the plaintiff in an effort to ensure that any steps taken to ameliorate the nuisance and/or to mitigate the problem are seen to be effective.

330. The assertion by Mr. Spicer that as far as he was aware the gearboxes were being maintained was wholly lacking in detail and he had no direct knowledge at all as to what condition the machines or gearboxes were in. While Mr. Meyer explained that the noise could be reduced by curtailing the speed of the blades in certain conditions and or by making adjustments to the gearbox the only curtailment option put forward by the defendant was the complete switching off of the turbines.

331. As set out in more detail in the analysis of the evidence relating to the potential to mitigate the WTN by measures other than shutting down the machines (see Section VI above), the evidence demonstrates that during 2019 (when the defendants were facing an Enforcement Notice from the Council) they had been in touch with the turbine manufacturers Nordex who had indicated:-

- a willingness to engage in relation to developing a potential "*mitigation plan*";
- a clear awareness of the potential issue of "*tonal noise*" (which was not something that was related to the planning permission or its conditions);
- an indication that the machines had different "*noise power modes available*" already on the machines;
- an indication of retrofits involving softer elastomer bearings with which Nordex had already "*had success with*" but which would have some costs if replacements were required; and
- a request for "*noise studies carried out*".

332. The evidence indicates that despite this engagement from Nordex, the defendants decided not to pursue *any* of these options. Nor did they give any explanation for why they did nothing in this regard.

333. The evidence from Mr. Meyer indicates that there were a range of potential solutions to address the concerns such as those being raised by the plaintiffs. Some of the proposed measures involved dealing with the gearbox, the generator and the rotor blades and could involve potentially making upgrades and adjustments to the machines and some involved potential adjustments to the software operating the machines. However, the defendants did not indicate any willingness to carry out such a process and the only curtailment option offered by them was the shutting down of the machines during nighttime and in the mornings at weekends, but otherwise operating the machines as they are currently operating and paying damages for this ongoing future nuisance.

334. The stark reality of the evidence in this case is that if the defendants had approached the plaintiffs' complaints in a wholehearted neighbourly manner and if they had engaged with them in a substantive way, then the evidence described above in Section VI indicates that within a period of year to fifteen months, many of the problems identified could have been substantially addressed, or at least significantly ameliorated.

335. While the evidence indicates that some cost and effort would have been required to this approach, it is quite conceivable that even if all of the complaints of the plaintiffs had not been fully addressed, they may not even have embarked on this High Court litigation in the event of genuine and substantial engagement and significant amelioration of the WTN problem. The course of the correspondence and the patience of the plaintiffs indicates that they were willing to afford a significant amount of time to trying to achieve a practical resolution of the problem.

336. Even if a claim was initiated following such a process and if the problems had been addressed by the type of process or measures identified in Mr. Meyer's report of 20 March 2025, then any claim for damages for nuisance would have been limited in time to a period of approximately 15 months, which would, based on my assessment of the appropriate measure of damages have meant that this case could comfortably have been dealt with in the Circuit Court, indeed each individual case could on its own probably have come within the jurisdiction of the District Court on the basis of some amelioration working well within the 15 month time period estimated by Mr. Meyer.

337. In *Fearn* (discussed above in detail in Section X), Lord Leggatt had described a series of questions that could usefully be considered by the trial court when weighing whether to award an injunction or damages *in lieu,* in respect of a future nuisance. In deciding to remit the matter to the High Court, Lord Leggatt stated as follows at para 132 of *Fearn*:

> *"In the circumstances, if the parties cannot reach agreement on a solution, a further hearing will be required to address the question of remedy which should take place before a judge of the Chancery Division. Without constraining the matters on which the court may choose to hear argument, they may need to include:-*
>
> > *(i) whether there is a public interest in maintaining the gallery with a 360° view capable of overriding the claimants' prima facie remedy of an injunction;*
> >
> > *(ii) whether any remedial measures which the Tate may propose are sufficient to avoid an injunction or damages;*

(iii) the scope of any injunction; and

(iv) questions of quantification of any award of damages."

338. The above guidance from Leggatt J. is useful as an approach to consider to this issue in this case. As it happens there was sufficient evidence adduced in this case to enable this issue to be analysed in the context of similar questions.

339. Firstly, as to the question of whether the public interest can be considered in the context of remedy, I am satisfied that it can. Humphreys J. in *Coolglass* admirably sets out the critical legal and environmental considerations that underpin the public interest in the State reaching its legal targets for the production of energy from renewable sources.

340. I also accept, for the purposes of this analysis, that the common law principles contained in the law of tort (in this particular regard in the context of the discretion of the court to award damages in lieu of an injunction where liability for a nuisance has been established) and section 2 of Lord Cairns Act (which refers to the discretion), merit being considered having regard to Ireland's EU legal obligations in relation to climate change. Equally, this must be balanced with a consideration of the expert evidence in this case, that a failure on the part of developers to engage with concerns about the impact of WTN represents a threat to the development of renewable energy and therefore, rewarding that lack of engagement, is, on the evidence in this case potentially a threat to the roll-out of wind energy.

341. In addition it must be remembered that, as explained by Kenny J. in *Cullen v Cullen* [1962] IR 268, Lord Cairns Act was not intended to turn the Court into a body that legalised wrongdoing and that the discretion, without laying down precise rules should only be exercised in exceptional cases. Kenny J. states in *Cullen* at p286:

> *"The effect of Lord Cairns's Act was explained by Lindley L.J. in Shelfer v. City of London Electric Lighting Co.(4).He said:—"The jurisdiction to give damages instead of an injunction is in words given in all cases . . . but in exercising the jurisdiction thus given attention ought to be paid to well settled principles; and ever since Lord Cairns's Act was passed the Court of Chancery has repudiated the notion that the Legislature intended to turn that Court into a tribunal for legalising wrongful acts; or in other words, the Court has always protested against the notion that it ought to allow a wrong to continue simply because the wrongdoer is able and willing to pay for the injury he may inflict. Neither has the circumstance that the wrongdoer is in some sense a public benefactor . . . ever been considered a sufficient, reason for refusing to protect by injunction an individual whose rights are being persistently*

infringed . . . Lord Cairns's Act was not passed in order to supersede legislation for public purposes, but to enable the Court of Chancery to administer justice between litigants more effectually than it could before the Act . . . Without denying the jurisdiction to award damages instead of an injunction, even in cases of continuing actionable nuisances, such jurisdiction ought not to be exercised in such cases except under very exceptional circumstances. I will not attempt to specify them, or to lay down rules for the exercise of judicial discretion."

342. The position is also succinctly addressed by Egan in *Webster (No.1)* where she states at para 42:-

> *"Although a plaintiff who establishes nuisance has a prima facie right to an injunction such that the defendant bears the legal burden of demonstrating that damages rather than an injunction is an appropriate remedy, the public interest must inevitably be a factor in the court's assessment of an appropriate remedy. At the very least it means that a generalised injunction ought not to be granted where a tailored injunction more suitable to the particular interference held to constitute nuisance is warranted."*

343. The fact that Wexwind has a planning permission for a wind farm is also clearly relevant for the reasons discussed by Neuberger P. in *Lawrence*, discussed above in Section X..

344. Accordingly, I am satisfied that in general there is clearly a public interest in maintaining energy production from wind at the Gibbet Hill wind farm. An injunction for the full shutdown of three turbines will have some impact on that, albeit, it will be miniscule in the context of the overall levels of renewable energy being provided to the grid. It should also be noted that the wind farm does have to "dispatch down" energy at certain times due to the needs and / or capacity of the grid. The defendants only belatedly provided information to the Court about this, at the Court's request, and the information was relatively limited.

345. The defendants have chosen to only propose one remedial measure – that is the shutdown of the turbines at certain "sensitive" times. Despite the expert evidence indicating that other solutions are usually possible, and despite being given ample opportunity to do so, the defendants chose not to explore or put before the Court any solution to abate the nuisance other than the shutdown of the turbines, As will be recalled, when the defendants were facing an Enforcement Notice from the Council back in 2019 they briefly explored potential solutions with Nordex, the manufacturer of the turbines, but did nothing to progress these options.

346. The defendants' expert conceded that, based on the evidence before the Court, the only measure that would fully abate the nuisance would be the full shutdown of the three turbines in question.

347. The evidence before the Court is that if such an order is made, that this will likely lead to the insolvency of Wexwind. Mr. Spicer indicated that in those circumstances an insolvency appointee would likely sell the wind farm to a purchaser who could then operate the wind farm with the remaining three turbines. These have a valid planning permission until 2033 or a further permission.

348. The defendants accepted they could not meet the *Shelfer* tests (adopted and applied in *Patterson*, as discussed above in Section X) on the basis, inter alia, that they accepted that the injury to the plaintiffs was not small. However, I agree that this is not determinative and that compliance with the *Shelfer* criteria is but a factor in the Court's overall consideration of this issue (see *Kirwan* and Egan J. in *Webster (No.1)* referred to earlier). They did submit that Wexwind would be insolvent if an order for the full shutdown of the three turbines was made but Mr. Spicer indicated that an administrator / liquidator would presumably sell the wind farm with the remaining three turbines to a new operator. It was not suggested that Wexwind had any employees or that anyone's livelihood would be affected.

349. In addition, while there is a planning permission for the facility and while the land zoning supports the use of this land for a wind farm, the expert evidence in this case and the evidence of the communications with Nordex, does not demonstrate that this facility could not be carried without causing the noise nuisance complained of; see the comments of Neuberger P. in *Lawrence* at para. 125, discussed above in Section X.

350. From the plaintiffs perspective, if the nuisance continues they will have to give serious consideration to selling their family home. It is a family home of longstanding and filled with decades of memories including of their children and parents. As Lord Mance observes in *Lawrence,* it is inevitably valued for reasons "independent of money". As will be seen in the paragraphs below, coming to a value for the damages for the future nuisance (which the court has elected to try to do on a provisional basis having heard the evidence) would not have been straightforward or indeed an entirely satisfactory task in this particular case. As Clarke J. (as he then was) observes in *AIB v Diamond* [2012] 3 IR 549 at 590 *"[t]he mere fact that it may, therefore, be possible to put a value on property rights lost does not, of itself, mean that damages are necessarily an adequate remedy for the party concerned is*

entitled to its property rights instead of their value". Even then, those comments were made in the context of the potential loss of a bank's property rights in its capital markets team, a scenario less likely to attract the comments of Lord Mance referred to above. To that extent, I am of the view that damages are not an adequate remedy for the plaintiffs in this case if a noise nuisance is allowed to continue into the future.

351. It is also clear that the plaintiffs are not guilty of any conduct that would disentitle them to an injunction. They were patient and measured in their approach to the problem and sought initially to engage with the defendants and then with the Council. They were patient with the process that ensued once the Council become involved. Their evidence was measured and supported objectively.

352. The conduct of the defendants on the other hand fails to meet most of the factors that might usually assist a defendant in securing the remedy of damages for a future nuisance in lieu of an injunction:-

(i) they failed to engage substantially with the nuisance complaints for years and even after proceedings were threatened and issued;

(ii) they failed to investigate the complaints properly;

(iii) they failed to initiate any substantive review of the facility or the turbines or to investigate and explore solutions to the problems complained of by the plaintiffs (in circumstances where the expert evidence and the evidence that emerges from the correspondence between the defendants and Nordex indicates multiple potential solutions);

(iv) they failed to notify the plaintiffs in advance of the trial that they would seek such an approach from the Court;

(v) they called no engineering witness or expert with evidence to give to address potential solutions;

(vi) the only expert witness called by the defendants made no proposal for mitigation (other than the shutdown of the machines) despite the defendants being given the opportunity to submit additional evidence;

(vii) they made a proposal to pay for the future damage based on a modest assessment by an expert valuer of the 'notional capital damage' if the nuisance continued into the future;

(viii) they submitted no clear evidence of the actual revenues that would be generated by the facility if they were to be allowed continue the nuisance.

353. In other words, to paraphrase the *dicta* from the case law referred to earlier, they did not behave in a neighbourly way in relation to the problem and they violated the concept of reciprocity. The nature of their conduct in this respect is discussed in further detail in the context of the decision to award the plaintiffs aggravated damages hereunder and that analysis contributes to my reasoning here not to exercise the Court's discretion to award damages in lieu of an injunction to fully restrain the nuisance.

354. In that regard, it is no bar to the relief of damages in lieu, that the owner of the wind farm is a special purpose vehicle (SPV) company with one shareholder which is a Luxembourg Fund, represented by corporate advisors based elsewhere. It is equally no bar to the application of the Court's discretion (which includes considering whether the operator of the nuisance behaves in a neighbourly way) that the Wexford wind farm facility is unmanned, controlled by technicians in a control room in Germany and with invoicing and scheduling of services handled by a man sitting in an office in Cornelscourt. Any corporate structure, devised for efficiency or otherwise, is entitled to be treated the same as, say for example, a wind farm owned by a collective of local farmers. However, if the owners structure their operation in this way, they will not escape the scrutiny of their behaviour that the caselaw indicates, in particular the questions as to whether they have behaved in a neighbourly spirit. If that does not come naturally, then while that may be as a result of the way they have chosen to set their business up, it is not an inevitable feature of same. It was within their control to have responded to the situation that arose differently.

355. On the other hand, if the Court were to accede to the defendants' application to allow the nuisance to continue between 7am and 10pm on weekdays and between 11am and 10pm on weekends and public holidays, then the plaintiffs will continue to suffer an admitted substantial interference in the ordinary use and enjoyment of their home. The interference will likely occur daily and in nearly all wind conditions. It will regularly surpass levels of interference considered intolerable by objective international standards. The plaintiffs do not want to receive damages for this interference. Nor do they want to have to leave their home, for all the reasons described above in Sections III and IV. The effect of not getting a full injunction will therefore be significant and difficult to assess in damages.

356. Weighing all of the above, I am not satisfied that the primary card of the defendants, that their facility supports an important public goal of increasing the supply of energy generated from renewable sources to the national grid, is sufficient in this case to disentitle the plaintiffs to their *prima facia* right to an injunction to restrain the wrong. The public interest involved here is an important one, but so are the plaintiffs' rights relating to their own home. The Court will always endeavour to strike an appropriate balance and to do justice as between the parties, while taking account of the important public interest invoked by the defendants

here, but the factors identified by the jurisprudence place weight on all the circumstances and the conduct of the parties. It is not an impressive approach to fail to engage with responsibilities to neighbours and to then hope to pay money to continue a serious interference with a neighbour's enjoyment and ordinary use of their home by relying on the broad public interest in renewable energy, particularly when other options were, on the evidence, available.

357. Accordingly, I propose to accede to the plaintiffs' application and to grant an injunction for the full shutdown of the three turbines referred to as T3, T5 and T6 at the Gibbet Hill wind farm. For the avoidance of doubt and for the same reasons, there is equally no proper basis for coming up with some slightly increased partial injunction (for example up to lunchtime, or a shutdown for the entire weekend). Such options would not be appropriate for the same reasons as the specific proposal made by the defendants above has been rejected.

358. If I am wrong in the exercise of discretion described above, and if the appropriate outcome should have been to allow the nuisance to continue in the context of a partial shutdown of the turbines as proposed by the defendants, and to award damages to the plaintiffs for this future nuisance, then I would have assessed damages based on an approach designed to facilitate the plaintiffs selling their home, if they wished, and moving to a property of equivalent comfort and value.

359. Firstly, it should be noted that this is therefore a different approach to that adopted by me in assessing the general damages for the nuisance to date. Secondly, there was insufficient evidence in this case to consider the value to the defendants of the partial injunction; a consequence perhaps of the failure of the defendants to give any notice that they intended to seek this approach from the court; in breach of the stricture proposed by Neuberger P. in *Lawrence* at para. 149, referred to above in Section X. Therefore, the application of the approach suggested by Millett LJ in *Jaggard* and Neuberger P. in *Lawrence* at para. 128 (described above in Section X) is best left to another case where it fully arises.

360. In the context of a future ongoing nuisance the plaintiffs are, in my opinion, therefore entitled to have the matter assessed from the perspective of the notional capital damage to the property so that they have the option of considering selling the property without suffering a capital loss. Even this approach does not fully take account of the strong personal attachment to a family home of longstanding, and in that regard doing this exercise (even on a hypothetical basis, lest the exercise of discretion above be considered in error) brings into real focus the force of the concept of damages not being an "adequate remedy" . In any event and pressing on with the exercise, without the presence of the wind farm the valuers

agreed that the plaintiffs' home would be worth €844,000.00. Based on the evidence of the plaintiffs' valuer, with the partial shutdown of the three turbines proposed by the defendants, then if the plaintiffs were to try and sell their home, he estimated that it would only be worth €450,000.00. Indeed, this was also his figure if the turbines remained on all the time. This would represent a drop in value of €394,000.00. On the other hand, the defendants' valuer, Mr. Corr felt that with the turbines operating fully the notional impact of the noise, without the shadow flicker, was between 12-17% of the value of the property, and with the partial shutdown "that would cut the noise component by about 50%" (Day 18, page 83, line 10) if the turbines were only operating partially, as proposed by the defendants. This would equate to a drop in value of between 6-8.5%, being a range of €50,640-€71,740 (having a midpoint of €61,190). The defendants proposed that this was the approach to be followed to assessing the damages for the future nuisance with a partial shutdown. These figures create a divergence in the view as to the notional impact on the capital value of the plaintiffs' home of a partial shutdown as between €394,000 on the plaintiffs' side and €61,190 on the defendants' side.

361. Overall, I would have preferred a figure closer to the estimate of the plaintiffs' expert on this issue for the following reasons. Mr. O'Regan had considerably more experience of buying and selling properties than the defendants' expert, who was not actually involved in buying or selling property at all. Mr. O'Regan's description of the likely impact on potential purchasers was more rooted in a real life set of experiences over decades, whereas as the defendants' expert had adopted a more academic and research-based approach to considering the impact of the noise nuisance on the likely sale price that might be obtained. Some of that research was based simply on proximity to wind farms as opposed to homes where the residents had actually experienced an objectively established and independently verified noise nuisance of a severe nature. In each case, the figures provided by the experts were necessarily rough estimates.

362. Accordingly, coming to a view as to the likely impact on the capital value of the plaintiffs' home in the event of a partial shutdown, also inevitably requires a degree of rough estimation. That, of course, is not a bar to the exercise. Damages in the present for wrongdoing to be committed in the future is, by definition, not perfect justice. However, the approach of the courts in these imperfect circumstances is to award an amount that is considered to be reasonable, proportionate and fair to both sides, and which is, in its assessment, reached in a manner which is reasoned, based on existing principles and which has a regard for analogous awards. While I prefer for these reasons a figure closer to that of the plaintiffs' valuer, I think, contrary to the view of the plaintiffs' expert on one point, some allowance has to be made for the partial shutdown of the turbines. The partial shutdown will undoubtedly reduce the nuisance. It would not be fair, not to reduce the capital impact accordingly. Ultimately, I would have assessed the likely impact on the capital

value of the plaintiffs' home in the event of a partial shutdown at €250,000. To that sum I would have added a further sum of €25,000.00 to allow for a period of time of potentially a year, during which an ongoing nuisance would be experienced, for the plaintiffs to find a home of equivalent standard. This figure of €275,000.00 would then have been awarded to the plaintiffs jointly as compensation for the future nuisance and would have been in addition to the figures for the general damages for the nuisance to date. I would not have proposed assessing damages based on a reinstatement basis as those figures would leave the plaintiffs with a house of equivalent standard but as a new build, whereas currently the plaintiffs' home is essentially twenty-six years old.

(4) Aggravated Damages

363. As can be seen from the summary description of the evidence in relation to the engagement as between the plaintiffs, the defendants and the local authority above in Section V, the level of engagement by the defendants was poor and it caused the plaintiffs additional upset and distress.

364. For example, Mr. Byrne explained that the defendants had filed a full defence without carrying out any substantive assessment of the noise nuisance complaint made by the plaintiffs. In addition, he also correctly drew attention to the fact that the defendants had not trialed, piloted or implemented any mitigation measures to address any of the issues raised by the plaintiffs since their complaints began in 2013. The defendants did not call evidence from any persons who had actually interacted directly with the plaintiffs.

365. The defendants only witness as to fact was Mr. Spicer who confirmed that he had no direct interactions with either of the plaintiffs. He endeavored to suggest that he believed the contents of correspondence that had passed to the plaintiffs was true and accurate but his evidence in this regard was generally lacking in specifics or detail. He was unable to give any significant evidence that substantially challenged the narrative of the plaintiffs that there had been a lack of engagement from the defendants. Indeed, when it was put to Mr. Spicer that he had refused to provide data to the sound engineer of the local authority who had requested it, he sought to suggest during the re-examination that he had done this but this evidence was inaccurate as he was referring to correspondence that preceded the particular request of the local authority.

366. Overall, I found Mr. Spicer to be a witness who did not appear to have been that involved and had a very limited role in making any decisions on behalf of the defendants. He made generalised statements about matters of which he appeared to know little and certainly had no detailed grasp of. He sought to give evidence about legislative climate change

requirements but as soon as he was asked any questions that fell outside of the prepared examination his answers were either incorrect or vague. Also, he was unable to give any detail as to the financing arrangements in relation to this wind farm. He could give no explanation as to whether the investment had been refinanced or why considerable financing appeared to be due in relation to the wind farm twelve years after its installation. He was unable to give any detail about the very considerable financial transfers being made each year of over €1,000,000.00 from Wexwind.

367. The evidence he endeavored to give in relation to the financial consequences of an injunction were hearsay and lacked detail or any real understanding of the underlying financial position. Indeed, when he was asked by the court as to whether provision had been made in the accounts of the first and second named defendants in relation to the case, he incorrectly stated without hesitation that provision had been made. The next day this was corrected but no explanation for this was given by Mr. Spicer, who was a director of the second named defendant and therefore should have had some familiarity with the accounts.

368. In fairness to Mr. Spicer, he was put forward by the defendants as the only witness as to fact and was tasked with dealing with many matters about which he appeared to be unfamiliar with. He knew very little about the level of engagement of the defendants with the plaintiffs and very little about the financial arrangements actually governing the wind farm. He also appeared to know very little about the climate change issues.

369. When he passed on requests from the local authority to the actual people in charge and in a position to make decisions, he did so in a relatively formalistic way and did not appear to engage in any meaningful way with those persons as to the actual decision being made, which in this regard was the decision to refuse to provide the data requested to the local authority.

370. By virtue of the continued failure of the defendants to engage in any meaningful or substantive way with the plaintiffs concerns and complaints an Updated Notice as to Damages was delivered on the 17 May 2021 on behalf of the plaintiffs. This Notice claimed aggravated and exemplary damages. In this Notice the plaintiffs asserted that by the continued operation of the Gibbet Hill wind farm the defendants were generating substantial revenue and also continued to generate nuisance in the form of noise, vibration and shadow flicker. It continued by claiming that the defendants continued to operate the wind farm notwithstanding their knowledge of the ongoing nuisance caused by the said operation. It also complained of their failure to mitigate the impact and pointed out that this was having an impact on the plaintiffs' constitutional rights. It further explained that because the

defendants had been notified of the plaintiffs' expert evidence that the defendants were aware of the position. The plaintiffs set out that they were claiming that the nuisance was continuing notwithstanding the ongoing protests of the plaintiffs and notwithstanding the defendants' awareness of the impact on the plaintiffs.

371. The defendants therefore have been on notice of the nature of this aspect of the claim and accordingly had ample opportunity to prepare a defence for this element of the case and to adduce any appropriate or relevant evidence to either demonstrate that they did not have the necessary knowledge that their actions were leading to the negative effects complained of or alternatively that they had some genuine or reasonable belief that what they were doing was not causing a nuisance.

372. The defendants failed to call any of the persons who had actually interacted directly with the plaintiffs. As explained above, Mr. Spicer was quite removed from the actual interactions that were taking place. It was also clear from the evidence that Mr. Spicer had no actual decision-making role in relation to any of the relevant matters relating to this litigation. The persons making the decisions chose not to give evidence. The persons who could have given evidence about the question of revenue or the "substantial revenue" as pleaded by the plaintiffs chose not to. In addition, Mr. Spicer, as the only factual witness put up by the defendants, was tendered in the knowledge that he would be left having to answer questions about this. In that context, Mr. Spicer did not dispute the analysis put to him in cross examination that in effect over €1million per year in the last four years was being paid out by the operating company Wexwind from the revenues being generated by the operation of the wind farm.

373. In addition, in relation to the nuisance, there was nothing new or surprising or outside the ambit of the pleaded case that emerged in the evidence given by the plaintiffs or their expert by the time the admission of liability for nuisance was made.

374. Even when liability was still an issue there was nothing in the cross-examination to suggest in any meaningful or substantive way that there was anything about the plaintiffs' evidence, as analysed by the defendants in advance of the trial, to suggest that there was any reasonable belief in an argument that the plaintiffs' likely evidence, or the examples given, or the details in their logs or diaries, were not substantially supported by the independent evidence and the recordings made by the experts.

375. In those circumstances I am satisfied that it is appropriate to make an award of aggravated damages. While there is an absence of explicit evidence that the defendants made a

conscious and deliberate decision to target profits while at the same time continuing the operation of their wind farm, their lack of engagement aggravated the sense of hurt and upset and distress suffered by each plaintiff.

376. The defendants were armed with the substantial results from the plaintiffs' experts. The knew what the view of the Council's independent expert was. They had been served with two different Enforcement Notices.

377. They had made a deliberate decision not to provide the Council's engineer with the necessary technical data. They had to be dragged "kicking and screaming" to co-operate with the Council's independent expert, according to Mr. McKeown. They had refused to provide the plaintiffs with the relevant technical data (until ordered by the court to do so). Their own expert had raised only technical objections. They knew that the plaintiffs had discovered that the business was returning substantial revenues all the while it was operating. They knew the nature of the case being made for both aggravated and, separately, exemplary damages. In the teeth of all this, they chose not to put forward any evidence from any actual decision maker to explain this behaviour. The one witness as to fact tendered conceded he had no direct interaction with either plaintiff ever. From his evidence it was clear he was not a decision maker in any real sense. Despite being given every opportunity to adduce additional evidence including to put forward meaningful proposals to mitigate the admitted noise nuisance the defendants failed to do so. They did not call evidence from an engineer, whether in-house, from Nordex or some independent engineer.

378. A defendant can of course seek to challenge the claims made for aggravated damages and exemplary damages. Where there is a real risk of proper inferences being drawn, they should do so by calling evidence from the persons who made the actual decisions. Those persons chose not to give evidence in this case even though on many days they were watching proceedings via the remote link from Germany.

379. In other words, the evidence overwhelmingly demonstrates that the defendants chose not to engage with the plaintiffs claim or to give it any serious or substantive consideration or to carry out any straightforward assessment of whether the plaintiffs claim had any substantive merits.

380. Here the defendants were benefiting from a business connected to the public electricity grid to which they were supplying energy generated from the renewable source of wind. They were making, based on the evidence, by any measure substantial revenues from doing so.

They had an unmanned facility. They were paying no serious heed to the complaints of the plaintiffs even though those complaints on any analysis had all the indicia of genuine and substantial complaints and were supported by an abundance of objective data and independent analysis.

381. As Mr. McKeown pointed out in his evidence on Day 14 engaging with the public and addressing legitimate concerns is essential to the goal of rolling out substantial wind energy. The conduct and approach of the defendants in this case represents a threat to the goal of developing wind farms and wind energy.

382. This evidence, which was not disputed by the defendants in this case, is also reflected in the comments of Egan J. in *Webster (No. 2)* at para 204: *"Devising appropriate measures to avoid WTN nuisance at the planning and development stage is clearly of critical importance to the achievement of the State's aim of substantially increasing renewable energy ... it is also critically important that turbine operators engage constructively with genuine WTN nuisance complaints and devise appropriate abatement measures".*

383. As described in Section V above, Mr. McKeown gave evidence about the failure of the defendants to provide him with all the SCADA data. He also gave unchallenged evidence that the defendants level of cooperation was not satisfactory in that, for example, short term switch offs were all that the defendants ever offered, and he explained why this was not practical. His overall view was that the defendant "*had been dragged kicking and screaming to facilitate anything*", Day 14, page 101, which was to be contrasted with other wind farms where "*things were sorted out with a phone call an e-mail or a cup of coffee*".

384. Based on the evidence before the court the only sensible inference that can be drawn is that the defendants made a decision not to engage in any substantive or proper way with the claims being made by the plaintiffs and that this has aggravated the obvious distress suffered by the plaintiffs and significantly prolonged the duration of the nuisance. This therefore merits an award of aggravated damages.

385. In part, by virtue of the approach I have taken to assessing the general damages for the nuisance to date (by taking into account how long the nuisance has continued and measuring compensatory damages on a yearly basis), the defendants are paying a price for their own lack of engagement.

386. In addition, this lack of engagement (and the corelated failure of the defendants to develop mitigatory measures to ameliorate the noise nuisance) is also a significant factor in my decision not to allow the defendants to partly continue the nuisance and to accede to the plaintiffs' application for an injunction fully shutting down the relevant turbines.

387. In addition, general damages have been assessed on the basis that the evidence indicates that this case should be considered a severe and extreme one and they have been measured in a way to reflect the duration of the nuisance, which in part is a feature that is related to the underlying factors that contributes to the decision to award aggravated damages.

388. Therefore, I not inclined in this case to follow the approach of Richards J. in *Uren* who made an award of aggravated damages in the same amount as the total award of compensatory general damages.

389. Accordingly, taking account of the legal principles in relation to how to assess an award of aggravated damages I am of the view that the aggravated damages in this case should be measured at 20% of the award of compensatory damages. Therefore, the first named plaintiff will be awarded the additional sum of €24,000.00 and the second named plaintiff the additional sum of €36,000.00 by way of aggravated damages.

(5) Exemplary damages

390. Despite a detailed claim, with particulars, seeking exemplary damages having been delivered to the defendants, there was a surprising failure on the part of the defendants to meaningfully engage with this aspect of the case.

391. Notwithstanding this, I am overall, not satisfied that I can safely conclude that the defendants behaved the way they did out of a deliberate and conscious decision to violate the plaintiffs' rights.

392. The level of engagement was shallow. The complaints were not treated seriously. On the other hand, as Mr. Spicer explained, it may have been that the focus was, in truth, really on the planning issues. In that context while the defendants took a technical approach to engaging with the Council, they did ultimately succeed in fending the Council off with their technical objections.

393. The evidence does indicate a deliberate lack of cooperation with the local authority and does indicate that during the last four years that Wexwind was generating substantial revenues in excess of €1million to repay financing. The defendants also decided not to call evidence from any actual decision maker to answer the claim for exemplary damages.

394. In those circumstances, it may seem naïve not to conclude that this approach is highly indicative of the behaviour that is intended to be captured by the second category of scenario justifying exemplary damages identified by the House of Lords in *Rookes v Barnard* [1964] AC 1129 (discussed in *Conway*, referred to earlier).

395. It may well be that the defendants did not care about the effect that the actual operation of the wind farm was having on the plaintiffs and that this attitude arose in a context where substantial amounts of money were being paid by Wexwind, an SPV set up to own the wind farm on behalf of the Luxembourg Fund which in turn was put in place by the ultimate owners. If the defendants had any different story to tell they had the opportunity to do so at the trial.

396. Nonetheless, while these facts are consistent with (if not fully probative of) a decision made deliberately in a context where the return from the wind farm and the benefits of that return were considered too far outweigh the potential downside of having to engage with the plaintiffs' claim, I am not satisfied that they are sufficient proof to make an award of exemplary damages.

397. I that regard I take account of the jurisprudence that also indicates that exemplary damages are for exceptional cases and, in general, where the evidence demonstrates a deliberate and conscious violation of the plaintiffs' rights.

398. In addition, this conclusion is partly informed by my consideration that when the outcome of the case is looked at in the round, I am of the view that the order for the permanent shutdown of the three machines combined with the award of compensatory and aggravated damages is probably sufficient in this case to indicate that a failure to properly engage with substantial and bona fide complaints is to be deprecated.

399. Finally, in that overview, I have taken account of the manner in which the defendants behaved during the trial, including making an admission of liability in respect of the nuisance on Day 11, initiating a partial shutdown of the machines at nighttime on Day 12, and making an apology to the plaintiffs at the end of the hearing.

XII. CONCLUSION AND FORM OF ORDER

400. Accordingly I propose to award the first named plaintiff the sum of €120,000.00 by way of compensatory damages, together with the further sum of €24,000.00 by way of aggravated damages. The second named plaintiff is awarded the sum of €180,000.00 by way of compensatory damages, together with the further sum of €36,000.00 for aggravated damages. These sums are awarded as against each defendant jointly and severally.

401. In addition, the Court grants the plaintiffs an injunction against each defendant, their servants and agents, directing them to take all steps necessary to forthwith fully shutdown the three wind turbines at the Gibbet Hill wind farm, Co. Wexford known as T3, T5 and T6 and which heretofore have operated pursuant to a planning permission from Wexford County Council 2009/0266. I will then hear from the parties as to any further orders required and as to costs.

From: Carol Nolan <Carol.Nolan@CorkCoCo.ie>
Sent: Tuesday, May 20, 2025 9:18 AM
To: Louise Ahern <Louise.Ahern@CorkCoCo.ie>
Subject: FW: 24/5503 Tullacondra Green Energy

Dear Louise,

To the above referenced planning application and a veterinary public health assessment of same, I refer.

The proposed wind turbine development presents a significant adverse risk to activities on an equine racing enterprise located on directly adjacent lands.
In particular - concern arises due to the fact that it is a bloodstock enterprise. Thorough-Breds have a highly evolved sensitivity to their environment and in my opinion there is a significant risk to health and safety from the proposed development.

In the absence of published guidance by Irish Equine Bodies, guidance from the British Horse Society is noted here. A minimum separation distance of three times blade tip height from a business with horses, (525M) is recommended by the British Horse Society. This development is large in scale with 9 turbines proposed. The proposed development is directly adjacent to the racing enterprise, the siting of which does not meet the minimum distance as recommended.

The three elements of wind turbines with potential to result in significant adverse risk to the safety of personnel and horses include;

- Blade movement and particularly when a blade comes into sudden view;
- The effect of shadow flicker which is particularly pertinent in the case of thorough-bred horses;
- Noise effect of large turbines, particularly at start -up. The Noise effect is accentuated by virtue of the scale of the development.

There are significant safety implications for personnel and equines within the impact area of shadow flicker from the development.
I recommend refusal.

Regards,
Carol Nolan
Veterinary Inspector

Tullacondra Turbine Awareness Coummunity

Re:Planning reference No. 24/5503
Tullacondra Green Energy LTD.
The Applicant is seeking permission for the construction, operation and decommissioning of a Wind Energy Development including: . 9 wind turbines each with a blade tip height of 175 metres, rotor diameter of 150 metres, hub height of 100 metres and a rated output of .5 megawatts.
An on-site 38 kilovolt electrical substation.
Permanent meteorological mast of 100 metres height above ground level on a concrete base.
Installation of approx. 13.5 kilometres of 38kilovolts underground electrical cable, mainly within the public road between the proposed wind farm substation to the boundary of Mallow 110 Kilovolt substation at St Josephs Road Mallow

We the undersigned have not given/will not give permission to Tullacondra Green Energy Ltd or any Private Company or Individual to interfere with our lands, boundary hedges and/or property or to trespass on same in relation to the following.

1. The Turbine Delivery Route from Boherash Cross on the L5523/l5302 to the entrance of the proposed site.

2. The Grid Connection Route from the site entrance to the Sub Station on St Josephs Road Mallow on the following local roads.
L15302,L1200,L1205, N20,R581,L1207.L5320,N72, St Josephs Road Mallow Sub Station.

T.D.R. option 1.

House No	Name	Signature	Post Code/Folio No	Turbine Delivery Route	Grid Connection Route	
	FRANCIS LOMBARD	Francis Lombard	P51A567	✓	✓	
	Rose Lombard	Rose Lombard	P51 A567	✓	✓	
	Jeremiah Shine		P51 P8P6		✓	
	KAY SHINE	Kay Shine	P51VOA5	✓	✓	
	ANDREW SHINE		P51VOA5	✓	✓	
	Liz Baraggia	Liz Baraggia	P51R9HV	✓	✓	
	Bill Baraggia	Bill Baraggia	P51R9HV	✓	✓	
	Denny Walsh		P57X1T0	✓	✓	
	Betty Walsh		P51X1T0	✓	✓	
	Donal Geyer	Donal Geyer	P51W535	✓	✓	
	Sheila Geyer	Sheila Geyer	P51W535	✓	✓	
	Mokoko	Mael Choi	P51CY28	✓	✓	
	Susan Keeffe	Susan Keeffe	P51C125	✓	✓	
	Allen O Callaghan		P51XA00	✓	✓	
	Collette O Callaghan	Collette O Callaghan	P51XA00	✓	✓	
	Ushita Madden	L Madden	P51W821	✓	✓	
	DANIEL O'CONNELL	Daniel O'Connell	P51CDH3	✓	✓	
	MARIE BOURKE	Marie Bourke	P51H4C9	✓	✓	
	TORA FRANCE	Tora France	P51PDRX	✓	✓	
	DAVID + NATHALIE O'LEARY	[illegible]	P51PX28	✓	✓	
	SARA QURESHI	Sara Qureshi	P51X592	✓	✓	
	AQUEEL QURESHI	[illegible]	P51X592	✓	✓	
	MARY O RIORDAN	Mary O Riordan	P51PP63	✓	✓	
	MICHAEL O RIORDAN	Michael O'Riordan	P51PP63	✓	✓	
	GERARD O CONNELL	Gerard O Connell	P57FC99	✓	✓	
	JOSEPHINE O CONNELL	Josephine O Connell	P51FC99	✓	✓	
	AILE BIZOU	[illegible]	P51F893			
	CARIONA CRONIN	Cariona Cronin	P51W223	✓	✓	
	WILLIE CRONIN	Willie Cronin	P51 W223	✓	✓	
	COLMAN CRONIN	Colman Cronin	P51 W223	✓	✓	
	John Cronin	John F Cronin	Grange	✓	✓	
	Andy O Keeffe	Andy O Keeffe	Grange	✓	✓	
	AOIFE HOLLAND	Aoife Holland	P51N9F1	✓	✓	
	Alan Holland	Alan Holland	P51N9F1	✓	✓	
	SEAMUS O DONOGHUE		P51XJ14	✓	✓	

House No	Name	Signature	Post Code/Folio No	Turbine Delivery Route	Grid Connection Route	
	TERESA ROBERTS	Teresa Roberts	P51YN66	✓	✓	
	DECLAN ROCHE	Declan Roche	P51AP57	✓	✓	
	NATALIE CONAGHAN	Natalie Conaghan	P51AP57	✓	✓	
	ELIZABETH GAYER	Elgayer	P51W535	✓	✓	
	Liam Kingston	Liam Kingston	P51W535	✓	✓	
	Jennifer Halliha					
	Tom Halliha					
	JENNIFER HALLIHAN	Jennifer Halliha	P51058W	✓	✓	
	TOM HALLIHAN	Tom Halliha	P51058W	✓	✓	
	NOREEN NOLAN	Noreen Nolan	P51058W	✓	✓	
	EIBHLÍN NÍ MHAIRTÍN	E. Ní Mhairtín	P51K1W2	✓	✓	
	DANIEL O'CONNELL	Daniel O'Connell	P51AE06	✓	✓	
	JOHN O CONNELL	John O'Connell	P51AE06	✓	✓	
	KARLA McCARTHY	Karla McCarthy	P51A2Y1	✓	✓	
	AMY CRANITCH	Amy Cranitch	P51AE06	✓	✓	
	HANNAH GAYER	Hannah Gayer	P51W535	✓	✓	
	GAVIN LYNCH		P51HX5X	—	—	
	ELIZABETH H		P51HX5X	—	—	
Buttevant →	MGT. O'CONNELL	Mgt. O'Connell	P51HX5X			
	[illegible]		P51AK66			
Knockane →	Margaret O'Connell	Margaret O'Connell	P51H76R	✓	✓	
	John Crowley	John Crowley	P513K1K			

T.D.R.

TDR OPTION 1 site to Boherash Cross ----
House owner marked in a white circle
Land owners marked in small white dots

Proprietary

Locations -
All done using
Post Codes
See Attached
RFI No 16



Tullacondra Turbine Awareness Coummunity

Re:Planning reference No. 24/5503
Tullacondra Green Energy LTD.
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L15302,L1200,L1205, N20,R581,L1207.L5320,N72, St Josephs Road Mallow Sub Station.

G.C. Route option 1

House No	Name	Signature	Post Code/Folio No	~~Turbine Delivery Route~~	Grid Connection Route	
	K COLLINS	K. Collins	P51THK3		✓	
	E COLLINS	E Collins	P51THK3		✓	
	C Collins	C. Collins	P51 THK3		✓	
	M COLLINS	M. Collins	P51 THK3		✓	
	S. O'Keeffe	Connie O'Keeffe	P51 AP99		✓	
	M SHEEHAN	Michael Sheehan	P51RYW5		✓	
	C O'Riordan	C O'Riordan	P51 HWK7		✓	
	T O'Riordan	Tom O'Riordan	P51 HWK7		✓	
	M Egan	Moss. Egan	P51 PWE		✓	
	A. Metcalfe	A Metcalfe	P51K46N		✓	
	JERRY O'KEEFFE		Y4W8W		✓	
	SO'CONNELL	S O'Connell	P51 NWX3		✓	
	T&S O'Connell	T&S O'Connell	P51 NWX3		✓	13 Eml
	DENIS SHEEHAN	Denis Sheehan				
	Jim Doody	Jim Doody	P51 PX9F		✓	
	Theresa Doody	Theresa Doody				Jim Doody ✓
	Noreen Noonan	Noreen Noonan	P51 WPF9		✓	
	Mary Kinsella	Mary Kinsella	P51 WPF9		✓	
	Margaret Gaulton	Margaret Gaulton	P51 AP84		✓	AP84
	Johnny O'Riordan	John O'Riordan	P51XRC3		✓	
	Elizabeth O'Connell	Elizabeth O'Connell	P51 AE74		✓	
	Diarmuid O'Riordan	Diarmuid O'Riordan	P51AE74		✓	
	Ray Collins	R Collins	P51CT82		✓	
	Don O'Gorman	Don O'Gorman	P51KD92		✓	
	T Keane	T Keane	P51 AY23		✓	
	Catherine Palmer	Catherine Palmer	P51AY23		✓	
	Kitty Reid	Kitty Reid	P51 E6H4		✓	
	Con Reid	Con Reid	P51E6H4		✓	
	Margaret Murphy	M Murphy	P51 AH3K		✓	
	Finbar Murphy		P51AH3K		✓	
	Noel Mahony	Noel Mahony	P51 AW2R		✓	
	Yvonne Costelloe	Yvonne Costelloe	P51A38K		✓	
	Mim Costelloe	M Costelloe	P51HUON		✓	
	Catherine O'Keeffe	Catherine O'Keeffe	P51 WSP1			
	Rory Murphy	Rory Murphy	P51 HPSW		✓	

House No	Name	Signature	Post Code	Folio No	Grid Connection Route	
	JOHN HORGAN	John Horgan	P51 P6VA		✓	
	Denis C. Madigan				✓	
	DAN NOONAN		P51 P2VK		✓	
	NOREEN NOONAN	NoreenNoonan	P51 P2VK		✓	
	Colm Crowley	Colm Crowley	P51 R22N		✓	
	MORNA McDONNELL	Morna McDonnell	P51 DR1T9		✓	
	Derry O Keeffe	Derry O'Keeffe	P51 RFVO		✓	
	Pauline O'Keeffe	Pauline O'Keeffe	P51 RFVO		✓	
	Melodie Saiz	Melodie Saiz	P51 NV0F		✓	
	ANNA COTTER	Anne Cotter	P51 XT0K		✓	
	PHILIP COTTER	Philip Cotter	P51 XT0K		✓	
	PHELIM COTTER	Phelim Cotter	P51 XT0K		✓	
	ANTHONY HIGLY	Anthony Higly	P51 XLX9		✓	
	JUDE GORDON	Jude Gordon	P51 C6WX		✓	
	TOM CORROON		P51 C6WX		✓	
	TESS SHEEHAN	Tess Sheehan	P51 X7KN		✓	
	DENISE SHEEHAN	Denise Sheehan	P51 X7KN		✓	
	SEAN CONCODAN	Sean Concodan			✓	P51 X47V
	LIAM METCALFE	Liam Metcalfe	P51 F67F		✓	
	Labu Paulose	Labu Paulose	P51 YW2P		✓	
	Laly Labu	Laly	P51 YW2P		✓	
	GILBERT LYSAGHT	Gilbert Lysaght	P51 DYX9		✓	
	URSULA LYSAGHT	Ursula Lysaght	P51 DYX9		✓	
	MARK LYSAGHT	Mark Lysaght	P51 HCP5		✓	
	JULIA LYSAGHT	Julia Lysaght	P51 HCP5		✓	P51HCP5
	SUSAN LEAHY	Susan Leahy	P51 AY16		✓	
	Sean Corey	Sean Corey	P51 AY16		✓	
	CHRIS MERRICK	Chris Merrick	P51 PE0E		✓	
	FINBARR SHEEHAN	Finbarr Sheehan	P51 X7FV		✓	
	IRENE O'BRIEN	Irene O'Brien	P51 NC03		✓	
	NOEL O'BRIEN	Noel O'Brien	P51 NC03		✓	
	MAIRIAD BRIEN	Mairiad Brien	P51 NC03		✓	
	SAM GRIEVE	Sam Grieve	P51 ANP4		✓	
	MARCO FRANCE	Marco France	P51		✓	
	Vm FRANCE	Vm France	P51 DK7V		✓	

House No	Name	Signature	Post Code	Folio No	Grid Connection Route
	ANDREW SHEAHAN		P51 FDW2		✓
	JOSEPHINE BREEN	J Breen	P51 Y8TP		✓
	HELEN O'SULLIVAN		P51 EY7A.		✓
	JEROME O'SULLIVAN	Jerome O'Sull	P51 EY7A.		✓
	EVELYN FARRISSEY	E Farrissey	P51 NNP2		
	SEAMUS FARRISSEY	S FARRISSEY	P51 NNP2.		
	DONOUGH BARRON		P51 CD5W.		✓
	GRACE HAUGH	Grace H	P51 E30R		✓
	DECLAN DUGGAN		P51 XE4A		✓
	Eileen Duggan	E Duggan.	P51 XE4A		✓
	NORA BURGESS	N Burgess	P51 PT6D		✓
	HANNAH O'CONNELL	H O'Connell	P51 F3PW		✓
	IAN Saunders	Ian Saunders	P51 F31W		✓
	NATIA COGHLAN		P51 E06K		✓
	DENIS WALSH	Denis Walsh.	P61 RCW6		✓
	REINE WALSH	Reine Walsh	P51 RCW6.		✓
	DANIELLE FINN		P51 LF6P		✓
	WILLIAM GLEESON		P51 V00E		✓
	MICHELLE GLEESON	Michelle Gleeson	P51 V00E		✓
	CATHERINE RYAN	Catherine Ryan	P51 XF2P		✓
	Elaine Hayes		P51 NE58		✓
	Sylvia Darcy	Sylvia Darcy	P51 FF9H		✓
	Derek Darcy	Derek Darcy	P51 FF9H		✓
	Nuala	Nuala Hayes			✓
	IAN ACHESON		P51 Y4E8		✓
	KATHERINE ACHESON	Katherine Acheson	P51 Y4E8		✓
	NOEL WALSH	Noel Walsh	P51 E7PF		✓
	Elizabeth Myers	Elizabeth Myers	P51 RR6P		✓
	Patrick Myers	Patrick Myers	086 2633639		✓
	Ciaran Myers	Ciaran Myers	085 [illegible]10		✓
	LAURA COLLINS	Laura Collins.	P51 NHP7		✓
	JASON BRENNAN	Jason Brennan	P51 N6MD		✓
	Bridget Brennan		P51 V6W1		✓ 3
	Bridget Brennan.				4
	WILLIAM GLEESON	W Gleeson	P51 YC9D		✓

House No	Name	Signature	Post Code	Folio No	Grid Connection Route	
	MARGARET GLEESON	Margaret Gleeson	P51 YC9D		✓	
	MARY	O Mahony	P51 WRX	2	✓	
	GERARD LYNES	Gerard Lynes	P51 NES8		✓	
	John O'Keeffe	John O'Keeffe	P51 AF84		✓	
	TOM BROWNE	Tom Browne	P51 YX9N		✓	
	Billy O'Connor	Bill	P51 FF8D		✓	
	Theresa Finnegan		P51 TNF	2	✓	
	John Finnegan		P51 TXF	2	✓	
	BARRY	TAYLOR	P51 TXF	2	✓	
	Ian	Finnegan	P51 TXF	2	✓	
	M HEALY	Michael Healy	P51 N996		✓	
X	VICENT	Vicent Healy	P51 E5WC			
	JOANNE HEALY	Joanne Healy	P51 N996		✓	
	PATRICK HEALY	Patrick Healy	P51 N996		✓	
	Tracy Lehane	Tracy Lehane	P51 DX6V		✓	
	Michael McRedmond	Mike McRedmond	P51 DX60		✓	
	Eoin O'Sullivan		P51 ~~WX0~~ HD8W		✓	
	TOD KIRBY	Tod Kirby	P51 R5WH		✓	
	Eileen Kirby	Eileen Kirby	P51 RSWH		✓	
	Sarah Daly	Sarah Daly	P51 Y2EF		✓	
	NORA KIRBY	Nora Kirby	P51 WNGA		✓	
	Jean McCarthy		P51 TRD2		✓	
[	MARY COLEMAN		P51 AD76		✓	
	MARY COLEMAN		P51 A66C		✓	
	Conor O'Gorman		P51 KCW4		✓	
	LUCIA JANCIK	Lucia Jancik	P51 YNXB		✓	
	JOHN PALMER		P51 D3CH		✓	
	JOHN WALSHE		P51 E97C		✓	
	MICHAEL	MURPHY	P51 NW9V		✓	
	MARY LYONS	M Lyons	P51 D3KT		✓	
	DAVE LYONS	D Lyons	P51 D3CT		✓	
	PAT LYONS	Pat Lyons	P51 C9CA		✓	
	EDWARD	E Ward	P51 E44A		✓	
	JAMES WARD	James Ward	P51 E44A		✓	

House No	Name	Signature	Post Code	Folio No	Grid Connection Route	
	JOHN BARRY		P51XY09		✓	
	PADDY SEXTON		P51FF6U		✓	
	Teresa O'Callaghan		P51C8ZU		✓	
	Lauren Gleeson		P51C8ZV		✓	
	Rachel Gleeson		P51C8ZU		✓	
	RICHARD	Richard Bohane	P51XFK6		✓	
	EVELYN BOHANE	Evelyn Bohane	P51XFK6		✓	
	MICHAEL O'KEEFFE	Michael O'Keeffe	P51V3PP		✓	
	IANO KEEFFE		P51U3PP		✓	
	CAROLINE DEANE	CDeane	P51FC64		✓	
	JONATHAN DEANE	JDeane	P51FC64		✓	
	[illegible]				✓	
	BERNIE DONOVAN		P51X681D		✓	
	MARY LYNES	Mary Lynes	P51YPP7			
	TONY LYNES		P51YPP7		✓	
	TOM SHEEHAN		P51X9WX		✓	
	URSULA SHEEHAN	Ursula Sheehan	P51RA4C		✓	
	ADRIAN ANTHONY	Adrian J Mahy	P51NY47		✓	
	BERNADETTE		P51D952		✓	
	AIDEEN McAULIFFE	Aideen McAuliffe	P51 N5K8		✓	
	MICHEAL	MILLIGENT			✓	
	M. Mulligan				✓	
	MARTIN O'BRIEN	Martin O'Brien	P51AE24		✓	
	SHANE O'CONNELL	SOConnell	P51XDR3		✓	
	CLAUDIE DALY		P51 NN25		✓	
	BRID McAULIFFE	Brid McA	P51 D73H		✓	
	George J Dwyer		P51 XY W1		✓	
	Geraldine Dwyer		P51 EC62		✓	
	MICHAEL		P51 DC34		✓	
	Anne Lynch	Anne Lynch	P51W5CH			
	C. KELLEHER		P51FF82		✓	
	EILEEN DALY	Eileen Daly	P51EDIW		✓	
	SEAN DALY	Sean Daly	P51EDIW		✓	
	LIAM SHEEHAN	Liam Sheehan			✓	

G.C.R. option 1

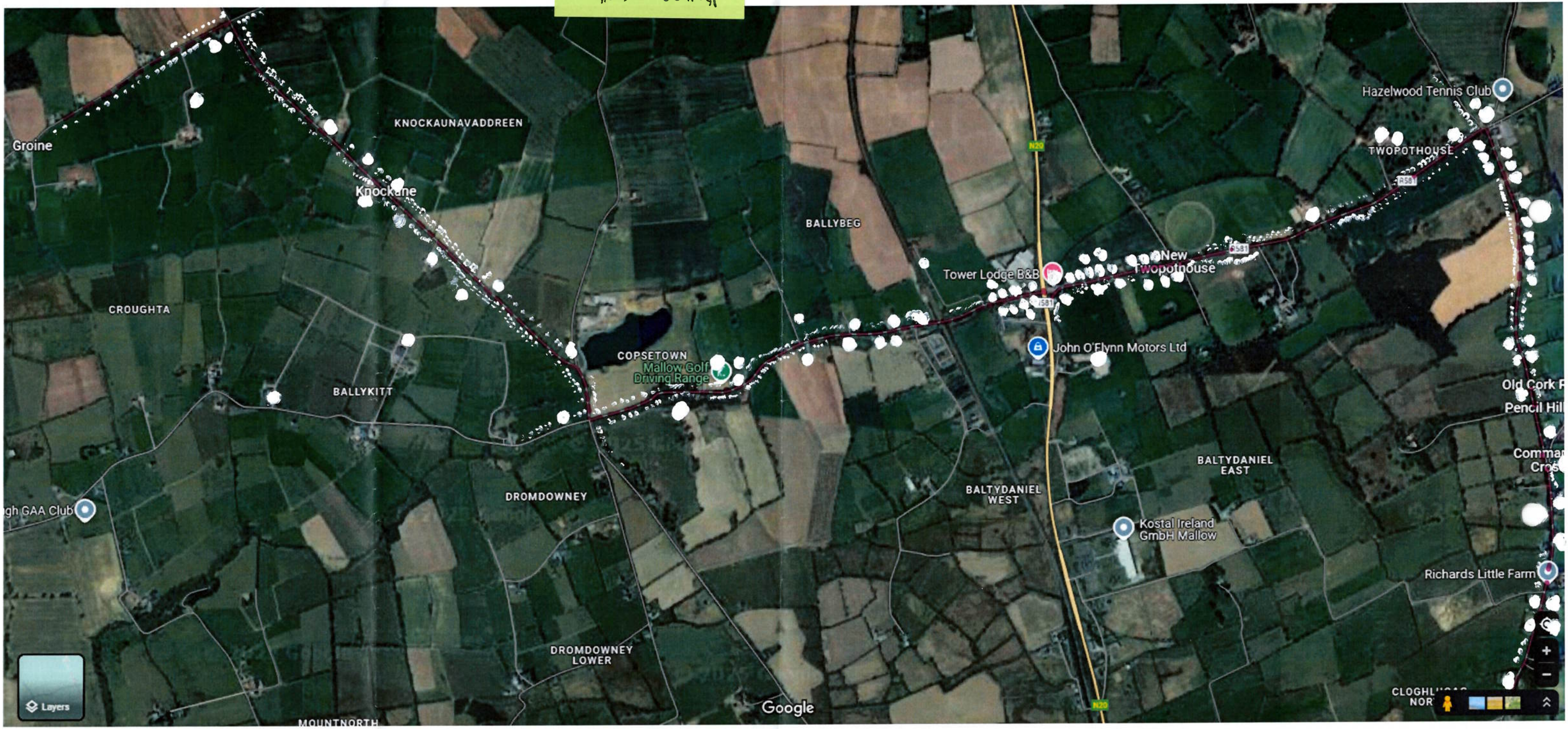
Home owners marked in a white circle.

Land owners marked in a white dotted l

Proprietary

Locations of Signatures All marked using Post code As Accurate as possible on map

G. C. R. Option 1



turbines.

The company has now shut the Preston New Road well and will monitor build-up as it continues to assess the results (which involves installing a flare, the subject of a recent parliamentary question which environment minister Thérèse Coffey's response was that the flaring noise was "not an issue" due to the flare design, site location and background noise).

Cuadrilla has again been refused planning permission for nearby Roseacre Wood, with a critical appeal being dismissed because the Secretary of State feels highway safety issues have not been satisfactorily addressed, and these are seen as determinative (which means other considerations such as noise need not be taken into account, hence the slightly strange wording of the response). As an aside, the night-time noise LOAEL was originally reduced from 42dB to 35dB, with the various proposed conditions in combination with a 37dB $L_{eq1hr\ free\ field}$ limit sufficient to control adverse night-time noise impacts. This is below the WHO Night Noise Guidance LOAEL of 40dB, with the Secretary of State agreeing that factors in this particular case supported a lower threshold.

Simon Stephenson, the technical director of RPS Planning & Development, agrees that the limits are excessive. "The kind of limits and scrutiny you get for fracking is a lot more than there would be for a wind farm. The reason is that it is a lot more politically motivated." He also stresses that it's important not to call the micro-seismic events earthquakes because of the very low magnitude compared to an event that would typically cause damage. "Looking at the vibration levels for fracking and, for example piling for a new industrial complex, the impact of piling is at a much higher level. Quarry blasting has much higher levels of vibration."

While fracking may be relatively new, the drilling processes are very standard and have been used for many years by onshore oil and gas companies, he argues. "The PPG for minerals should be used – it is word for word the same as the previous NPS. Essentially these guidelines have always been used for oil and gas exploration sites, for decades, and should still be used. The guidance is already there."

He also believes that North Yorkshire's proposal for a 500m exclusion zone is unnecessary. "I have been involved on sites where there are houses at significantly less than that – a couple of hundred metres. The difference is that you have to increase the amount of mitigation." His company has worked intensively with a manufacturer testing a drilling rig that incorporates significant mitigation. This now produces just 42dB at 120m from the site boundary, and he believes that potentially more noise reductions could be achieved if necessary – though the lower the requirement, the more complex and difficult the challenge.

Innovation is constantly reducing the amount of noise produced by the equipment required for fracking, he adds, though there can be trade-offs. Silencers on the exhausts of diesel generators, for example, create more back pressure and thus reduce efficiency. He predicts that much more can be achieved in terms of equipment noise as the industry matures in the UK. "A lot of equipment comes in from the US, where they are not particularly keen on reducing noise."

He also points out that the potential noise sources occur mainly during the early stages of the fracking process – the short period when the seismic survey truck is vibrating ground to determine the geology, a process that has a similar dispensation to quarrying, and the exploratory drilling, which takes an average of three months. The appraisal period, when gas has to be flared, can also create noise, he explains. "It is necessary to have a flare that can handle the widest possible range of scenarios. A shrouded ground flare is noisier than an enclosed ground flare, because it has to be able to handle all conditions and meet Environment Agency requirements for atmospheric emissions."

The Ellesmere Port public inquiry (for a proposed IGas site), which has just finished, focused on flaring as an example of potential noise. The Cheshire West and Chester Council expert argued that IGas should have considered collecting the gas rather than flaring it and Frack Free Ellesmere Port, one of the main anti-fracking protest groups, alleged that IGas had disregarded noise and air quality impacts of the well.

The potential for fracking to cause noise is mainly due to the fact these early stages do not use permanent noise mitigation installations, as the costs of installing such mitigation when the site might be unsuitable for development would be prohibitive and make the process uneconomic, Stephenson explains. When a permanent well is installed, which will be active for a period of 10 to 30 years, solid enclosures with full acoustic control are constructed.

Expanding on the skewed treatment that fracking receives, Stephenson cites a new geothermal well at Jubilee Pool, Penzance, in Cornwall. "Because it is not oil and gas but green energy, it is operating with significantly higher noise limits than would be allowed for an oil and gas drilling programme. The drilling rig used will be the same process and noise sources as used for oil and gas drilling. It may well be exactly the same rig, although I don't know which rig is being proposed." Many of the oil and gas rigs are also used to drill for water, he notes.

In this case, the operators are proposing night time noise limits of 55dBA, compared to a maximum of 42dBA allowed under the PPG for Minerals. "I note that the baseline noise levels appear quite high (48dBA at night during the week) but even so, 55dBA is much higher than you would get away with for an oil and gas development."

Proof of that, he says, is the Ellesmere Port wellsite, which is next to a motorway and with baseline noise levels at the nearest properties of up to 61dB LA_{eq} at night. In that case, the MPA only reluctantly agreed to raising the noise limits from 42dB LA_{eq} to 45dB LA_{eq}. Ellesmere Port is currently going through a public inquiry, as mentioned above, for which Stephenson prepared the evidence on noise. The closest property to the rig in Cornwall is 45m away, compared to the North Yorkshire plan's proposed 500m standoff for drilling of oil and gas wells due to noise.

Despite the ferocious opposition, there is still plenty of impetus in the sector. The well-known Third Energy site at Kirby Misperton in Yorkshire may be delayed pending government approvals, but an IGas Energy site in Doncaster has gained planning permission for exploration and an Angus Energy oil site in Brockham, Surrey, is moving forward quickly. Oil giant Ineos is pushing hard to exploit shale gas reserves across the country (for example, the controversial Sherwood Forest site and its extensive licence interests across North and South Yorkshire, the East Midlands and Cheshire).

However, fracking is still banned in Northern Ireland and Scotland and there is a moratorium in Wales. Compared to wind, or geothermal energy, fracking is struggling for acceptance not least because of the dread factor. This is despite the considerable neighbour noise misery sometimes inflicted by wind farms (as seen in the previous pages). Noise is just one of the objections raised to fracking however, which is blessed with a range of issues relating to carbon footprint, climate change, sustainability and (of course) vibration.

However, the industry is following closely in the footsteps of the accepted (and similarly not "green") onshore oil and gas, using pretty well identical equipment and techniques for which (certainly in terms of noise) mitigation is available. It would seem that being relatively new, and not "green", is sufficient to have caused the recent policy inconsistencies with wind.

SOUND BITES

The UK does not normally need to pay much heed to European guidance on rail track access charges for freight operators. We have very little rail freight and very little demand or indeed capacity to let others run freight trains on our tracks.

The European Commission has released a long and detailed consultation on the evaluation of noise differentiated track access charges.

Up front it says: "The prime objective of the implementing regulation is to contribute to the improvement of the well-being of the EU citizens; and reduce the risks to the competitiveness of the rail freight sector by incentivising retrofitting through reduced track access charges.

"Consultant Ricardo is supporting the Commission in its evaluation, and will be launching surveys for Railway Undertakings and Wagon Keepers/Wagon Owners, and will have a wider interview programme covering these stakeholders as well as infrastructure managers, national authorities, citizens' associations, and rail equipment manufacturers."

Unless we are missing something, this level of concern for EU citizens seems to apply to rail but not road. We cannot recall any such consultations on the impact of eastern European hauliers with 1000 litre belly tanks of diesel (to avoid our high fuel charges) thundering around the UK undercutting UK hauliers. Nor indeed any examination of the sense of quite so much trans-European freight going by road across the Channel then deafening the good people of Kent and beyond who have the misfortune to live near a motorway.

UK road investment in the UK is driven by value for money and how many seconds can be shaved off journeys for "businessmen". The level of scrutiny afforded to European rail wagons does not appear to be applied to European (or domestic) trucking operations.

No matter – we'll be out of Europe within days and Gove's faux concern for the environment can slip. Or not – as the case might be!

Two turbines are being demolished in the US representing the end of a long fight. This comes as nuisance action appears to have succeeded in Aberdeenshire (*see page six*) .

Falmouth residents have long been vocal about two huge turbines that were put up near their homes. The Massachusetts residents complained of an unholy noise and have made repeated attempts to silence them.

They had little help from their local authority – because they were installed by the local authority as a showpiece green project. There was huge reluctance by the council to intervene – it even held a referendum which unsurprisingly found most wanted to keep the turbines.

Referendums are problematic as we in the UK have found out. But it defies principles of noise management to start to ask the population as a whole whether action should be taken to protect individual noise sufferers.

The whole saga started in 2010 and it has taken nine years to abate the nuisance despite clearly excessive noise. As in the UK, the subtleties of noise nuisance are that it is devilishly hard to get rid of a problem turbine once it starts operating.

COMING EVENTS 2019

2019

May 13th-14th
ACOUSTICS 2019
IoA two day conference to be held in Milton Keynes, details www.ioa.org.uk

May 20th – 25th
NOISE ACTION WEEK
www.noiseactionweek.org.uk

June 6th
ANC ANNUAL CONFERENCE AND AWARDS
Association of Noise Consultants conference and awards to be held at the Crowne Plaza in Manchester, www.association-of-noise-consultants.co.uk

June 16th – June 19th
INTERNOISE 2019
to be held in Madrid, https://euracoustics.org/event

June 12th – 14th
WIND TURBINE NOISE 2019
to be held in Lisbon. www.windturbinenoise.eu

June 15th – 18th
13TH ICBEN CONGRESS
(International Commission on Biological Effects of Noise ICBEN) to be held in Stockholm, more details, www.icben.org

June 25th
SOUNDSCAPE WORKSHOP
Overcoming traditional acoustic challenges to urban planning and development, IoA workshop to be held in London details www.ioa.org.uk

Aug 25th – August 29th
NOISECON 2019
to be held in San Diego USA, www.inceusa.org/conferences/noise-con-2019

September 8th – 13th
ICA 2019
23rd International Congress in Acoustics (ICA 2019) to be held in Aachen, Germany, more details http://ica2019.org

September 25th
CIEH NOISE CONTROL CONFERENCE
to be held in London www.cieh.org

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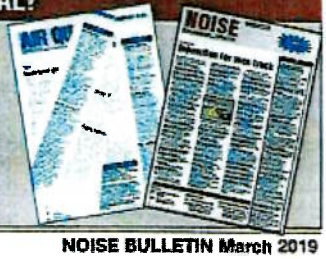
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Jack Pease



Assessment of Infrasound and Low Frequency Noise—Case Study in a Community of Inhabitants Near Wind Turbines



Cristina Trigueiro, João Almeida, João Paulo Figueiredo, and Ana Ferreira

Abstract Technological advances in the construction of wind turbines with lower noise emission have been many, however they continue to be responsible for producing infrasound and low frequency noise that can affect the quality of life of human populations (hypertension, discomfort, sleep disorders, among others). Assess the levels of infrasound and low-frequency noise at which residents in the vicinity of the wind turbines were taking into account wind direction, air speed and distance to the source. The analytical collection was carried out inside houses in the district of Viana do Castelo, using a CESVA SC420 sound level meter. The distance to the noise source was not a relevant factor in the attenuation. The wind speed and direction were responsible for the noise expression. The southernmost dwellings in the region under study were more exposed to higher levels of this types of noise. It is important to adopt territorial management measures taking into account the protection of public health, environmental impact studies within the scope of the types of noise and safety distances, taking into account the population.

Keywords Infrasound · Wind turbines · Noise pollution · Vibroacoustic disease · Sound pressure level

1 Introduction

The World Health Organization defines health as complete physical, psychological and social well-being and not merely the absence of disease (WHO 1980). Currently, the concept of quality of life has emerged in several contexts, namely in health, politics and environment. It is understood as a general concept that encompasses

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environmental factors, income levels, health, lifestyle, satisfaction, and self-esteem (Cassou 2001). This is affected by several factors, including population growth, stress, social status, but also pollution (Santos et al. 2000). Among the various forms of pollution that affect humans is noise pollution. This fact is considered to be the responsibility of the growth of cities and the change in mobility behaviors (WHO 2012; Tang and Wang 2007).

In recent years, the need for alternative energies has found in wind energy an inexhaustible source of electricity production. This fact, combined with technological development, has led to an exponential growth of both the equipment and its implementation, neglecting the negative impacts they cause in their area of influence (Maia 2010).

Wind energy represents the use of the kinetic energy contained in the wind, which is captured by the blades of the wind turbine engine and converted into mechanical energy. Later, the mechanical energy is transformed into electrical energy in the generator. The electrical energy is then injected into the electrical distribution, or transmission (Fernandes et al. 2009). Despite the advantages in using wind energy for electricity generation, this type of wind energy use also has significant disadvantages and impacts mainly in the use of large wind turbines, wind farms and turbines (ENEOP s.d.).

Despite the advantages in using wind energy for electricity generation, this type of wind energy use also has significant disadvantages and impacts mainly in the use of large wind turbines, wind farms and turbines (Stewart 2006). Since there is a wide difference in individual tolerance levels to noise, there is no completely satisfactory way to measure its subjective effects, as well as the corresponding annoyance reactions (Filho and Azevedo 2013).

It is empirically known that noise exposure can cause a wide range of disorders, such as hypertension, annoyance, sleep alterations, and most exponential deafness (Alves-Pereira and Branco 2009, 2007b).

Hearing loss is the most studied effect and the only one considered in the Portuguese legislation. Hearing loss manifests itself particularly in the sound frequencies in which the ear has greater sensitivity. However, when exposed to Infrasound and Low F, there are other effects of exposure, such as loss of sleep quality, stress, cardiovascular disorders, gastrointestinal complications, endocrine disorders, changes in respiratory rate, central nervous system, fatigue, harmful effects due to the resonance frequency of internal organs, among others (Alves-Pereira and Branco 2007a; Antunes 2009; Bento 2011).

The objectives of the present study were to measure and understand the levels of Infrasound and Low Frequency Noise (ILFN) that residents living near wind farms are exposed to, and also to understand how some variables, such as distance to the source, wind direction, air speed, and geomorphology of the region are related to the propagation of sound pressure levels.

2 Materials and Methods

The present study is of the observational type of transverse timeline. As regards the level of knowledge, it was classified in level II (descriptive-correlational). In terms of duration, the study took place from October 2020 to July 2021, and data collection took place between May and June 2021.

The sample was of the non-probabilistic type and, as for the technique, for convenience. The study population consisted of the residents of the three dwellings (located in the district of Viana do Castelo) where 124 measurements were taken. Of the total number of comprised the sample, 46 were made in Housing A, 40 in Housing B and 38 in House C.

For data collection, a CESVA sound level meter equipped with the FFT module for Fast Fourier Transform analysis, was used, with 10,000 lines from 2 to 20,000 Hz (2 Hz/line). This equipment was calibrated before and after measurements using a CESVA acoustic calibrator, model CB006.

Measurements were taken inside the three houses, in the "Kitchen", "Living Room" and "Bedroom" divisions. For a better understanding of the data obtained and their treatment, the divisions of the dwellings were classified according to their location and exposure to wind turbines.

The sound meter was positioned 1.5 m from the floor, in the center of the divisions facing the nearest PE and as far away from infrastructure and furniture as possible. The measurements were taken for 60 s (maximum time allowed for the sound meter with the FFT analysis module). In each room, at least 4 measurements were taken, for three days, during the same time period (Kitchen: 12:00–14:00; Living Room: 18–20 h; Bedroom: 20–22 h) representative of the longest stay of the inhabitants in the respective divisions.

The data measured with the sound level meter were transferred using CESVA lab software (version 3.2). Based on the frequencies collected, the following types of noise were calculated: Infrasound from 2 to 20 Hz; and RBF from 20 to 500 Hz.

The climatic data collection was made through the website of the Portuguese Institute of The Sea and Atmosphere and was corresponding to the measurement period. This data collection was made through the hourly summary of the meteorological station of "Viana do Castelo". The variables "Air Speed", "Wind Direction" and "Temperature" were collected. During the period of measurements was not verified occurrence of precipitation.

Google Earth pro Software (version 7.3.3.7786) was used for georeferencing the dwellings and the location of the wind turbines.

Data obtained were statistically treated using IBM SPSS Statistics version 27 software. For this purpose, the 1-Factor ANOVA, Brown-Forsythe, Kruskal–Wallis and Pierson Linear Correlation Coefficient test were applied for statistical inference. For the estimation of statistical inference, a 95% confidence level and a random error of less than or equal to 5% were taken into consideration.

3 Results

Regarding the location of the dwellings, Dwelling A is located in the parish of São Pedro d´Arcos (municipality of Ponte de Lima), 7 km south of the wind farm of the Serra de Arga. North of the house (300 m) is located on the A27 motorway and south (2.20 km) a wastewater treatment plant. Dwelling B is located 11 km south of the Serra de Arga wind farm, in the parish of Lanheses (municipality of Viana do Castelo). To the north of the dwelling is the A27 highway (2.27 km) and the national road 202 (325 m), to the west is the national road 305 (150 m). North of it is located the Lanheses Industrial Park. Dwelling C is located in the parish of Arcozelo (municipality of Ponte de Lima), 9 km east of the Serra de Arga wind farm. At 150 m north of the dwelling is the A27 highway (tunnel area), three quarries (2 km) and also the bituminous plant (725 m).

After identifying the dwellings (geographically) we sought to compare the levels of Infrassounds between the different dwellings evaluated (Table 1). It was found that the infrasound do not differ between the dwellings, regardless of their location and distance from the emitter source (p-value > 0.05).

The same analysis was performed for the variable "RBF" (Table 2). Also in this type of noise it was found that there were no differences between the dwellings regardless of location and distance from the source of emission a (p-value > 0.05).

The variation of Infrasound and RBF was also evaluated as a function of air velocity. In Dwelling A, according to the results obtained, it can be seen that the noise type "RBF" ($r = 0.369$; p-value $= 0.012$) and "Infrasound" ($r = 0.699$; p-value < 0.001) showed to be correlated with air speed. Also in Dwelling C, there was a

Table 1 Expression of infrasound (dB) by dwelling under study

Dwelling	N	Average	Standard deviation	p-value
A	46	57.63	7.59	0.172
B	39	59.73	10.10	
C	37	56.51	3.41	
Total	122	57.96	7.65	

Test: Brown-Forsythe

Table 2 Expression of low frequency noise (dB) by dwelling under study

Dwelling	N	Average	Standard deviation	p-value
A	46	42.78	9.73	0.809
B	39	43.28	6.82	
C	37	42.17	5.34	
Total	122	42.75	7.64	

Test: ANOVA 1 Fator

significant (inverse) correlation between air speed, regarding RBF ($r = -0.431$; p-value $= 0.008$) and Infrasound ($r = -0.435$; p-value $= 0.007$). However, in Dwelling B there was no correlation pattern.

As for the variation of the noise level as a function of the wind direction per dwelling (Fig. 1) we found that in Dwelling A, when the measurements were taken, wind directions from NW and S did not present any significant effect on the levels of Infrasound and RBF. As for Dwelling B, wind directions from NW, S, N and W were verified, with a significant impact on the levels of Infrasound. Finally, in Dwelling C there were differences in terms of Infrasound and RBF when the direction of the wind came from NW, SW and E.

It was also intended to analyze the behavior of the sound pressure level of Infrasound and RBF to which each dwelling is exposed. Based on Fig. 2, there was a similar behavior in Dwellings A, B and C. There were several increases in the sound pressure level (peaks) common in the three dwellings along the frequency spectrum, namely, at 40, 62, 102 and 302 Hz.

4 Discussion

The distance of the dwellings from the noise emission source did not influence its propagation. The reduced energy loss of this type of noise (infrasound and low-frequency noise) over distance is due to a very particular characteristic of this type of noise: extremely long wavelengths. This feature makes noise transmission occur over long distances without energy loss (Berglund et al. 1996).

In the transversal elevation profiles of the houses to the nearest wind farm, it was found that, compared to Dwelling A and B, the turbines of the Serra de Arga wind farm are located on the extensive plateau, with no morphological structures that constitute obstacles to the propagation of the wind noise. Regarding air speed, it was found that the influence on sound propagation is significant, presenting a positive correlation in Dwelling A and C.

In fact, it was possible to verify in these dwellings that the higher the air speed, the higher the sound pressure levels. As the air speed increases, the wind turbine rotor rotates more, and the higher frequency of the blade passing through the tower, therefore, leads to more infrasound (Van Den Berg 2005). In Dwelling B there was no correlation, which may be due to other external variables, namely the presence of highway.

As for the wind direction, it was found over the period of measurement wind from several cardinal points. However, the points where significant differences in the expression of Infrasound and RBF stand out were when they had a North (N) and Northwest (NW) direction, a worrying fact due to the most characteristic wind direction in Mainland Portugal, from North (Almeida 2018).

Given the impact of these exposures to different noises in homes, it can give rise to a set of symptoms and pathologies in its inhabitants, namely headaches, sleep disorders, changes in the respiratory system, changes in the cardiovascular system,

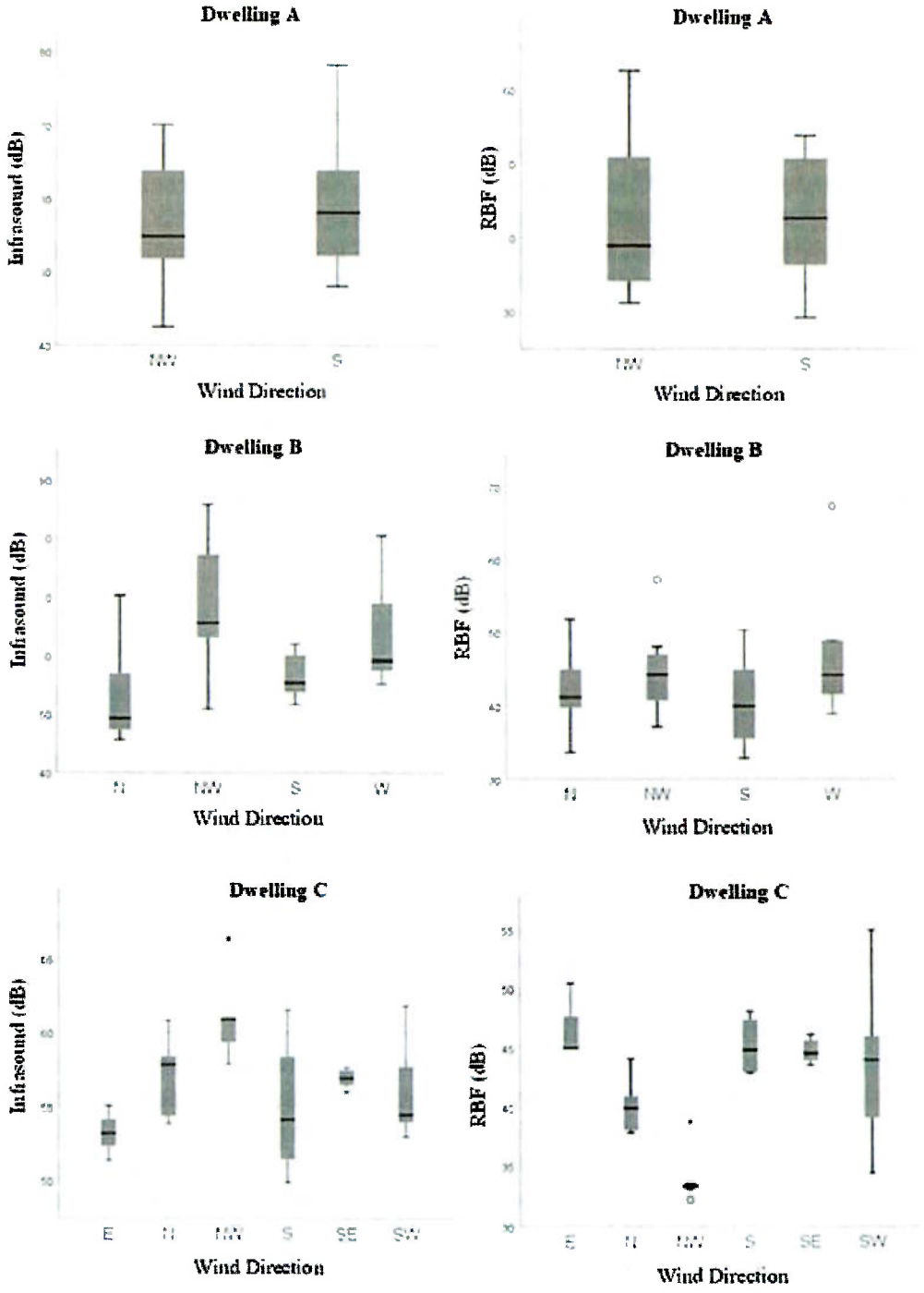


Fig. 1 Correlation between infrasound and RBF against wind direction and housing

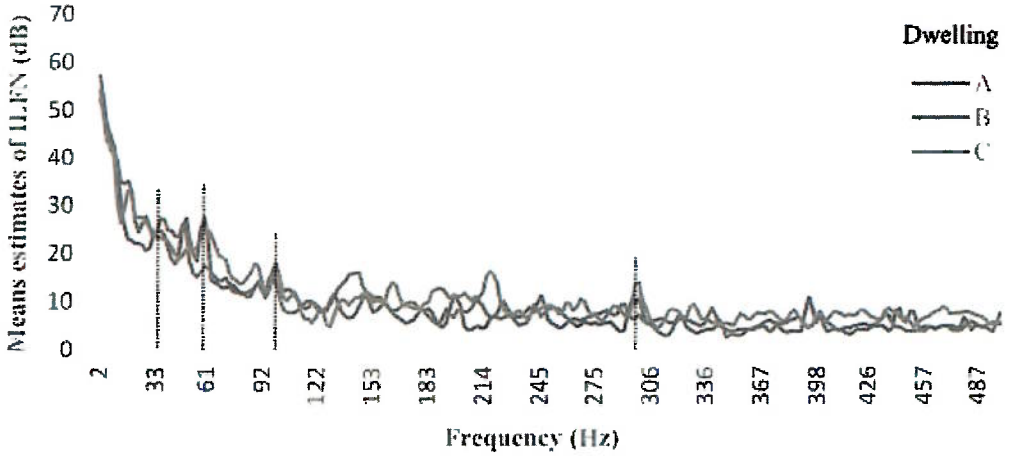


Fig. 2 Sound pressure level (dB) by frequency (Hz)

changes in the gastrointestinal system, increased of muscle tension, irritability and aggression, increased fatigue, decreased attention span, concentration, learning and memory (Stansfeld and Matheson 2003; EEA 2010; Carvalho and Rocha 2008; Freitas and Cordeiro 2013; Mendes and Silva 2017).

5 Conclusions

It was concluded that the residents of the houses under study are exposed to considerable sound pressure levels, and the distance to the emitting source is not significant in their expression. It was possible to conclude that air speed and wind direction are directly related to the noise levels recorded. There are also other variables, including the existence of highways, forests, geomorphological structures and terrain topography between the dwellings and the wind turbines that influence the propagation of infrasound and low frequency noise.

Throughout the study, some limitations were identified, which despite not putting into question the scientific veracity of the same could improve its execution. In particular at the level of noise measurement equipment, limited to the level of the measurement time.

In view of the above, it becomes increasingly important a greater planning and land-use planning, with regard to the implementation of Wind Farms, and also the adoption of measures to mitigate the propagation of noise in existing farms. The environmental impact study is a tool that should be taken into account for the protection of the population living near wind turbines, as also, the study of the consequences of their implementation, and the dose–response relationship in the population.

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The Impact of Wind Farms on Property Values: A Geographically Weighted Hedonic Pricing Model

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The Impact of Wind Farms on Property Values: A Geographically Weighted Hedonic Pricing Model

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ABSTRACT

Wind power is the most important renewable energy source in many countries today, characterized by a rapid and extensive diffusion since the 1990s. However, it has also triggered much debate with regard to the impact on landscape and vista. Therefore, siting processes of wind farm projects are often accompanied by massive public protest, because of visual and aural impacts on the surrounding area. These mostly negative consequences might be reflected in property values and house prices. The aim of this paper is to investigate the impacts of wind farms on the surrounding area through property values, by means of a hedonic pricing model, using both a spatial fixed (viewshed) effects (accounting for spatially clustered unobserved influences) and a Geographically Weighted Regression model (accounting for spatial heterogeneity). The analysis is the first of its kind undertaken for a local region in Continental Europe (North Rhine-Westphalia, Germany). Viewsheds are calculated for each property using a digital surface model. Focusing on proximity and visibility effects caused by wind farm sites, we find that proximity, measured by the inverse distance to the nearest wind turbine, indeed causes significant negative impacts on the surrounding property values. Thereby, local statistics reveal varying spatial patterns of the coefficient estimates across and within the city areas and districts. In contrast, no evidence is found for a statistically significant impact of the visibility of the wind farm turbines.

Keywords: Wind power, Hedonic pricing, Spatial fixed effects, Geographically Weighted Regression

JEL Classification: C31, Q2, Q42, R31

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I. INTRODUCTION

Against the background of climate change and increasing concerns about security of energy supply, the expansion of the renewable energy supply and the substitution of fossil fuel-based energy sources have become key topics on political agendas worldwide. Therefore, national energy policies are increasingly focusing on the promotion of wind, solar, biomass, geothermal, and other energy sources through extensive support schemes. As a result, the share of renewable sources has substantially increased in many countries since the 1990s. Although the further expansion and promotion of renewable energies is crucial with regard to a substantial transition to a more sustainable future energy mix, renewable energy projects, just like conventional ones, often trigger public concern and resistance.

In Germany, considerable growth in the share of renewable energies is attributable to the introduction of the *Act of Granting Priority to the Renewable Energy Sources* (Erneuerbare-Energien-Gesetz, EEG) in 2000, amended in 2004, 2009, and 2012 (EEG, 2000, 2004, 2009, 2012). Introducing this regulatory framework for the promotion of electricity and heat from renewable energy sources, which is essentially based on feed-in tariffs guaranteed over 20 years, had a substantial impact on the speed and extent of the diffusion of renewable energy technologies. Particularly, the wind energy sector in Germany saw a rapidly increasing contribution, with a total of 22,297 installed wind turbines (onshore and offshore) and an installed capacity of 29,075 MW by 2011 (Figure 1). Although wind energy already accounts for the highest share of electricity production within the renewable energy sector[1], its annual growth rate of installed capacity in 2011 of about 7% was still fairly high. In terms of the total electricity consumption in Germany in 2011, wind power accounted for a share of 7.6% (BMU, 2012).

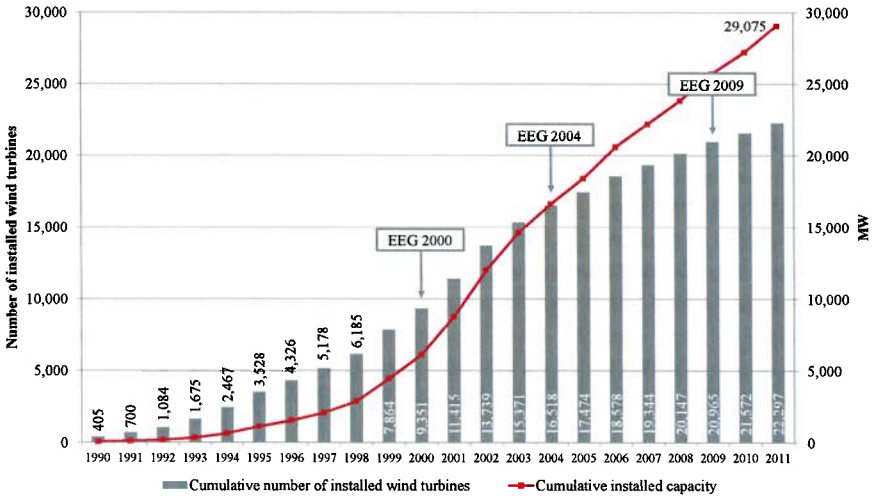


FIGURE 1
Development of the wind energy sector in Germany, 1990-2011
Source: BMU (2012), own illustration

[1] Wind energy accounted for 38.1%, biomass energy for 30.3%, hydro power for 16.0% and photovoltaics for 15.6% of the total amount of electricity produced by the renewable energy sector in 2011.

The heavily promoted expansion of renewable energy technologies is mostly justified by referring to the advantages and benign attributes associated with them. In the case of wind power, these attributes are, e.g., a "green" and in particular CO_2-free energy generation without fuel costs as well as reasonable land consumption (Ackermann and Söder, 2002; Manwell, et al., 2009, pp.443-447; BWE, 2012). However, not only advantages and positive effects are associated with wind farm sites. Firstly, the amount of electricity produced is to some extent unreliable and unpredictable due to unsteady wind conditions. Secondly, the hub heights of wind turbines, both newly constructed and after repowering[2], have been increased over the last years in order to further raise efficiency (Junginger et al., 2005; Sieros et al., 2012). As a consequence, the upscaling of wind turbine nacelles to heights of 100 m and more, and corresponding blade diameters, has led to a substantial change of landscape and vista.

The negative externalities caused by wind farm sites have led to major public concern that particularly refers to the impact on the environment and landscape. The latter tends to result in massive public protest, because of apparent visual[3] and aural[4] impacts on the surrounding area, with negative consequences that are supposed to be reflected in property values and housing prices. Public debates accompanying siting processes solely involve the argument of the expected devaluation of property or house prices as a consequence of siting in the proximity of a property or a house. Apart from the existing economic and regulatory complexity of siting processes, social acceptance and, especially in the case of wind farms, "NIMBY" (Not In My Backyard) attitudes become increasingly virulent (Wolsink, 2000; van der Horst, 2007; Wolsink, 2007). However, with decreasing social acceptance regarding siting decisions, the sound and transparent estimation and valuation of potential environmental impacts and other acceptance-biasing aspects should play a paramount role within the siting process, in order to mitigate public protest and related unanticipated and underestimated (external or internal) project costs.

The aim of this paper is to investigate the impacts of wind farms on the surrounding area through property values, by means of a hedonic pricing model, using spatial fixed effects (accounting for spatially clustered unobserved influences) and a Geographically Weighted Regression (GWR) model (accounting for spatial heterogeneity). The main focus lies on the investigation of site proximity and visual impacts of wind farms, such as the impact of visibility and shadow flickering, as these are the dominant subject of public debates associated with siting processes.

In a first step, we apply three different spatial fixed effects models in order to capture effects of unobserved spatial factors.[5] Since spatial fixed effects models have been applied to the case of wind farm effects before (e.g. Heintzelman and Tuttle, 2011 and Hoen et al., 2009, 2011), we improve upon the already applied methodologies in the literature, investigating the

[2] Repowering is the replacement of older turbines in favor of new and more efficient ones, which most often also have a higher installed capacity (Madlener and Schumacher, 2011; Sieros et al., 2012).

[3] Visual impacts comprise general visibility and shadow flickering effects (Álvarez-Farizo and Hanley, 2002).

[4] Aural impacts refer to turbine noise and sound pressure (Rogers et al., 2006; Harrison, 2011).

[5] The three spatial fixed effects model specifications are varying according to their geographical scale, where smaller scales of the fixed effects allow for tighter control with regard to omitted variable bias (Heintzelman and Tuttle, 2011). The spatial fixed effects included in our analysis are fixed city effects, fixed city district effects and fixed cadastral district effects. For a detailed description of the model specifications see section 3.

importance of the view on the facility by means of a fixed viewshed effect model specification. Controlling for visibility effects will emphasize and highlight the importance of distance to the facility, therefore, providing a more sophisticated measure of proximity than commonly applied. A specific element is the application of Geographical Information System (GIS) techniques[6], which allow for an accurate derivation of viewsheds[7] for each property in a 3D environment on the basis of high resolution geodata.

In a second step, we additionally apply a GWR analysis in order to gain a more detailed picture of local impacts and spatially varying relationships compared to global estimation results. This particularly includes the consideration of spatial correlation and the analysis of the biasing influence of spatial non-stationarity on the estimation results. To the best of our knowledge, there is no other hedonic pricing analysis applied to wind farm impacts yet that specifically adopted a GWR approach in combination to other regression techniques in order to emphasize the importance of local dependencies. Hence, the merit of our contribution is the specific investigation of spatial patterns and locational dependencies in the frame of a hedonic pricing model applied to the case of a wind farm site.

There is a number of studies investigating the impact of wind farm sites on the surrounding area from a social acceptance point of view, using survey-based approaches (e.g. Krohn and Damborg, 1999; Wolsink, 2000; Álvarez-Farizo and Hanley, 2002). The number of studies that aim at quantifying economic impacts of wind farms on the surrounding area is much lower. Albeit there are several studies in this context using non-market valuation techniques, with the hedonic pricing approach most commonly being applied (e.g. Hoen et al., 2009; Canning and Simmons, 2010)[8], to our knowledge there are only a few analyses in the peer-reviewed literature so far (Sims and Dent, 2007; Sims et al., 2008; Laposa and Mueller, 2010; Heintzelman and Tuttle, 2011; Hoen et al. 2011), which are briefly discussed in the following.

Sims and Dent (2007) investigated the impact of a wind farm near Cornwall, UK, on house prices, using a hedonic pricing approach and comparative sales analysis. Applying straightforward OLS regression, they found some correlation between the distance to a wind farm and property values. Due to data limitations, the overall model results had a fairly weak explanatory power.

Sims et al. (2008) modeled the impact of wind farm proximity to houses for a region near Cornwall, UK. There was some evidence to suggest that noise and flicker effects as well as visibility may influence property value in a wind farm's vicinity. However, the hedonic analysis, in which standard OLS regression techniques were used, showed no significant impacts caused by the wind farm.

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[6] GIS software is a powerful tool for enhancing the spatial precision of estimation techniques. With the capability to capture, store, manage, analyze, and display space-related information, GIS software systems are frequently used for underpinning hedonic pricing models. In this context, implementation possibilities are quite diverse, such as analyzing spatial heterogeneity (Geoghegan et al., 1997) or developing Digital Elevation Models (DEM), in order to apply visibility analyses (Paterson and Boyle, 2002; Lake et al., 2010).

[7] Viewsheds display areas of land, water, or other environmental elements that are visible to the human eye from a fixed vantage point (in our case the considered properties). The visibility of a large-scale wind farm in the close vicinity of a property might have a significant impact on its value.

[8] There is also research on the impact of wind farm proximity, applying a simple quantitative approach (Sterzinger et al., 2003), and published in the form of project reports. Sterzinger et al. (2003) compared property transactions within a five-kilometer radius around the site, using a group of comparable control transactions outside of this range, but without controlling for other factors explaining property prices.

Laposa and Müller (2010) examined the impact of wind farm project announcements on property values for northern Colorado, US. Including observations before and after the announcement of the wind farm project, they applied a hedonic pricing model accounting for announcement and spatial characteristics of three location groups. The results obtained indicated no significant impact of the planned project's announcement.

Exploring the impacts of new wind facilities on property values in northern New York, US, by means of a fixed effects hedonic pricing model, Heintzelman and Tuttle (2011) found that nearby wind facilities can significantly reduce property values. Decreasing the distance to the wind farm to one mile indicated a property price devaluation of between 7.73% and 14.87%. In addition, they controlled for omitted variables and endogeneity biases by applying a repeat-sales analysis.

In a peer-reviewed and published version of the Hoen et al. (2009) project report, Hoen et al. (2011) investigated 7,459 sales of single-family houses surrounding 24 wind farm sites in the US. They applied various hedonic pricing model specifications, using spatial fixed effects to account for spatial dependence and spatial autocorrelation. A main focus was put on the impact of view and distance to the site. Overall, they found no statistically significant effects on property sales prices.

Table 1 provides an overview of selected hedonic pricing analyses on wind farm impacts.

TABLE 1
Overview of hedonic pricing studies

Study	Study area	*n*	Time period [years]	Pre-/Post-construction	Distance to wind farm [km]	Repeat sales	Property value impact
Sims and Dent (2007)	Cornwall, UK	919	5.5	post	< 16	no	negative
Sims et al. (2008)	Cornwall, UK	199	7.5	post	0.8-1.6	no	none
Laposa and Müller (2010)	Colorado, US	2,910	9	pre	< 80	no	none
Heintzelman and Tuttle (2011)	New York (state), US	11,331	10	pre/ post	< 86	yes	negative
Hoen et al. (2009, 2011)	US (24 sites)	7,459	11.5	pre/ post	< 17.6	yes	none
Canning and Simmons (2010)	Ontario, Canada	83	2.5	post	n.a.	yes	none

Source: own illustration

As most of the hedonic pricing studies on wind farms were conducted in the UK and the US, respectively, such a study investigating the impacts of wind farms in a Continental European location (North Rhine-Westphalia, Germany) can be expected to yield new insights. The reason is that, in contrast to the regional dimensions of the areas typically considered in US studies, regional structures and thus study areas in Europe are often much smaller, which likely affects the results and insights gained. A wind farm near the German cities of Rheine and Neuenkirchen in the federal state of North Rhine-Westphalia (NRW), constructed in 2002, is chosen for applying the selected model specifications. We are not aware of any other scientific study on wind farm impacts using German real estate market data.

The remainder of this paper is organized as follows. Section II provides the theoretical background and literature overview. Section III introduces the hedonic pricing model and the estimation techniques applied. Furthermore, section III presents the dataset and the description of the estimation variables. Section IV reports on the results obtained from the

different model specifications. Section V concludes and also draws some attention to future research needs.

II. THEORETICAL BACKGROUND AND RELATED LITERATURE

The methodology adopted in this paper is associated with non-market valuation techniques. These comprise various techniques for estimating the value of goods and services that are not traded in markets and whose value is, therefore, not revealed in market prices (Tietenberg and Lesiw, 2009, p.35). This applies particularly to environmental goods, such as air and water quality, as well as landscape and related positive or negative externalities.

There are different methods in the field of non-market valuation, which can be categorized according to the individuals' preferences that are either stated or revealed. *Stated preference methods*, such as contingent valuation or choice modeling, are based on practical survey techniques, essentially investigating the willingness to pay (WTP) for obtaining a particular good (Kriström, 2002; Bateman, 2010; Tisdell, 2010, p.203; Krueger et al., 2011). Alternatively, *revealed preference methods* rest upon the assumption that individuals' preferences can be derived from their consumption behavior (Tietenberg and Lesiw, 2009, p.39; Tisdell, 2010, p.203), and comprise methods like the travel cost method and the hedonic pricing method.

Rosen (1974) pioneered the economic formalization of a hedonic pricing model, although earlier studies tackled the approach of implicit markets (Tiebout, 1956) and statistical relationships between air quality and housing values (Ridker and Henning, 1967). According to Rosen (1974), hedonic pricing models seek to explain the overall price $p=p(x)$ of a differentiated product that is characterized by a bundle of n attributes $x = (x_1,\ldots, x_n)$. The hedonic function, therefore, results from the market interaction of demand and supply. Product differentiation implies the availability of alternative bundles, so that in market equilibrium p equals each consumer's bid for the differentiated product (Rosen, 1974).

In the field of environmental economics, hedonic pricing models are widely used to estimate the WTP for improvements in environmental goods (Palmquist, 2002), most frequently applied to the housing or property market. Houses or properties are compound products, characterized by sets of structural (e.g. house/lot size, age, and type of building), neighborhood (e.g. income distribution, crime rate, and taxes), spatial (e.g. distances to local amenities or disamenities) and environmental (e.g. noise levels, air quality, and vista) attributes.

Hedonic studies show a wide range of application fields. Commonly, they are used for investigating air quality (Nelson, 1978; Kim et al., 2003; Chay and Greenstone, 2005), water quality (Steinnes, 1992; Leggett and Bockstael, 2000; Poor et al., 2007), noise (Espey and Lopez, 2000; Theebe, 2004; Baranzini and Ramirez, 2005; Dekkers and van der Straaten, 2009) and proximity to hazardous facilities (Kohlhase, 1991; Nelson et al., 1992; Simons et al., 1997). Moreover, hedonic models are increasingly applied in the field of energy and the environment (Gamble and Downing, 1982; Clark et al., 1997; Clark and Allison, 1999; Des Rosiers, 2002). While the number of studies on the impact of renewable energy technologies, including wind farms, has been rapidly growing in the past, to date only few peer-reviewed articles exist in the scientific literature.

III. HEDONIC PRICING MODEL

Estimation methods

An attempt to estimate the impacts of wind farm proximity in the framework of a hedonic pricing study has to take into account the possible bias caused by model misspecification, particularly through omitted variables. In this context, the main concern refers to regional or local factors which remain unobserved. In case of unobserved factors, partly explaining the variation in property prices or being correlated with included variables, the model estimations will likely be biased and, therefore, unreliable (Chay and Greenstone, 2005; Greenstone and Gayer, 2009; Kuminoff et al., 2010).

The unobserved variables bias can directly be addressed by applying a spatial fixed effects model specification. Spatial fixed effects basically capture spatially clustered unobserved influences in the considered study area through incorporating a set of dummy variables, e.g. representing city districts of the study area. According to this example, the fixed city district effect will then implicitly absorb all unobserved factors within the defined geographical scale of this fixed effect. However, the effect of this approach in capturing spatially clustered unobserved factors crucially depends on the definition of the geographical scale. The definition of the geographical scale is accompanied by a tradeoff between the level of control and the variation in the explanatory variables (Heintzelman and Tuttle, 2011). Therefore, a higher level of control for omitted variables, i.e. a small geographical scale of the fixed effect, results in less variation in the explanatory variables due to the limited scope of the fixed effect (Heintzelman and Tuttle, 2011). The definition of several scales for spatial fixed effects in different model specifications seems reasonable in order to derive a comprehensive picture of the ability of spatial fixed effects in terms of capturing spatially clustered unobserved factors.

Accompanied by spatially clustered omitted variables, we have to be aware of spatial dependence and spatial heterogeneity. Spatial dependence refers to dependencies among spatially contiguous observations within the dataset which cause spatial autocorrelation (Anselin and Getis, 2010). Thus, based on Tobler's First Law of Geography, spatially nearby observations are stronger correlated to each other than observations farther away (Tobler, 1970). Likewise, unobserved factors for one observation may be correlated to unobserved factors for a neighboring observation, inevitably causing spatial autocorrelation. Therefore, not controlling for spatial autocorrelation would bias our estimations. We address this spatial dependence problem by applying spatial fixed effects and error clustering in a procedure proposed by Heintzelman and Tuttle (2011). According to this, using spatial fixed effects is methodologically related to the application of a spatial lag model, where the spatially weighted average of neighboring observations in the spatial lag model is given here by the scale of the fixed effects. Similarly, the error clustering is related to employing a spatial error model allowing for correlation of error terms.[9] Besides the wide application of spatial econometric techniques, such as the use of the spatial lag and spatial error model, "spatial fixed effects are clearly the preferable strategy for addressing spatially correlated omitted

[9] For further details on the spatial lag and error model see e.g. Anselin (1988).

variables in cross-section data" (Kuminoff et al., 2010, p.158), as spatial fixed effects offer a less rigid and more flexible structure on spatial relationships between included and omitted variables (Kuminoff et al., 2010).

The hedonic pricing model in a spatial fixed effects and error-clustering specification is given by:

$$\ln p_{ijt} = \alpha_j + \lambda_t + W_{ijt}\beta + S_{ijt}\gamma + N_{ijt}\delta + \eta_{jt} + \varepsilon_{ijt}, \qquad [1]$$

where p_{ijt} is the sales price of property i in group j at time t, α_j represents the spatial fixed effects, λ_t denotes the set of time dummy variables (month and year), W_{ijt} represents the wind-farm-related variables, S_{ijt} describes a set of structural variables, N_{ijt} denotes the neighborhood variables, η_{jt} and ε_{ijt} are grouped and individual-level error terms, and β, γ as well as δ are the parameters to be estimated.[10]

We use three different spatial fixed effects specifications which are derived according to the administratively defined structure of the study area. The study area contains two cities which again consist of four defined city districts and 39 cadastral districts, respectively.[11] From large to small geographical scale, the first three group the observations with regard to their location in one of the cities (2 groups), in one of the city districts (4 groups) and in one of the cadastral districts (39 groups). In a fourth specification, the fixed viewshed effects model, we group the observations according to the number of visible turbines (10 groups). Compared to the three specifications first mentioned, the fixed viewshed effects are not deduced from administrational structure, but rather from an underlying spatial structure. The fixed viewshed effects should essentially absorb the influence of wind farm visibility on properties, therefore, highlighting the importance of pure proximity in the sense of distance measures. In many hedonic pricing studies focusing on wind farm impacts, simple distance measures are used as a proxy for various effects that are caused by proximity to the facility. But besides the measurement of distance, proximity can also be investigated in the sense of visibility, shadow flickering effects and aural impacts. Therefore, applying the fixed viewshed effect specification, we try to provide a more differentiated picture on potential impacts caused by the presence of wind farms.

Spatial heterogeneity is a further concern that we should be aware of. Spatial heterogeneity refers to the presence of spatial non-stationarity within the dataset, as the measurement of a relationship depends on where the measurement is taken (Fotheringham et al., 2002, p.9). There might be various dependencies between spatially nearby observations, so that spatial relationships may vary across the considered study area. We address one form of spatial heterogeneity again by using spatial fixed effects. Furthermore, we explore spatial heterogeneity in our dataset by means of a GWR, as this approach allows for a comprehensive view on spatial relations providing local statistics.

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[10] We apply a semi-log specification. The semi-log specification is a commonly used regression form in hedonic pricing studies (Clark and Allison, 1999; Baranzini and Ramirez, 2005; Heintzelman and Tuttle, 2011), which allows for an intuitive interpretation of the results. The estimated coefficients can be interpreted as elasticities if the independent variable enters the model in the log scale and as semi-elasticities if the variable does not enter in the log scale (Gujarati and Porter, 2009, p.162). In the case where the independent variable is a dummy variable, the coefficients are interpreted as median impacts (Gujarati and Porter, 2009, p.298). In addition, using a semi-log regression form often reduces heteroscedasticity (Gujarati and Porter, 2009, p.394).

[11] A more detailed description on the study area is provided in the data subsection further below.

Most importantly, compared to conventional regression models, the GWR provides separate, local regressions for each observation, instead of generating a single, global regression. Therefore, it is possible to account for different local relationships, weighting each observation adaptively.

According to this, the GWR model specification is given by:

$$\ln p_{it} = W_{it}\beta(u_i, v_i) + S_{it}\gamma(u_i, v_i) + N_{it}\delta(u_i, v_i) + \varepsilon_{it}, \qquad [2]$$

where (u_i,v_i) indicates the coordinates of the ith observation. Again, following Tobler (1970), the GWR has to be calibrated in a way that observations near to observation i have more influence on the estimation of the parameters ($\beta(u_i,v_i)$, $\gamma(u_i,v_i)$, $\delta(u_i,v_i)$) than data located farther away from i. The calibration of the model is set by spatial kernels which can be fixed or adaptively fitted to the spatial distribution of the regression points. Figure 2 graphically illustrates a spatial kernel and a GWR with adaptive spatial kernels.

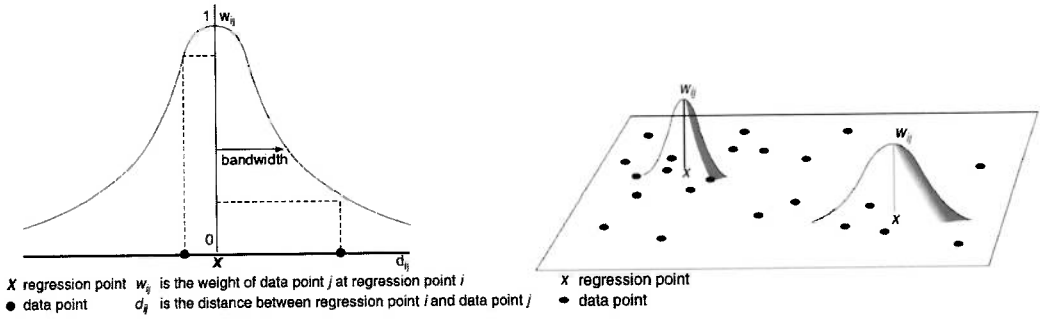


FIGURE 2
A spatial kernel and a GWR with adaptive spatial kernels
Source: Fotheringham et al. (2002), pp.44 and 47

The estimation of the parameters for each location depends on the particular weighting function chosen in order to capture the spatial differences in a certain area. According to the weighting function and its bandwidth, the weight of the data point w_{ij} decreases with increasing distance to the regression point d_{ij}. The definition of the optimal bandwidth of the weighting function is crucial for the precision of the GWR. Therefore, it might be useful not to assume fixed spatial kernels with fixed bandwidth for each regression point, but rather adaptive kernels that take account of differing density of data points around regression point i (Figure 2).

In order to determine the optimal spatially-varying weighting method, we adopt an adaptive kernel that uses an Nth-nearest neighbor weighting of point i with a bi-square decay function.[12] Following Fotheringham et al. (2002), p.58, that is,

[12] We are aware that the appropriability of the Nth-nearest neighbor weighting is an empirical matter, as this is a nonparametric approach, forcing each observation to have the same number of neighbors (Anselin, 2002). However, accounting for spatial variations in the framework of a GWR, the Nth-nearest neighbor weights provide a straightforward method capturing the 'bump of influence' around i, without assuming that the given administrational structure of the study area (e.g. through cadastral districts) really represents local variations

$$w_{ij} = \begin{cases} [1-(d_{ij}/b)^2]^2 \text{ if } j \text{ is one of the } N\text{th-nearest neighbors of } i \text{ and} \\ b \text{ is the distance to the } N\text{th-nearest neighbor} \\ 0 \text{ otherwise.} \end{cases} \quad [3]$$

The determination of the weighting function and optimal bandwidth selection was obtained by minimizing the corrected Akaike Information Criterion (AIC_c) (Fotheringham et al., 2002, p.61).

In summary, we address spatial autocorrelation caused by spatially clustered unobserved factors and spatial heterogeneity in the sense of spatial non-stationarity using various spatial fixed effects model specifications. Additionally, we emphasize the relevance of spatial heterogeneity through the application of a GWR. We explicitly explore the importance of locally varying relationships, exposing additional insights that can be derived from local statistics compared to global regressions.

The data

Investigating the impact of a wind farm site on surrounding property values, this study focuses on property sales within an area of 119 km^2 in the north of the German federal state of NRW, including parts of the city of Rheine and the city of Neuenkirchen. Both cities, at least two city districts in the case of Rheine (Mesum and Hauenhorst), are in the immediate proximity of the considered wind farm site. This northern region of NRW can be defined as a semi-urban region mainly characterized by medium- and small-sized towns.[13] In 2011, a population of 26,900 lived within a radius of about 5.5 kilometers around the site.

As Figure 3 illustrates, the considered study area contains two cities (the city of Rheine and the city of Neuenkirchen), each consisting of two city districts. City districts of Rheine are Mesum and Hauenhorst, and Neuenkirchen (city area) and St. Arnold in the case of Neuenkirchen. Besides the apparent spatial structure depicted in Figure 3, the German land register provides further spatial classifications. In the German land register, cadastral districts are the smallest spatial unit that groups a particular number of parcels in respect of their location. According to the cadastral register of the region, each property, i.e. each parcel, is assigned to a particular cadastral district. The property sales in our dataset can be grouped correspondent to 39 cadastral districts. As described in the estimation methods subsection above, the different spatial administrative structures defined are used to incorporate spatial fixed effects in our hedonic pricing model.

In 2000, the local administration announced the construction of a wind farm consisting of nine turbines, which was eventually built in July 2002. The nine turbines, each with a capacity

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appropriately. There is a vast body of literature on the specification of the weight matrices in spatial analysis. For a detailed discussion on the construction of weights see e.g. Smirnov and Anselin (2001) and Anselin (2002).

[13] The definition of town-size categories for German cities is taken from Bähr and Jürgens (2005). According to their categorization, towns with a population of about 2,000 to 5,000 are small rural towns, cities with a number of inhabitants ranging from 5,000 to 20,000 are small-sized cities, cities with 20,000 to 100,000 inhabitants are medium-sized cities and large cities are defined by comprising more than 100,000 inhabitants. Rheine is a medium-sized town with an overall population of about 76,500 in 2011 (IT.NRW, 2012). In 2011, Mesum's population was about 8,400 and Hauenhorst had about 4,500 inhabitants. Neuenkirchen is a small-sized town with about 14,000 inhabitants in 2011 (IT.NRW, 2011). Corresponding to Neuenkirchen is also the village of St. Arnold (population about 3,000), which is about one kilometer away from the actual city area in a northerly direction.

of 1.5 MW, have hub heights of 100 meters and rotor sizes of 77 meters. Particularly in view of the fact that this area of northern NRW is very flat regarding its relief, with an average altitude only varying between 30 and 90 m above sea level, the wind farm substantially influences the landscape. Figure 3 illustrates the study area and the location of the wind farm site.

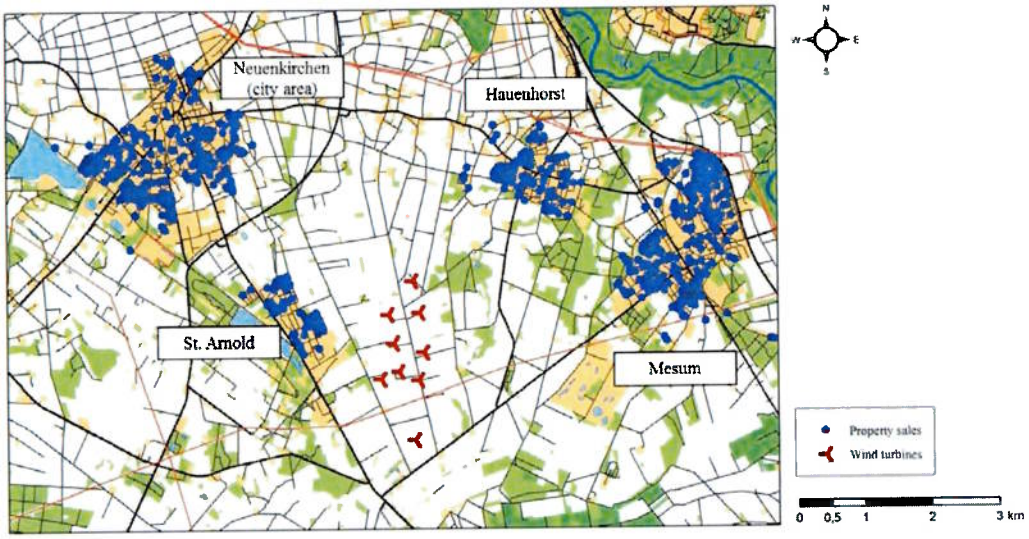


FIGURE 3
Study area
Source: Own illustration, based on data provided by the Geodatenzentrum NRW (2011)

Property market data for the two cities contained 1,405 property sales within the period of 1992 until 2010 and was provided by the Expert Advisory Boards (*Gutachterausschüsse*) of the federal district of Steinfurt[14] and the city of Rheine. The dataset included the sales prices of the properties, lot sizes, sales dates, and the address-based location. All property prices in the dataset were deflated by the German Construction Price Index, published by the German Federal Statistical Office, with 2005 as the base year.[15] The distance of the observations to the wind farm site ranges between 945 m to 5,555 m, so that, compared to other hedonic studies (cf. Table 1), the properties are very close to the site. Table 2 gives an overview of the observations and their distribution according to cities, city districts, wind farm announcement and construction.[16]

A major difference to most of the hedonic pricing studies in the literature is the usage of property values, i.e. prices of parcels of land, and not house prices. This is mainly due to data availability issues and privacy restrictions of address-based house price data in Germany.[17] Nevertheless, we assume that properties are likewise suitable for conducting a hedonic pricing study, as their values are also sensitive to changes in the surrounding location. Only the

[14] Rheine and Neuenkirchen are cities that both belong to the federal district of Steinfurt. In this context, the term 'federal district' is equivalent to a 'county council'.

[15] Available online at https://www.destatis.de/EN/FactsFigures/Indicators/ShortTermIndicators/Prices/bpr110.html (accessed January 14, 2012).

[16] Re-sales were not excluded from the data sample as these only account for a small share of the total sales. As a consequence, the re-sales data does not provide a sufficient basis for applying a repeat sales analysis.

[17] The data provided by the Expert Advisory Boards only contained the price for the property in terms of a parcel of land (separated from prices for homes).

selection of the (structural) variables differs, compared to hedonic pricing studies using house prices.[18] Furthermore, in our study we only consider developed and undeveloped properties for residential utilization.[19] The regional land use, such as residential utilization, is defined in the regional development plan.

TABLE 2
Summary statistics – Property sales in the study area, 1992-2010

	N	Percentage
Total no. of observations	1,405	100.0
City of Rheine	690	49.1
City district Hauenhorst	220	15.7
City district Mesum	470	33.4
City of Neuenkirchen	715	50.9
City district Neuenkirchen (city area)	556	39.6
City district St. Arnold	159	11.3
Total sales	1,202	85.6
Total re-sales	203	14.4
Pre-announcement	724	51.5
Post-announcement	681	48.5
Pre-construction	872	62.1
Post-construction	533	37.9

Table 3 provides summary statistics of the 15 wind-farm-related variables and the other 17 explanatory variables that were tested in different model specifications in order to explain the variation in the property prices.

The set of wind-farm-related variables tries to measure the wind farm presence in different ways. First of all, the set includes Euclidean distance measurements as the most commonly used proxies of wind farm effects.[20] We used the inverse distance from each property to the nearest wind turbine, which also allowed for the consideration of the date of construction.[21] Besides the inverse distance measure from each property to the wind farm, we also tried to identify local distance effects within five kilometers around the wind farm, using dummy variables containing properties in 0.5 km steps.

Negative environmental effects often associated to wind farm sites refer to the shadow flickering effect caused by the rotor blades in relation to the position of the sun (Hau, 2006). In order to capture the shadow flickering effects caused by the rotor blades, we determined the potentially affected areas, taking into account the heights of the turbine, the rotor blade

[18] Hedonic pricing studies using house prices include a large set of structural variables, such as the number of rooms, the age of the house, or the availability of a garage, which are irrelevant for properties in terms of parcels of land. For parcels of land, structural variables can be limited to the lot size and the development status, whereas more emphasis has to be put on neighborhood variables, capturing locational attributes.

[19] In comparison to an untilled parcel, we include four types of possible development statuses: a parcel with a single-family house, a parcel with a duplex house, a parcel with a row house, and a parcel with a multi-family house.

[20] All distance variables, also those that were used to capture general neighborhood features, were calculated using GIS software. We used the ESRI ArcGIS Desktop software package (Version 9.3.1), including the Spatial Analyst Tool, Spatial Statistics Tool, and the 3D Analyst Tool.

[21] Using inverse distance measures to the nearest turbine, the measured values increase with decreasing distance. Note also that values for property sales with sales dates before the turbines' existence measure the inverse distance to the next existing wind farm in neighboring regions at that time.

diameter and the positions of the sun during a day. Identifying the affected areas, we were able to determine the temporary presence of shadow flickering effects for each property during the year.[22] In this context, we tested a simple dummy variable as well as a variable that explicitly takes into account shadow flickering caused by multiple turbines.

TABLE 3
Descriptive statistics

	Variable	Units	Mean	Std. dev.	Min	Max
Wind-farm-related	ln *Inverse Wind farm distance*	ln *m*	-9.26	0.99	-10.02	-6.89
	Distance 0.5 - 1 km	dummy	0.00	0.06	0	1
	Distance 1 - 1.5 km	dummy	0.03	0.18	0	1
	Distance 1.5 - 2 km	dummy	0.01	0.11	0	1
	Distance 2 - 2.5 km	dummy	0.06	0.24	0	1
	Distance 2.5 - 3 km	dummy	0.01	0.11	0	1
	Distance 3 - 3.5 km	dummy	0.04	0.20	0	1
	Distance 3.5 - 4 km	dummy	0.09	0.28	0	1
	Distance 4 - 4.5 km	dummy	0.04	0.19	0	1
	Distance 4.5 - 5 km	dummy	0.09	0.28	0	1
	Shadow flickering	dummy	0.03	0.18	0	1
	Shadow flickering (no. of turbines)	classes	0.08	0.47	0	3
	Visibility (no. of visible turbines)	classes	0.29	0.99	0	9
	Announcement effect	dummy	0.45	0.50	0	1
	Construction effect	dummy	0.38	0.49	0	1
Structural	ln *p*	ln €	10.43	0.84	4.34	12.59
	ln *Lot size*	ln m²	6.18	0.70	1.10	9.83
	Waterfront	dummy	0.00	0.07	0	1
	Type single-family house	dummy	0.55	0.50	0	1
	Type duplex house	dummy	0.17	0.38	0	1
	Type row house	dummy	0.02	0.15	0	1
	Type multi-family house	dummy	0.02	0.15	0	1
Neighborhood/ Spatial	ln *CBD*	ln *m*	-6.83	1.12	-8.28	2.30
	ln *Supermarket*	ln *m*	-6.28	0.60	-7.45	-2.52
	ln *Commercial area*	ln *m*	-7.36	0.88	-8.56	-3.71
	ln *School*	ln *m*	-6.41	0.60	-8.01	-4.25
	ln *Forestland*	ln *m*	-5.29	0.90	-6.54	2.30
	ln *Major road*	ln *m*	-5.25	0.89	-6.72	-2.11
	ln *Road*	ln *m*	-2.48	0.42	-4.53	-0.02
	Street noise	classes	1.07	0.38	1	5
	ln *Railroads*	ln *m*	-7.53	1.28	-8.91	-3.54
	ln *Transmission line*	ln *m*	-6.85	0.74	-7.72	-3.47
	ln *Lake*	ln *m*	-6.40	0.73	-7.52	-3.23

To measure the visibility of the wind farm site, we calculated viewsheds for each property. Viewsheds refer to the visible area from an observer's perspective, in our case from a property. A precise measurement of the view crucially depends on capturing all features in the landscape that are visible from the observer's point of view. The view of a certain feature in the landscape might be hindered by heights, slopes, vegetation, or buildings. In order to calculate viewsheds as precisely as possible, we applied a digital surface model[23] with an

[22] We consider properties as impacted by shadow flickering effects, if these are located in the affected areas.

[23] The digital surface model is essentially based on multipoint information that contains x and y coordinates as well as the z-value, referring to longitude, latitude, and height. The surface model for the whole study regions

accuracy of one meter, which was provided by the Geodatenzentrum NRW.[24] The digital surface model included height level information of the terrain, the vegetation, and buildings, and allowed us to calculate a raster of the area terrain. On the basis of raster data, we were able to conduct a viewshed analysis using the ESRI ArcGIS Spatial Analyst and 3D Analyst tool. Figure 4 illustrates the results of the viewshed analysis, indicating the areas with a view of the wind farm. Overall, for 128 properties in the dataset at least one turbine was visible.[25] The calculated viewsheds were used to specify the fixed viewshed effects model described in the estimation methods subsection above.

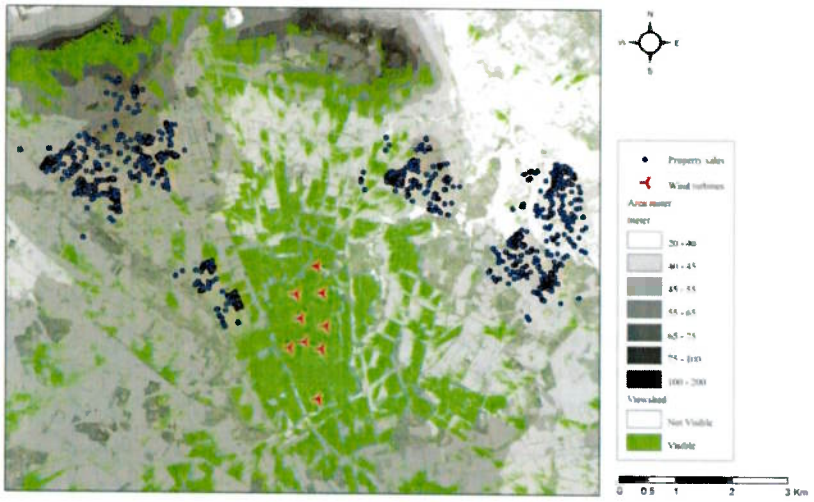


FIGURE 4
Visibility analysis
Source: Own calculation and illustration, based on data provided by the Geodatenzentrum NRW (2011)

The dummy variables capturing possible effects of project announcement and construction base on the date of the wind farm project announcement (June 2000) and date of the wind farm construction (August 2002), respectively.

Substantial aural impacts of wind turbines that result in an increase of the dB-level above the average ambient noise level in urban or semi-urban regions[26] are only measureable within the immediate vicinity of a turbine of about 350 m (Hau, 2006; Rogers et al., 2006; Harrison,

consists of about 120 million data points. For reasons of data operability, the multipoint surface information was converted into a surface raster. Raster data on surface information correspond to a surface as a grid of equally sized cells that comprise the attribute values for representing the x and y coordinates and the z-value. We are aware of the suggested potential inaccuracies using predicted viewshed pointed out in the GIS literature (Maloy and Dean, 2001; Riggs and Dean, 2007). There is a tradeoff regarding the effort of conducting systematic field visits for a whole region, which would guarantee an accurate definition of visibility, and the use of GIS techniques, which, dependent on the data resolution, might produce inaccuracies. However, we do believe that in our case a sufficient degree of accuracy of the viewshed calculations is ensured, given the precision of the obtained digital surface model. The digital surface model used recorded elevations every single meter and is, therefore, more precise compared to the digital terrain models investigated and reviewed in the GIS literature mentioned before.

[24] The Geodatenzentrum NRW provides geodata on the basis of the ordnance survey. Available online at www. geodatenzentrum.nrw.de/ (accessed November 2, 2011).

[25] The visibility analysis only included properties that were sold after the construction of the wind farm.

[26] The average noise level in urban areas is 55 dB during the day and 40 dB at night, respectively. In semi-urban or rural areas these values range between 50 dB during daytime and 35 dB at night, respectively (Hau, 2006).

2011). As in our case the shortest distance to a property is 945 m, aural impacts are not considered.

The structural variables, such as the sales price, the lot size, and the four types of development statuses of the properties, were directly taken from the property sales dataset provided by the Expert Advisory Board. We investigated the impact of different development statuses, compared to an undeveloped, untilled parcel. The waterfront variable was derived using data services of the Topographic Information Management of the federal state of NRW (Topographisches Informationsmanagement NRW).[27] Most importantly, we expect a highly positive relationship between the property price and the lot size.

The spatial variables characterizing the neighborhood for each property also predominately contain Euclidean (inverse) distance measures to the amenities and disamenities in the surrounding area, e.g. shopping opportunities or proximity to the road network. Data on the neighborhood features and their location was obtained from statistical offices on the state, district, and city level.[28] Commonly used data on neighborhood variables, such as crime rates, unemployment or income distribution was only available at the city district level or even city level. As these variables only vary over time and the four different city districts (or two cities), effects are implicitly captured by the spatial fixed effects and time dummies.

IV. RESULTS

In this section, we firstly discuss the results obtained from the different spatial fixed effects model specifications, focusing on the wind-farm-related variables. Secondly, we further investigate wind farm proximity and visibility in a GWR model.

Spatial fixed effects

Table 4 provides an overview of the estimation results obtained from applying different spatial fixed effects specifications.

According to the overall model performance, we find that all four spatial fixed effects specifications perform very well with regard to the adjusted R^2 obtained.[29] The specification with the tightest controls for spatially clustered omitted variables, the fixed cadastral district specification, performs best. Overall, we obtained mostly consistent results across all specifications regarding the expected signs.

We use a stepwise procedure of introducing the wind-farm-related variables in order to prevent multicollinearity, particularly in the case of the different distance measures.

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[27] Available online at http://www.tim-online.nrw.de/tim-online/nutzung/index.html (accessed February 2, 2012).

[28] The data was obtained upon request from the federal statistical office of NRW, the federal district administration of Steinfurt and the city administrations of Rheine and Neuenkirchen.

[29] We tested for autocorrelation, multicollinearity and heteroskedasticity by applying the Durbin-Watson test, variance inflation factor (VIF) and the White test, respectively.

TABLE 4
Estimation results for the different spatial fixed effects specifications

	Fixed city effects		Fixed city district effects		Fixed cadastral district effects		Fixed viewshed effects	
Variable ‡	Coef (SE)		Coef (SE)		Coef (SE)		Coef (SE)	
ln *Inverse wind farm distance*	-.067***	(.024)	-.053**	(.043)	-.047**	(.022)	-.098***	(.042)
Distance 0.5 - 1 km	-.287**	(.139)	-.215*	(.152)	-.297**	(.148)	-.286*	(.303)
Distance 1 - 1.5 km	-.153*	(.101)	-.079	(.105)	-.175*	(.102)	-.180	(.291)
Distance 1.5 - 2 km	-.107	(.111)	-.044	(.141)	-.115	(.131)	-.108	(.290)
Distance 2 - 2.5 km	-.080	(.091)	-.118	(.106)	-.116	(.072)	.031	(.285)
Distance 2.5 - 3 km	-.178	(.216)	-.218	(.199)	-.300	(.199)	-.110	(.370)
Distance 3 - 3.5 km	-.176	(.123)	-.194*	(.109)	-.195	(.133)	-.128	(.290)
Distance 3.5 - 4 km	-.114	(.109)	-.139	(.107)	-.155	(.147)	-.098	(.273)
Distance 4 - 4.5 km	.011	(.115)	-.000	(.115)	-.142	(.124)	.035	(.321)
Distance 4.5 - 5 km	.009	(.114)	.006	(.123)	-.108	(.143)	.051	(.308)
Shadow flickering	-.091**	(.043)	-.022	(.054)	-.058	(.047)	-.157***	(.039)
Shadow flickering (no. of turbines)	-.034**	(.016)	-.001	(.019)	-.023	(.017)	-.054***	(.014)
Announcement effect	-.032	(.103)	-.039	(.087)	.044	(.097)	-.077*	(.042)
Construction effect	-.102	(.068)	-.108***	(.039)	-.119*	(.068)	-.028	(.039)
ln *Lotsize*	1.069***	(.037)	1.069***	(.033)	1.082***	(.030)	1.063***	(.027)
Waterfront	.076	(.280)	.005	(.286)	.026	(.313)	.051	(.341)
Type single-family house	.183***	(.054)	.175***	(.022)	.138***	(.068)	.180***	(.079)
Type duplex house	.293***	(.058)	.282***	(.027)	.235***	(.073)	.291***	(.082)
Type row house	.270**	(.106)	.241**	(.057)	.164**	(.093)	.222**	(.079)
Type multi-family house	.326***	(.077)	.311***	(.056)	.295***	(.098)	.343***	(.069)
ln *CBD*	.049***	(.036)	.048***	(.043)	.029**	(.030)	.030***	(.023)
ln *Supermarket*	.058***	(.051)	.053***	(.050)	.027	(.057)	.077***	(.042)
ln *Commercial area*	.067***	(.038)	-.035*	(.025)	.017	(.057)	.029*	(.023)
ln *School*	.016	(.025)	.024	(.030)	-.019	(.038)	-.004	(.035)
ln *Forestland*	-.021**	(.020)	-.022**	(.032)	-.019	(.032)	-.014	(.022)
ln *Major road*	-.026**	(.027)	-.024**	(.025)	-.031**	(.030)	.005	(.010)
ln *Road*	.099***	(.048)	.102***	(.038)	.090***	(.040)	.109**	(.048)
Street noise	-.022	(.023)	-.031*	(.017)	-.013	(.026)	-.036*	(.022)
ln *Railroads*	-.056***	(.043)	-.029*	(.042)	.007	(.074)	.017	(.024)
ln *Transmission line*	-.014	(.013)	-.001	(.035)	.024	(.085)	.012	(.024)
ln *Lake*	-.023*	(.024)	-.006	(.024)	-.027	(.044)	-.027*	(.025)
(Intercept)	2.891***	(.717)	3.551***	(.991)	2.986**	(1.397)	3.293***	(.779)
Number of observations	1,405		1,405		1,405		1,405	
Adjusted R^2	0.889-0.890		0.890-0.892		0.903-0.904		0.886-0.888	
AIC_c	458.5-469.8		440.3-454.4		311.5-318.5		495.7-517.2	
Time dummies (year and month)	Yes		Yes		Yes		Yes	
Clustered errors	Yes		Yes		Yes		Yes	

*, ** and *** indicates significance at the 10%, 5% and 1% levels, respectively.

‡ Following the regression procedure of Heintzelman and Tuttle (2011), the wind-farm-related variables (ln *Inverse Wind farm distance*, *Shadow flickering*, *Shadow flickering (no. of turbines)*, *Announcement effect* and *Construction effect*) were included individually to the set of structural, neighborhood and spatial variables. The set of the nine distance variables were included jointly. Because of high consistency in the estimates for the structural, neighborhood and spatial variables, we have taken the coefficients from the ln *Inverse Wind farm distance* regression representatively. In the bottom part of the table we present the ranges for the adjusted R^2 and the AIC_c, respectively.

Regarding the wind-farm-related variables, most importantly, the inverse distance to the nearest turbine is negatively significant across all models. Therefore, a 1% increase in the inverse distance (i.e. a decrease of distance to the nearest turbine) decreases the property sales price by -.047% to -.098%.[30] Taking into account the different geographical scales of the fixed effects, tighter controls lead to less significance and lower coefficients, confirming the

[30] For an average property price of about €42,500, the estimated coefficients correspond to a decrease of €19.98 to €41.65 for a 1% decrease of distance to the nearest turbine.

mentioned tradeoff between control for omitted variables and variation. The fixed viewshed effect model yields the highest coefficient (-.098 at the 1% significance level) for the inverse distance variable. Therefore, controlling for visibility effects underlines the importance of proximity measured by simple distance.

Further, investigating the distance to the wind farm site through a set of dummy variables, negative wind farm impacts are mostly detectable in the close vicinity within the first 1.5 km around the site. Hence, within the first kilometer around the wind farm, prices decreased by 21.5% to 29.7% according to the estimations. In case of the fixed cadastral district model, the estimate of -29.7% is even significant at the 5% level. For a distance of 1 km to 1.5 km, the negative impact decreases and is only significant at the 10% level in the case of the fixed city effect and fixed cadastral effect model (-15.3 and -17.5, respectively). The negative impact within 3 and 3.5 km in the fixed city district effects model seems quite ambiguous, but is more or less negligible and significant at the 10% significance level only.[31]

Based on the shadow flickering variables, the estimates hardly allow a clear interpretation. The coefficients of the shadow flickering dummy are quite diverse across the different spatial fixed effects models, ranging from -.022 to -.157. Furthermore, the estimates only became significant in the fixed city effects (at the 5% level) and fixed viewshed effects (at the 1% level) model, respectively. As the measurable effects of shadow flickering are only limited to parts of one city district (St. Arnold) and, therefore, only to a small number of observations, this variable might not be adequate in representing a potential effect caused by shadow flickering. A further explanation, also regarding the highly negative coefficient in the fixed viewshed effects model, might be that, in essence, the shadow flickering dummy is quite similar to a small-scale distance dummy. The same argumentation applies to the second shadow flickering variable.

Regarding a possible effect of announcing the wind farm project, no significance was found in the fixed city effects, fixed city district effects and fixed cadastral district effects model specifications. Despite a small negative effect (-.077%) at the 10% level in the fixed viewshed effects model, the impact of announcing the project remains highly doubtful.

The construction of the wind farm negatively impacted property sales in the two best-performing model specifications overall, with significance levels of 1% (fixed city district effects) and 10% (fixed cadastral effects), respectively. Thus, properties that were sold after the construction of the wind farm showed price decreases between 10.8% and 11.9%. Despite the different significance levels, there is evidence for a negative construction effect, particularly as we used time dummies for years and months to capture annual and seasonal variations.

The other explanatory variables mostly also perform well in the sense of an intuitive interpretation. As expected, the lot size of a property is the most important determinant of its sales price, with estimated coefficients of 1.062 to 1.082. Therefore, a 1% increase in the lot size of a property increases its value by approximately 1%. Positively related to the property prices is also the development status compared to an undeveloped or untilled parcel.

[31] Note that the number of transactions within each distance category varies substantially, particularly regarding the number of transactions after the announcement and construction of the wind farm. In some cases, the distance dummies only contain a very few transactions, therefore, implying a limited interpretability. Table A1 in the Appendix provides an overview over the distance dummies' statistics.

The proximity to the city center (variable ln *CBD*) and to supermarkets is also positively significant across nearly all models. This goes along with the common circumstance that properties in the city center have higher values than properties in remote areas. Furthermore, the proximity to forestland was found to be negatively correlated to property values, with significance at the 5% level in the case of the fixed city effects and fixed city district effects specification. In this case the forestland variable cannot be interpreted as an indicator for an environmental amenity but rather representing less centrality of the location.

Major roads in the close vicinity of properties have significant negative impacts on their values, whereas the proximity to roads is positively significant across all models. While the proximity to a major road implies negative effects of high traffic density (ln *Major road*), the proximity to the cities' road network indicates positive effects, such as a higher degree of accessibility (ln *Road*).

The proximity to railroads, which is also frequently investigated by means of hedonic pricing studies (e.g. Bowes and Ihlanfeldt, 2001; Theebe, 2004), only appeared negatively significant in the fixed city effects and city district effects models (at the 1% and 10% level, respectively). Using fixed cadastral district and fixed viewshed effects, the railroads variable turned out to be insignificant and changed sign as well. In this case, the results obtained barely allow for a clear interpretation.

No statistical evidence was found for the impact of proximity to schools, transmission lines, lakes as well as for higher street noise or the availability of a waterfront.

Geographically weighted regression

In a similar model setup, compared to specifications described in the last subsection, specifically regarding the composition of the included variables, we applied a GWR model to estimate local coefficients and significance levels for the two variables ln *Inverse wind farm distance* and *Visibility (no. of visible turbines)*. The inverse distance to the wind farm is analyzed in a local GWR model in order to reveal a more complex picture of the local variation of the estimates and significance. The information provided by the variable *Visibility (no. of visible turbines)* was used to specify the fixed viewshed effects model in the previous subsection. Therefore, this variable is analyzed in a GWR model in order to assess the local distribution of possible visibility effects and to derive more insights about the predictive performance of a fixed viewshed model. Statistics on the GWR coefficient estimates for both model specifications are provided in the Appendix (Tables A2 and A3).

Both local model specifications performed very well in respect of the given quasi-global adjusted R^2 (.910 for both variables) and AIC_c (308.1 for the distance variable and 312.5 for the visibility variable). Therefore, comparing the model performance of the local GWR and the global spatial fixed effects specifications on the basis of the two indicators, the local model exhibits a similar performance power like the fixed cadastral effects model. Figures 5 and 6 map the local coefficient estimates and significance levels for the investigated variables.

According to Figure 5(a), which provides an overview of GWR model coefficients for ln *Inverse wind farm distance*, we can identify strong spatial variation within the study area. The strongest impacts are located predominantly in Neuenkirchen (city area) and not, as expected, in areas which are in the immediate vicinity of the wind farm site. Now also taking into account the local variation of the significance levels (Figure 5(b)), there is a clear difference

between properties located in the west and the east of the study area. In the east of the study area, particularly in Mesum, the inverse distance variable mainly becomes significant only at the 10% level or even not significant at all. On the contrary, properties located in the west, especially in Neuenkirchen (city area) and St. Arnold, are negatively influenced with significance levels at 1% and 5%, respectively. Properties in the immediate vicinity of the wind farm (St. Arnold and Hauenhorst) are also significantly negatively affected (mainly at the 5% level). In the city district Neuenkirchen (city area), we can identify the strongest significance, whereas the significance decreases towards the city center. Overall, the local estimations for the inverse distance to the wind farm provide evidence for a stronger negative impact on the city of Neuenkirchen than on the city of Rheine.

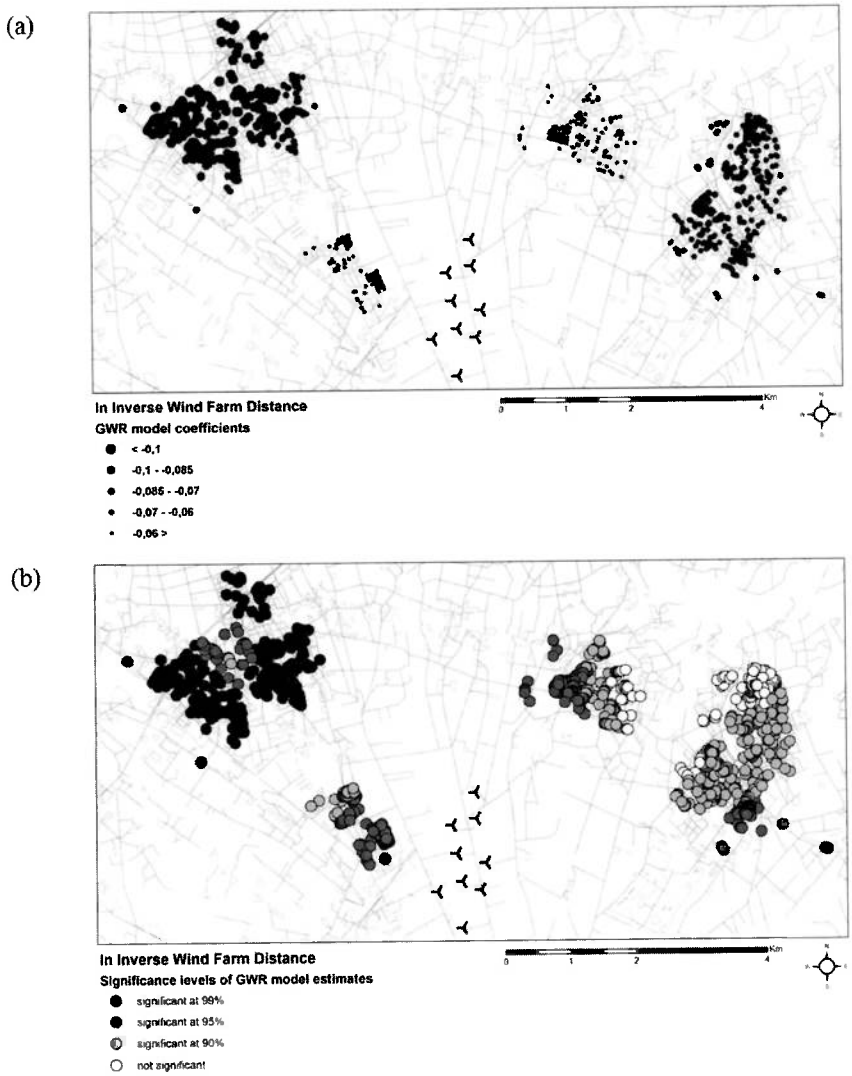
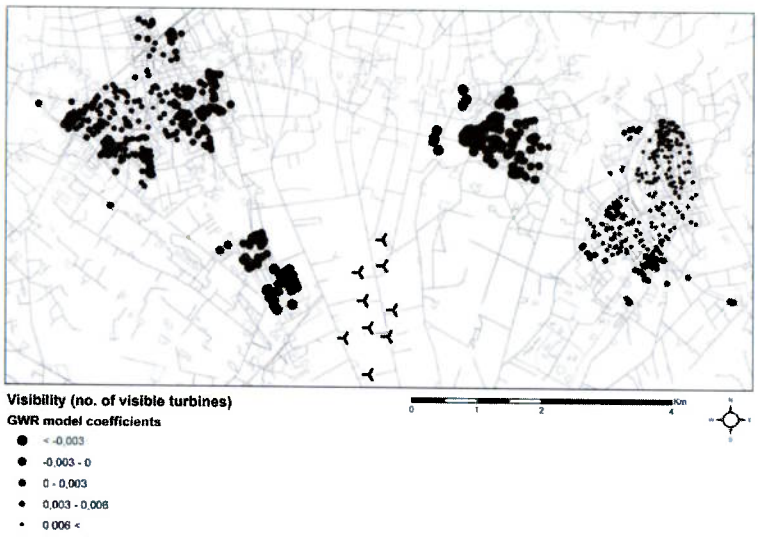


FIGURE 5
GWR model coefficients (a) and significance levels (b) for variable ln *Inverse wind farm distance*

Figure 6(a) maps the GWR model coefficients for the variable *Visibility (no. of visible turbines)*. Thus, negative coefficients are solely located in the immediate vicinity of the wind farm site. As the properties in the close neighborhood to the site likely have an unimpaired

view on several turbines, these findings seem reasonable. But considering the local distribution of the significance levels of the visibility variable (Figure 6(b)), no statistical significance of a visibility impact can be detected for the entire study area. Only in the immediate vicinity of the site, significance levels strengthen, but still remain insignificant (with p-values between 0.1 and 0.25). Overall, no statistical evidence was found for the particular consideration of wind farm visibility.

(a)



(b)

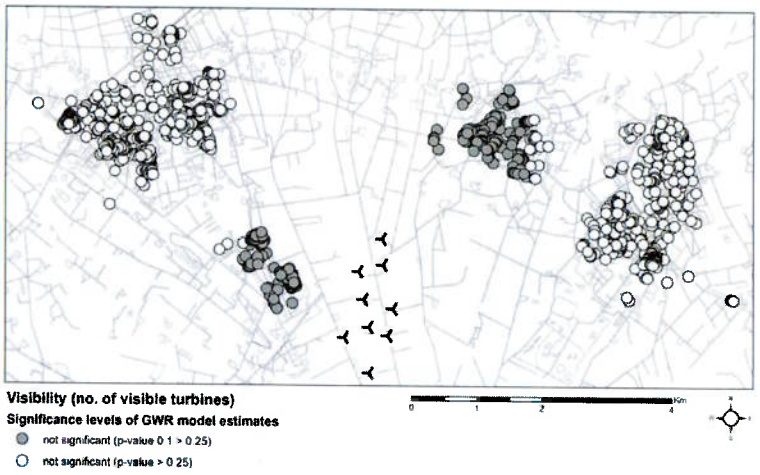


FIGURE 6
GWR model coefficients (a) and significance levels (b) for variable *Visibility (no. of visible turbines)*

In summary, the negative impact of wind farm proximity (measured by the inverse distance to the nearest turbine) that was found in the spatial fixed effects models could be confirmed, investigating the variable using the GWR method. Additionally, we found that proximity effects vary substantially across and within the cities, contrasting the estimated results of the distance dummy variables. The investigation of the local coefficients of the visibility variable revealed that visibility has no significant impact on property values.

Therefore, the results obtained in this case could not provide any validation for the relevance of applying a fixed viewshed effects model specification.

V. CONCLUSIONS

In order to investigate the impacts of wind farms on the surrounding area following the current public debates associated with siting processes in Germany, we applied a hedonic pricing model to the property market of the two neighboring cities Rheine and Neuenkirchen in the northern part of NRW. We investigated wind farm proximity by means of different spatial fixed effects model specifications, addressing spatial autocorrelation through spatially clustered omitted variables and spatial heterogeneity, and a local GWR model in order to further account for spatial heterogeneity caused by spatially varying relationships in the underlying data. As many hedonic pricing analyses investigating wind farm impacts focus on distance measures as a proxy for wind farm proximity, we also included variables capturing potential shadow flickering and visibility effects. We applied GIS techniques on the basis of high resolution geodata for the implementation of these variables.

We used four different spatial fixed effects models accounting for the underlying administrational and spatial structure of the study area, with a particular focus on a fixed viewshed effects model specification. Comparing the models, the specification with the tightest controls for spatially clustered omitted variables performed best.

According to the estimation results provided by the spatial fixed effects regressions, there is statistical evidence for a negative impact of wind farm proximity measured by the inverse distance to the nearest turbine. Various distance dummies also indicated that negative impacts are mainly limited to properties in the immediate vicinity within 1.5 km. Due to lower significance levels of the distance dummy variables, local variations of coefficients and significance levels needed further consideration. Properties that were sold after the construction of the wind farm showed lower values compared to those which were sold before, indicating a negative post-construction effect. Alternatively, the announcement of the wind farm project had no measurable influence on property prices. The results obtained for the shadow flickering variables did not allow for a clear interpretation.

The fixed viewshed effects model provided the lowest values regarding the overall model performance, although the results were largely consistent with the other models. The major insight is that absorbing potential effects of visibility, the inverse distance to the nearest turbine still remains negatively significant.

The application of the GWR revealed a more complex picture of proximity effects through the weighting of spatial relationships and local variations in the data. The negative impact of wind farm proximity that was found using spatial fixed effects could be confirmed applying the GWR method. Based on local GWR estimates, the negative effects are attributable to strong local influences of the wind farm site. Therefore, the local significance levels of wind farm distance provide evidence for a stronger negative impact in the city of Neuenkirchen than in the city of Rheine. Local coefficients and significance levels of the visibility variable revealed that visibility has no significant impact on property values. Therefore, the investigation of visibility by means of a GWR could not provide any validation

for the relevance of applying a fixed viewshed effects model specification. Against this background, the results obtained by the fixed viewshed effects model remain ambiguous.

Nonetheless, further investigation of wind farm proximity and specifically visibility, also combining global and local spatial regression techniques, is needed, particularly to derive general conclusions and reliable recommendations with regard to the impact of wind farm siting in Germany. As social acceptance aspects of the siting of energy facilities become more important, especially with regard to the increasing relevance of decentralized energy supply from renewables, research on external effects of these technologies is crucial.

Future research on the impacts of wind farm proximity should essentially include the further investigation of spatial autocorrelation and spatial heterogeneity, also comparing and exploring the performance of different spatial models, such as spatial error and lag models vs. spatial fixed effects, and spatial weighting approaches. Further research incorporating local statistics, such as the GWR, alongside with established spatial models is needed, in order to underline the relevance of geographical techniques in economics.

As local authorities are increasingly aware of social acceptance problems in Germany, projects that involve civic participation in the planning process become increasingly important in order mitigate public protests. Therefore, it might be interesting to comparatively investigate wind farm projects that were planned with and without civic participation by means of the hedonic pricing approach.

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APPENDIX

TABLE A1
Statistics of the wind farm distance dummy variables

Distance dummies	Total number of transactions	Transactions after announcement	Transactions after construction
Distance 0.5 - 1 km	15	15	6
Distance 1 - 1.5 km	77	66	45
Distance 1.5 - 2 km	74	21	16
Distance 2 - 2.5 km	139	108	89
Distance 2.5 - 3 km	74	18	17
Distance 3 - 3.5 km	119	61	56
Distance 3.5 - 4 km	336	152	120
Distance 4 - 4.5 km	275	82	52
Distance 4.5 - 5 km	296	158	132

TABLE A2
Statistics of the GWR model coefficients – ln *Inverse wind farm distance*

	Minimum	25% Quartile	Median	75% Quartile	Maximum
Intercept	2.771	2.881	4.719	5.119	6.009
ln *Inverse Wind farm distance*	-.111	-.094	-.070	-.055	-.047
ln *Lot size*	.919	.948	1.056	1.080	1.087
Waterfront	-.061	.011	.037	.113	.147
Type single-family house	.115	.145	.164	.170	.184
Type duplex house	.200	.231	.260	.271	.282
Type row house	.159	.188	.194	.199	.216
Type multi-family house	.170	.235	.341	.359	.428
ln *CBD*	.001	.006	.032	.065	.082
ln *Supermarket*	-.001	.012	.074	.089	.110
ln *Commercial area*	-.066	-.041	.006	.023	.036
ln *School*	-.013	-.006	-.008	.061	.117
ln *Forestland*	-.069	-.052	-.037	-.006	.012
ln *Major road*	-.040	-.024	-.006	.005	.012
ln *Road*	.031	.042	.076	.088	.103
Street noise	-.139	-.077	-.052	-.042	-.019
ln *Railroads*	-.185	-.055	-.036	.020	.044
ln *Transmission line*	-.050	-.028	.018	.071	.189
ln *Lake*	-.045	-.039	-.012	.004	.022

TABLE A3

Statistics of the GWR model coefficients – *Visibility (no. of visible turbines)*

	Minimum	25% Quartile	Median	75% Quartile	Maximum
Intercept	3.412	3.505	5.335	5.690	6.733
Visibility (no. of visible turbines)	-.005	-.002	.003	.006	.011
ln *Lot size*	.921	.950	1.056	1.080	1.087
Waterfront	-.039	.046	.073	.142	.175
Type single-family house	.118	.150	.161	.168	.181
Type duplex house	.207	.241	.261	.271	.287
Type row house	.157	.185	.190	.196	.213
Type multi-family house	.182	.245	.342	.358	.426
ln *CBD*	.003	.007	.037	.072	.093
ln *Supermarket*	.000	.016	.082	.095	.144
ln *Commercial area*	-.068	-.053	.009	.028	.043
ln *School*	-.015	-.005	-.010	.050	.118
ln *Forestland*	-.066	-.051	-.036	-.006	.014
ln *Major road*	-.042	-.025	-.006	.005	.012
ln *Road*	.031	.042	.071	.084	.100
Street noise	-.125	-.068	-.053	-.042	-.016
ln *Railroads*	-.222	-.059	-.042	.021	.041
ln *Transmission line*	-.039	-.019	.024	.084	.214
ln *Lake*	-.045	-.037	-.007	.001	.019

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Operation & Maintenance Manual

NM52/900
NM52

50 Hz. – 60 Hz.
Standard-Arctic-Tropical

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Preface

This Operation & Maintenance Manual applies to wind turbines from Vestas with cast machine frame and integrated yaw system. It includes both 50 and 60 Hz types of which includes the following types: NM52 & NM52/900

This manual is a handbook written for wind turbine owners and operation managers. It contains safety instructions, operational instructions and a general description of the wind turbine design and layout. The manual describes possible error situations and how to reset the control system and resume wind turbine operations.

The appendix contains technical data from the main specification, an Alarm List and service plan.

By following the Operation Manual in detail the owner can secure safe and uninterrupted operation of the wind turbine, which in turn will provide the highest possible performance and profit.

The manual is subject to on-going revision based on experience in order to obtain the best possible performance and availability. The system of revision is described on the following page.

The contents and procedures in this manual have been generated by Vestas's Technology-R&D and Service Departments and compiled by the Documentation department in co-operation with our suppliers and in accordance with recommendations and requirements from the approval bodies.

Vestas Technology-R&D/Documentation would welcome any suggestions for corrections and improvement for inclusion in subsequent editions.

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Vestas Wind Systems A/S

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Revision Status

Revisions of this manual are shown in the following table. This page must always be replaced when revisions are released.

The revisions are named -' 01, -' 02, -' 03 etc. The manual is released in a new edition when Vestas judges that revisions are required.

	Date	Short description of changes
Revision 01	2004-11-15	Old document system nr. TIC_140'002_GB entered in SAP
Revision 02	2005-01-13	Old document system nr. TIC_140'005_GB entered in SAP
Revision 03	2005-11-03	New release with right document number, logo and Company name.
Revision		

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Appendix

- Main specification
- Error & Alarm List
- Service Plan & checklist
- Installation & Service Data

1 General Information

1.1 The Wind Turbine

The Vestas NM52 wind turbine is a mechanical plant, which functions as power generator and supplies electricity to the grid. It is very important for safety reasons always to operate the wind turbine correctly and according to the "Operation Manual". By following all rules and instructions the wind turbine will enjoy a long life with the lowest possible operational and maintenance costs.

This "Operation Manual" must be read very carefully before operation of the controller or before climbing the ladder or any inspection. All safety precautions must be followed unconditionally.

In the description of the turbine's various components, terms such as front, back, right-hand and left-hand are used. All directional indications must be understood from a position in the nacelle facing the rotor blades. However, the rotational direction of the blades is described as to the right (clock-wise) when standing in front of the turbine with the observer's back to the wind.

1.2 Wind turbine versions

The wind turbine is made in different versions to observe various and specific requirements from authorities, wind classes grid-frequency and climatic conditions. This manual is general for all versions. Where special equipment is used, which is different from standard, a comment is made in the text. The appendix of the manual is specific for actual wind turbine version

As a main rule the versions are separated in 50 Hz and 60 Hz wind turbines, and in temperature classes, which are stated as standard, arctic or tropical.

1.2.1 Frequency

The grid is either 50 Hz (cycles) or 60 Hz. As the frequency determine the generator speed the ratio of the gearbox is chosen specifically to secure an appropriate rotor speed

1.2.2 Temperature classes

1.2.2.1 Standard

Temperature interval for operation from	-10° C to +25° C.
Temperature interval for structure from	-20° C to +50° C.

1.2.2.2 Arctic

Temperature interval for operation from	-30° C to +25° C.
Temperature interval for structure from	-40° C to +50° C.

1.2.2.3 Tropical

Temperature interval for operation from	-10° C to +40° C.
Optional temperature interval for operation from	-20° C to +40° C.
Temperature interval for structure from	-20° C to +50° C.

1.3 Responsibility and Guarantees

The owner has the responsibility for the plant in terms of operation, security and for preventing any risk of endangering the grid system by wind turbine operations. Normally the owner will co-operate with the Vestas Service Department by means of a Service Contract.

If a major renovation or replacement of heavy components should be required after expiry of guarantee or service period, the owner of the turbine must contact the Vestas Service Department. The owner or operator should be aware that it requires comprehensive knowledge and experience of lifting equipment and the weights and weight distribution of the different components to avoid damage or accidents to parts or personnel during such special work.

If the owner carries out any work on the wind turbine without prior approval from Vestas, or employs persons not approved by Vestas to work on the wind turbine, the Vestas's guarantee or liability will immediately be nullified.

The owner should frequently visit the plant to ensure familiarity with the normal operation and sound emissions of the wind turbine. In this way he will be able to detect an abnormal situation or sound at an early stage and report it to Vestas's Service Department.

In addition the wind turbine should be kept in a clean and orderly condition for safety reasons and to help detect any leakage.

During the Vestas guarantee or service agreement periods, all servicing or other work must be performed solely by Vestas's service technicians, or by personnel working under Vestas's direction and responsibility. If the owner without explicit acceptance or instructions from Vestas carries out work on the wind turbine himself or with the use of unauthorised personnel for whom Vestas has no responsibility, Vestas's guarantee and liability for service work will immediately be nullified.

1.4 Service and Maintenance

Before doing any service or maintenance checks it is mandatory to read, follow and fully understand the safety requirements and rules described in the following chapter.

The regular service routines and instructions are described in the Service Manual, strictly for the use of Vestas service technicians.

In order to control proper maintenance for the owner/operator this manual includes a description of service schedule accompanied with a task-list called "Service Plan", which is shown in the Appendix. Further, "Installation & Service Data" include comprehensive information of oil and lubrication, component weight and dimensions, and bolt torque levels.

1.5 Special equipment for arctic version

The entire wind turbine design is recalculated to be suitable for and endure extreme cold conditions. The limitations are to operate at temperatures down to -30° OAT (Outside Ambient Temperature) and structural endurance down to -40° C at stand still.

In general all steel, welds, casts and cables are specified to this special requirement. Further, all components, lubrication and hydraulic oil are selected to meet the cold conditions keeping required properties.

Some components are especially selected to replace normal equipment or special heating systems are added. This paper describes the areas where an arctic wind turbine version differs from a standard version.

1.5.1 Running conditions

During normal operations the gearbox and generator will generate heat within the closed nacelle compartment and secure suitable temperature conditions for all components. After a stand still, where components have become very cold, nacelle-heating equipment will ensure heating up before resume of running operation. The purpose is twofold: 1 - ensure that the lubricants have optimal properties and 2 - to heat up the nacelle including gearbox, generator, main bearing and yaw mechanism. Operation will not commence unto specified components have obtained their minimum temperature acceptance level. The wind turbine computer continuously checks this.

During operation the nacelle heating equipment will be turned on and off automatically to secure acceptable operation temperature inside the compartment.

1.5.2 Nacelle heating

The nacelle is heated by electrically operated heating elements and a fan. The unit is placed next to the rotor shaft and pointing toward the top of the tower, primarily to warm up the yaw mechanism and the main gear. Secondary all other components in the nacelle. The heating elements are 2 x 10 kW; the fan has a 0.55 kW motor.

The heating unit is controlled by the wind turbine computer on basis of temperature sensors, which are placed in the nacelle compartment, gear oil and bearings, cooling liquid, and the bearings of generator, rotor shaft and yaw system.

1.5.3 Anemometer and wind vanes

The anemometer and both wind vanes have each an electrically heating element. The built-in heater will consume from 30 watt and up to 150 watt continuously, to keep the instrument ice-free. The heat source is a self-regulating constant-temperature system. In severe wind and icing conditions the instruments draws nearly full power and remains clear of ice. When conditions improve, the systems use less power.

1.5.4 Wind turbine control system

The wind turbine control cabinets are electrically heated as appropriate.

1.5.4.1 CPU cabinet

A thermal thermostat controls a heat element, which is turn on if the temperature decrease below zero degrees Celsius. The cabinet heater will secure adequate temperatures for running the wind turbine computer, independent of computer measurements.

1.5.4.2 Power panel

The temperature is measured inside the panel by a PT100 sensor, monitored by the computer. The computer will turn-on and –off the electrical heating element according to the pre-set operation parameters.

1.5.4.3 Phase compensation cabinet

The temperature is measured inside the cabinet by a PT100 sensor, monitored by the computer. The computer will turn on and off the electrical heating element according to the pre-set operation parameters.

1.5.4.4 Top box

The top box has no heating as it is designed to operate in low temperature.

1.5.5 Rotor blades

The arctic version of the LM blade is developed for operation in an arctic climate, in operation temperatures down to -30° C (normally -20° C). When the temperature drops below -30° C, the turbine has to be stopped.

1.5.5.1 Design details on blades

Blades for arctic conditions have been manufactured using special materials in different areas of the blade. The special materials comprise a few steel parts in the mechanical tip brake system and lightning protection system, as well as modified composites with improved low temperature properties. In this way the strength and fatigue properties of the blades have been ensured thus providing a maximum availability even in very cold operating conditions.

Blades for arctic operation do not include a de-icing system, preventing ice from building up on especially the leading edge of the blade. Under extreme climatic conditions where icing has added an unbalance to the rotor, the operation must stop until a de-icing has taken place. Unbalance is one of two problems caused by icing on blades — the second problem is loss of efficiency. Due to the presence of ice, which will change the profile of the blade, the power curve of the turbine tends to drop whereby a de-icing of the blades is required to re-establish maximum efficiency. The build up of ice on rotor blades is very much depending on the actual site.

Even when the rotor has been stopped, the build up of ice can continue. When stopped, the blades are actually able to withstand a very large quantity of ice building up. The exact quantity can be calculated comparing the amount of ice with the certified static blade loads.

1.6 Special equipment in tropical version.

1.6.1 Heating in gearbox.

The gearbox in NM52/900 & NM52 tropical version, can be equipped with heating elements, to allow the gearbox to gain operation temperature, or to maintain operating temperature in the gearbox, even when the turbines is not producing in wheaterconditions down to -20°.

2 Safety

A wind turbine power plant with its rotating mechanical parts presents many potentially dangerous situations. A few basic safety rules must always be followed during any visit, and in general the plant must be treated with respect.

The safety signs and instructions in the wind turbine must be followed. If a sign is damaged or unreadable it must be replaced.

Never climb the ladder or inspect the turbine alone. For safety reasons at least two persons must be present if any kind of job has to be carried out on the wind turbine.

All persons present must always be aware of the location of the other individuals. Remember to tell the other persons when you intend to move to another location and what you will be doing, and make sure that everybody understands and confirms your message before you move.

The following safety instructions must be read and unconditionally followed.

2.1 Safety Precautions

2.1.1 Approach to the Wind Turbine

Adults must keep children under close surveillance.

Do not stand beneath the rotor or near the wind turbine when the rotor blades are covered with ice.

The door to the wind turbine tower must be kept locked to prevent unauthorised persons gaining access or operating the control panel.

2.1.2 Entering and Ascending the Tower

The wind turbine must always be shut down before ascent. If the stop command has not been given at the control panel before leaving the tower floor, the wind turbine will automatically stop when the platform hatch is opened during ascent.

A safety helmet must be used for head protection. Use suitable safety shoes for climbing the ladder.

The remote control system must be locked and the controller set to "service mode" before ascent or inspection of the wind turbine to prevent undesired remote start commands.

The safety harness and fall arrest must be used during ascent and descent.

Safety harness in tower



Wire and glider on ladder



Do not remain in the ladder shaft when another person is climbing.

All hatches in the platforms must be closed after passage.

Tools, lubricants or spare parts must be placed in a bag or box and properly secured when hoisting up and down. If a person is to carry parts on the ladder, the parts must be tied individually to his belt. Do not carry tools or a small spare part loose in one's pocket during ascent or decent.

Do not hook the safety lines to cables, pipes or similar parts. Use the yellow painted eyebolts to hook safety lines.

Read instructions for safety and rescue equipment. Instruction signs are placed in the tower.

2.2 In the Nacelle Compartment

2.2.1 Precautions regarding hatch opening

At wind speed above 8 m/s the nacelle hatch should not be opened unless the nacelle is positioned upwind or downwind. Regardless the nacelle orientation it is not allowed to open the hatches in wind speeds above 15 m/s.

2.2.2 Use of safety equipment and service crane

It is mandatory requirements to wear fall arrest, safety harness, hard hat and safety boots while working or inspecting the wind turbine. However, it is not mandatory to use the safety line inside the nacelle compartment. The hook points, are the yellow painted eyebolts, or other rigid parts.

NOTE: No work or inspection may take place outside the nacelle compartment, unless the person is using safety harness and secured to a rigid part of the construction, as the yellow painted eyebolts in the nacelle, by a safety line.

External hoisting of parts to or from the nacelle or the use of cranes must not take place unless the rotor is stopped and locked mechanically with the rotor lock device.

2.2.2.1 Special precaution to hydraulic systems

It is not allowed to dismantle any hoses or components of the hydraulic power units, which service the blade tip air brakes and the mechanical brake. The systems are constantly pressurised by means of hydraulic accumulators, and not-skilled or unauthorised persons are strictly forbidden to make any kind of work or adjustment to the systems.

2.2.2.2 Cleanliness

Oil and dirt must always be cleaned away, both for safety reasons and for easier identification of eventual leaks.

2.2.3 Fire Precautions

Smoking is not allowed.

Inflammable materials, oily rags, oil containers, waste sacks etc. must be removed after completion of work and before starting the wind turbine.

When electrical tools like soldering irons shrink blowers or grinders are used, necessary ventilation must be provided. Further, a protective shielding must be arranged all superfluous oil and grease must be cleaned away, and a fire extinguisher must be within reach.

2.2.4 Grid Voltage Precautions

Before any inspection or work on the control panel, either the control panel circuit breaker or the main transformer switch must be switched off and secured with a padlock. (The control panel doors cannot be opened without turning the switch to "off".)

Doors to High Voltage rooms, if any must always be shut and locked when a person is in the nacelle or climbing the ladder. When work is being carried out in the High Voltage room (specially trained personnel – over 1000 V), no other work may be carried out elsewhere in the wind turbine.

2.3 Safety Instructions

2.3.1 In Case of Fire

In case of fire in the nacelle or the wind turbine controller the plant must be evacuated immediately and the power supply from the grid cut off as soon as possible, either at the power panel circuit breaker within the wind turbine or at the transformer station. If possible the operations manager must be informed without delay so that the necessary procedures relating to the grid can be implemented.

Put out the fire with the extinguisher if possible. Fire extinguisher is not standard equipment.

If the fire is out of control, the area around the wind turbine must be cordoned off and the Police/Fire Department/Service Department informed.

2.3.2 In Case of Run Away

An uncontrolled run away will hardly ever take place, because it would require a combination of many unfortunate circumstances. However, should an uncontrolled run away take place the area around the wind turbine must be evacuated immediately and the area cordoned off. Do not try to stop or save the wind turbine. The plant can be replaced - human lives cannot be!

No persons must venture closer than 500 metres to a runaway rotor.

2.3.3 Lightning and thunderstorms

A thunderstorm entails the possibility of lightning striking the wind turbine in spite of all lightning protection equipment.

Do not remain inside or near the wind turbine and so be exposed to a possible fatal injury caused by lightning.

When the thunderstorm has passed over, personnel must wait at least an hour before approaching the wind turbine. Continuing rustling or hissing sounds from wet rotor blades show that they still carry an electric charge, so do not go near or touch the plant.

If the wind turbine is hit by lightning strike, the power supply must be cut off and the Vestas Service Department informed. Normally a strike will cause tripping of the maximum current breaker and damage of the lightning MTA-block only.

2.3.4 In Case of Unusual Sound Patterns

It is always important for the wind turbine owner or operator to become familiar with the sound patterns of the plant. An unusual sound or noise often reveals that an abnormal or dangerous situation has occurred or is under development.

If unexplained or strange noises should occur during normal operation, the Service Department should be informed. Further the wind turbine should be stopped if it is judged that continued operation could turn out to be dangerous or cause greater damage and repair costs.

2.3.5 Instructions for Locking the Yaw System

The locking can be carried out in several ways, see below.

The yaw system can be locked mechanically by switching off the automatic fuse at the control panel. Locking of the cabinet and making a note will prevent personnel from resetting the fuse by accident. The yaw friction will secure adequate braking force during normal service tasks, where yawing is not allowed.

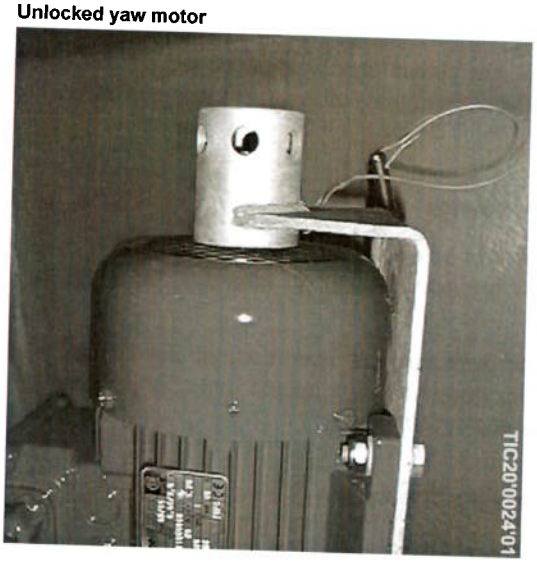
If any work is to be carried out on yaw system components, the rotor or renew of components with external crane, the yaw system must be locked mechanically.

2.3.5.1 Yaw locking with yaw motor shaft lock pins

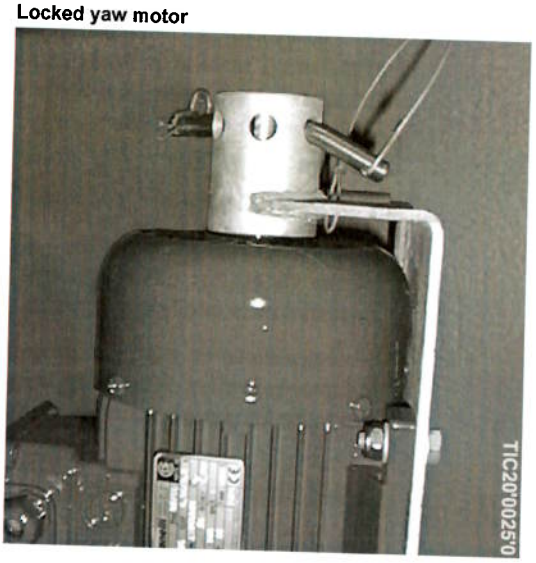
The yaw system can be locked mechanically by mounting a cotter bolt with split pin in the yaw motor shaft end. All cotter bolts can be mounted through step-operation of the motors. When the cotter bolts are not in use they are mounted in each motor bracket stand

WARNING: During step-yaw of motors and mount of cotter pins beware not to get your fingers squeezed. Continue step yawing until it is easy to push the cotter bolts into the shaft holes. Never use force to push the cotter bolts in.

Unlocked yaw motor



Locked yaw motor



2.3.6 Instructions for Use of Manual Brake Disc Locking Bolt

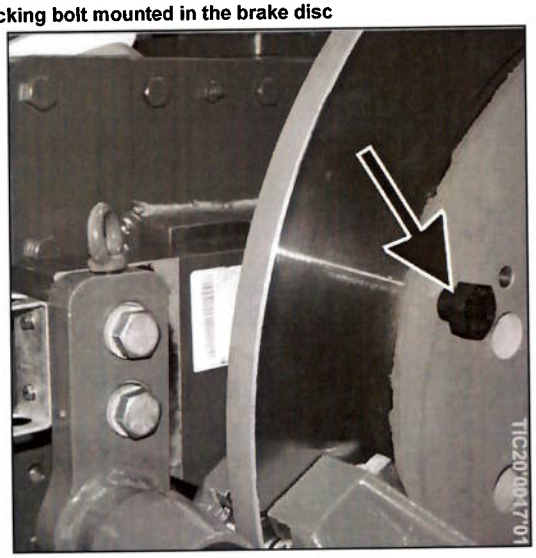
A locking bolt is placed underneath the hydraulic brake bracket. The brake disc has two opposite holes of 20 mm and either can be used.

The rotor must be locked by means of the locking bolt mounted in the brake disc when any work is carried out on the rotor, rotor shaft, gear box or when changing brake pads. The wind speed limit for use of locking bolt is 20 m/s.

Locking bolt resting on the gearbox housing



Locking bolt mounted in the brake disc



2.3.7 Lock of rotor

When it is need to lock the turbine, a special designed bracket has to be fitted on the backside of the main shaft flange, and a guide pin pushed into the hole directly under the main shaft bearing.

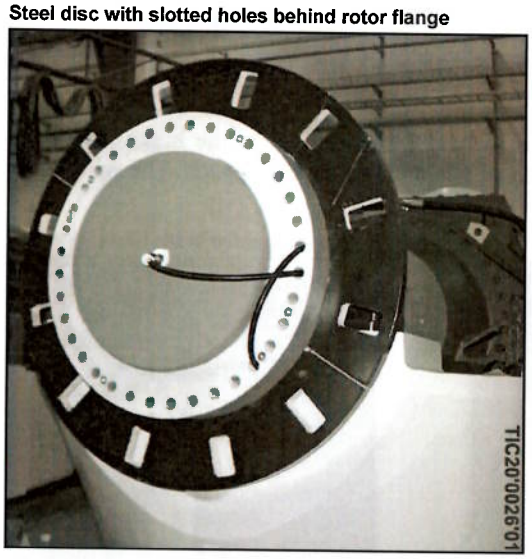
2.3.8 Lock of Rotor (Optional)

The hub is at the rear side equipped with a circular steel disc with slotted holes.

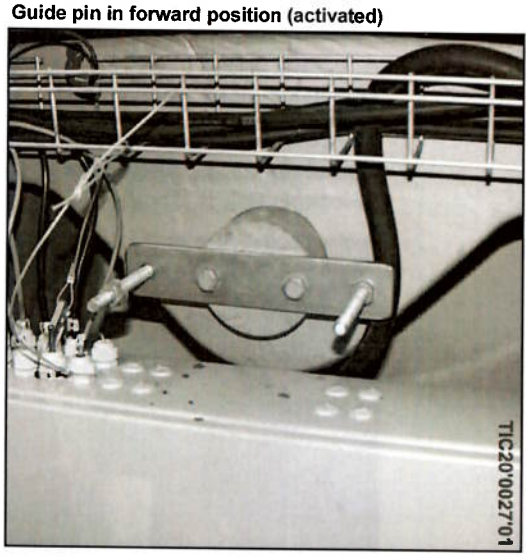
In the front end of the machine frame and directly below the rotor shaft main bearing is placed a rigid steel shaft formed as a guide pin, which can be pushed into mesh with the rotor disc. The rear end of the guide pin has a horizontal steel bar with two holes and stay bolts with adjusting nuts on each side.

When the guide pin is not in use it is fixed in the "out" position.

Steel disc with slotted holes behind rotor flange



Guide pin in forward position (activated)



2.3.8.1 Activation of Rotor Lock Guide Pin

Stop the wind turbine and yaw the nacelle into a position, where it is possible to turn the rotor manually by hand at the mechanical brake disc. Rotate unto smooth mesh of the guide pin.

2.3.8.2 Deactivation of Rotor Lock Guide Pin

Before pulling back the guide pin rotate the mechanical brake disc unto free motion is obtained. Activate the mechanical brake. Pull back the guide pin and lock it with the nuts in "out" position.

2.3.9 Instructions for Use of Personal Safety Equipment

Instructions for use of safety harness and rescue equipment are placed just inside the tower entrance and in the nacelle.

An information sign regarding location of rescue equipment and signs is placed just inside the tower door.

NOTE: For further information about safety equipment and safety signs.

2.3.9.1 Fall arrest safety harness and safety lines

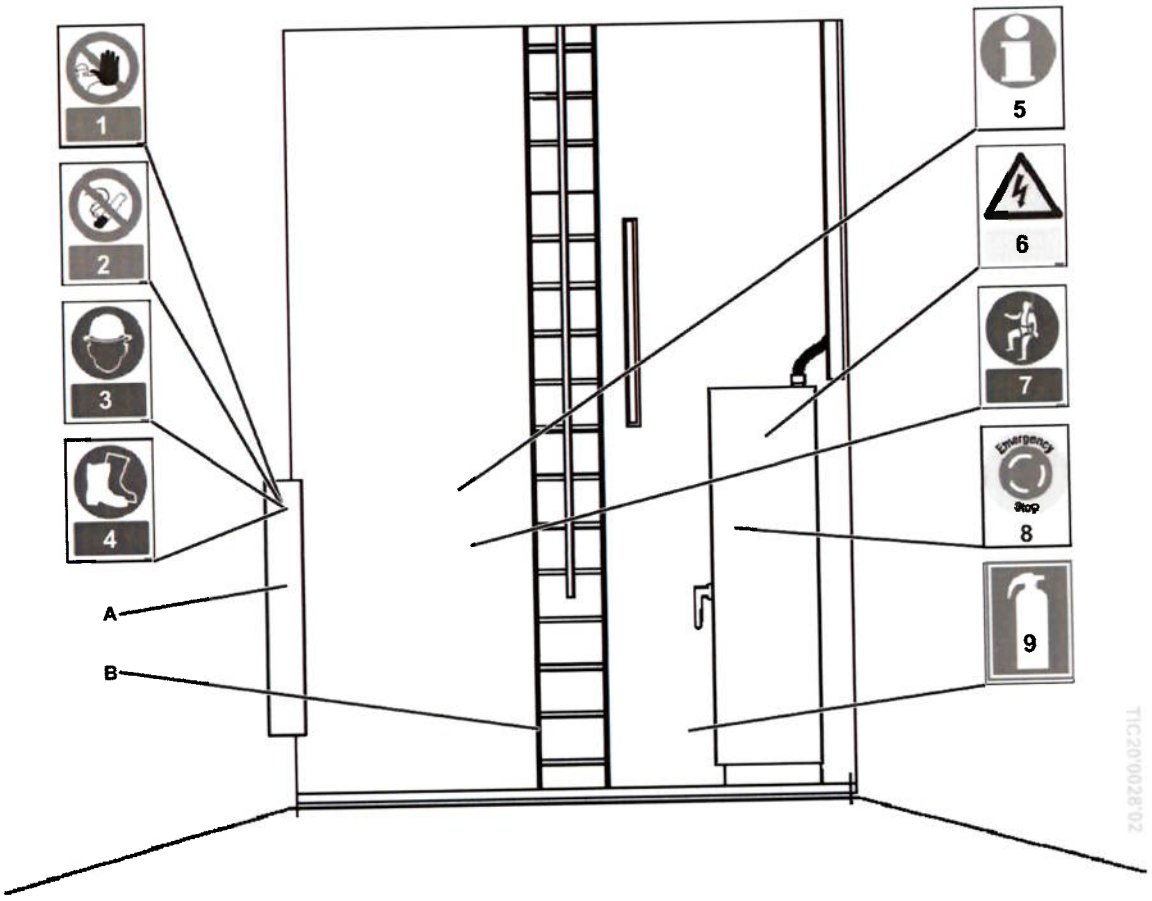
For further instructions in use of personal safety equipment, read instructions delivered with the safety equipment.

2.4 Safety Equipment and Signs

Note that some of the safety equipment and signs described in this manual are optional and not included in a Vestas standard delivery. The following figures are shown as examples only.

2.5 In the Tower

Safety equipment and signs in the tower



A. Tower door

B. Ladder

1. No admittance

2. No smoking

3. Safety helmet must be worn

4. Safety footwear must be worn

5. Information

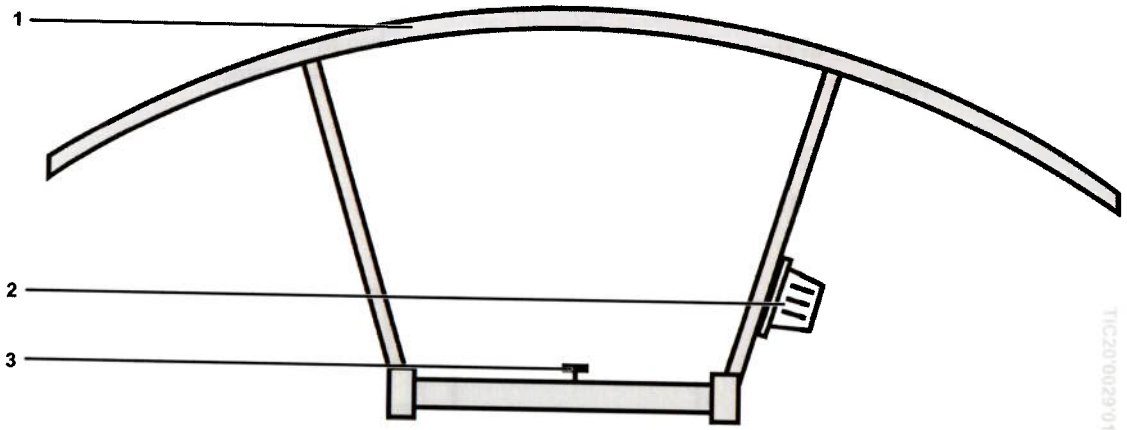
6. DANGER High voltage

7. Fall arrest and safety harness must be worn

8. Emergency stop

9. Fire extinguisher (not standard)

Ladder



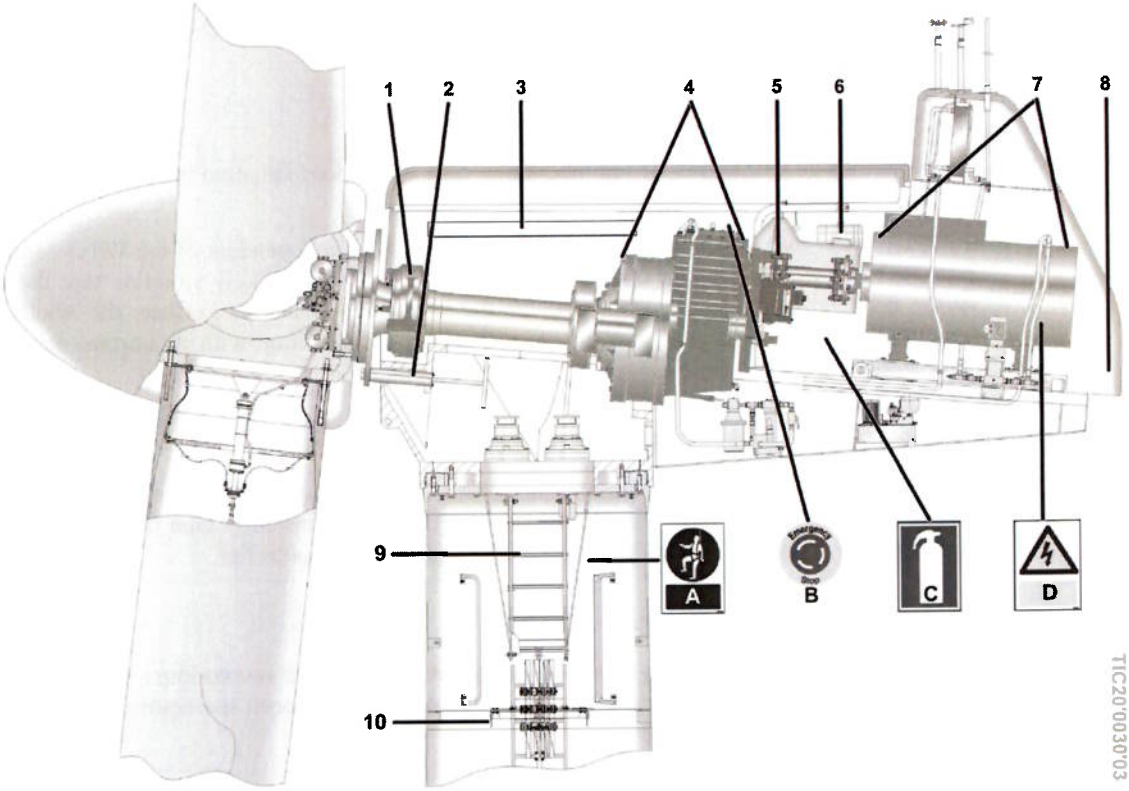
1. Tower wall

2. Lighting

3. Slide bar for fall arrest (wire in some windturbines)

2.5.1 Safety in the nacelle

Safety and signs in the nacelle



1. Main bearing house with eyebolt

2. Rotor lock guide pin

3. Light in nacelle

4. Eyebolts on each side and end of gear box

5. Brake disk with rotor lock bolt

6. Swing crane davit for maximum load of 125 kg.

7. Eyebolt on generator top

8. Vibration sensor and guard

9. Ladder for access to the nacelle

10. Platform below yaw system

A. Fall arrest and safety harness must be worn

B. Emergency stop on top box

C. Fire extinguisher

D. DANGER – High voltage

2.6 Safety Systems

2.6.1 TAC 84 Vibration Guard System

The vibration sensor TAC 84 is placed in the rear end of the nacelle compartment. The system is principally independent of the WTG controller, except for power supply, and the sending of signals to the controller.

The TAC 84-guard system measures continuously the frequency picture of the nacelle, which the controller analyses and eventually reacts to. In case of vibrations in the frequency areas, which can not be accepted, the wind turbine is stopped with information of the incidence.

The vibration guard system makes continuously self-control of the sensor.

2.6.1.1 Edgewise oscillations

At very rare conditions in connection with strong and turbulent wind the rotor blades can be exposed to edgewise oscillations during rotation. If it should occur TAC 84-guard system will react immediately, and the controller will make a stop followed by a start-up command.

2.6.2 Stop in Over-speed Situations

The wind turbine will be stopped immediately, if an over-speed situation is observed by the rpm-sensor at the generator shaft.

However, two other systems can activate the brake system, independent of the WTG controller. They are described below. Both would on beforehand require the very unlikely situation that the generator rpm-sensor does not provide correct signal, or the controller is faulty. Further, the wind speed must be adequately high and the generator unable to keep grid connection with its normal operating resistance. Only at these coincidences a run-away can take place.

2.6.2.1 Over-speed (TAC85)

The TAC85 module make generator shaft speed surveillance by inductive sensors. If the shaft speed exceed 105% of synchronous speed an emergency stop will instantly take place. TAC85 has automatic reset function. The system is independent of the wind turbine controller.

2.6.2.2 Over-speed (TAC 84)

The vibration level will change in connection with increased revolutions. If vibrations are detected equivalent to a frequency pattern of 113 % of nominal rotor speed the controller will instantly make a stop resembling an emergency stop.

2.6.3 Stop in Case of High Winds

At excessive wind speeds the wind turbine stops. The specific limits and time intervals are stated in the Alarm List in the appendix. There are three stop categories: Overwind, Overwind High and Fatal Overwind. A restart will be made automatically after 10 minutes if the wind speed has been measured to be below 22m/s, or the computer will wait unto the criteria can be met. Limitations and time intervals can be found in the Alarm list in Appendix.

2.6.4 Emergency Stop Button

Both on the controller cabinet in the bottom of the tower, in the yaw compartment and on the top box within the nacelle an EMERGENCY STOP button is mounted. See description in section 4.

A restart cannot be made unless the emergency stop button is reset.

2.6.5 Mechanical Vibration Ball Switch

In the rear end of the nacelle a ball linked by chain with a micro-switch is placed. The ball lies in a ring. In the case of severe vibrations causing the ball to fall out, the emergency stop circuit will be activated. The wind turbine cannot be restarted unto the ball is replaced.

2.6.6 Stop in Case of Grid Drop-Out

Should the grid supply be disconnected, the magnetic valves in the hydraulic system will immediately open, activating the wind turbine brake system. The stop sequence is the same as an emergency stop. The wind turbine will automatically resume operation when the grid power supply has been back to normal for 10 minutes.

3 Service & Maintenance

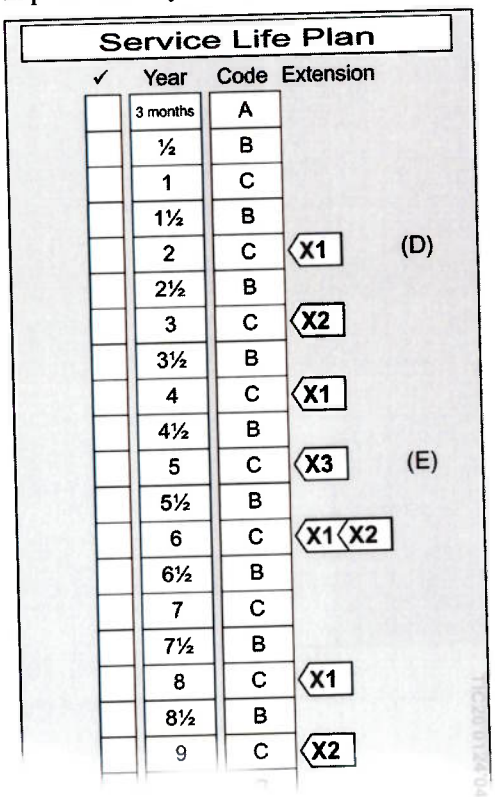
The service routine includes careful check, inspection and test of the wind turbine according to this manual, service plan and I&S Data (See Appendix). This information will make it possible for a competent service crew to carry out proper service and maintenance. In connection with service visits the work carried out must be reported by the service technicians in the valid service reports and work sheets.

3.1 Service – Service Life Plan

The service procedures consist of a check of components and testing of the wind turbines operations and safety systems. Service is carried out in accordance with this Service & Maintenance Manual, associated "Service Plan & Checklist QR 09.270 and I&S Data TIC 265". See Appendix.

The Service Engineer is responsible for ensuring that the work is carried out in accordance with this manual and associated service documents. The Area Service Manager is responsible for supervision of the work and can be contacted by the service fitters for further advice and guidance in connection with service.

The service life plan is a helping tool that provides the technician with one or more codes, showing which points that has to be executed on the Service Checklist. The Service life plan has a point for each service in period of 20 years after commissioning.



Description of Service

A – Service
A – Service is executed 1 to 3 months after commissioning.
A – Service is a single event service, and will be executed only once in the Service Life Time of the Wind Turbine.
A – Service is executed ±1 month according to Service Life Plan

B – Service
B – Service is executed 6 months after commissioning, and repeated with one year intervals in the Service Life Time of the Wind Turbine.

B – Service is executed ±1 month according to Service Life Plan

C – Service
C – Service is executed 6 months after commissioning, and repeated with one year intervals in the Service Life Time of the Wind Turbine.

C – Service is executed ±1 month according to Service Life Plan

X – Service Extensions

In some occasions an extension to service is needed. Extensions can be executed only once, or repeated through out the Service Life Time of the Wind Turbine.

NOTE – **(D)** & **(E)** refers to old naming of Service visits at this point in the turbine life.

3.1.1 Log Book

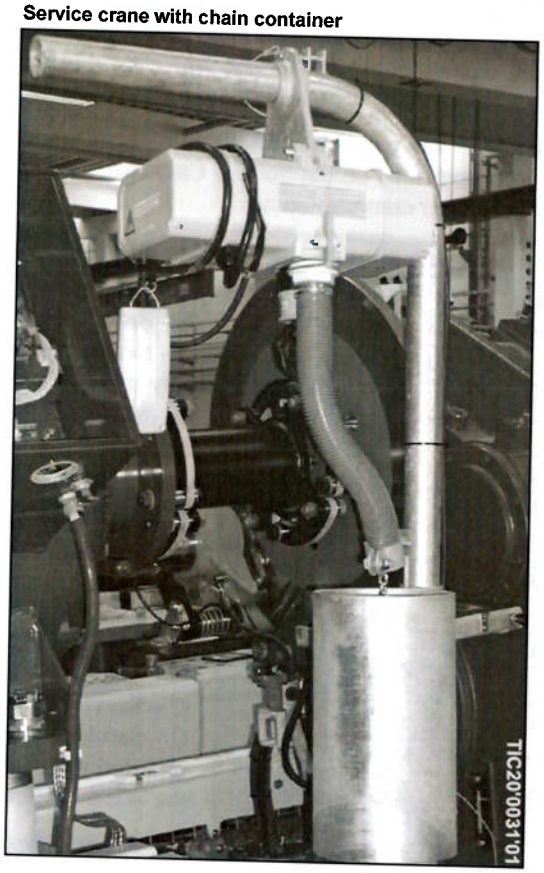
At each service visit or scheduled service, the date, the purpose of the visit and the work carried out must be reported in the logbook, which is placed in the wind turbine.

3.2 Service crane

External hoisting of parts to or from the nacelle or the use of cranes must not take place unless the rotor is stopped and locked mechanically.

In the nacelle right side is mounted a short davit equipped with an electrical chain hoist. It is exclusively for lift of light equipment, components and tools through a service hatch in the nacelle bottom (outside the tower). Maximum weight is 125 kg. During use a person should be placed on ground and manage a controlling rope to secure, that the moving subject do not swing and hit the tower.

Service crane with chain container



3.3 Test of Safety Systems

In connection with regular service checks the wind turbine brake systems are tested by performing a normal brake procedure (push of stop button) and an emergency stop (activation of emergency knob

Extended tests of safety systems can be carried out of the wind turbine control system. This is a task that requires a comprehensive knowledge of the controller program and parameter settings, to which the wind turbine owner/operator have no access. Special trained personnel only can perform the extended test. (Technicians from Vestas Service or Vestas Control Systems).

The extended test includes extensive function control of sensors and brake procedures in connection with rotor over-speed, generator over-speed, TAC84 measured over-speed and grid cuts.

3.4 Replacement of Parts

All main components have a life of more than 20 years. However, this does not mean that defects or errors cannot occur since durability depends on preventive maintenance and service.

The different procedures regarding replacement of main components are described in the Service Manual. The jobs are strictly for Vestas service technicians. It is mandatory, that renew or the taking down of bigger components for repair are made by skilled and experienced technicians. Extensive knowledge of component weights and balance, handling and ways of hooking on is of utmost importance as to avoid the occurrence of dangerous situations.

4 Operation and Control

In normal operation the wind turbine functions automatically. Correcting commands can be given manually directly from a control panel, a modem and communications PC or a wind farm monitoring system (if installed).

The different control units are all cable-connected. At the base of the tower is the Power Panel Cabinet and Control Cabinet (CPU-panel). The nacelle contains a Terminal Topbox (cable bus-bar) and a Topbox. As a further option the wind turbine can also be remote controlled.

4.1 Wind Turbine Control Units

Vestas uses systems from Vestas Control Systems to control its wind turbines.

The primary task of the system is to cut the generator in and out of the electricity grid and to monitor the plant's vital functions so as to prevent operating conditions ever arising which could lead to a dangerous situation or damage. On the basis of the incoming data the computer always implements safe operation of the wind turbine in the most beneficial manner.

The control system collects and stores data related to automatic operation. This makes it possible to see historic data and statistical information on the display or on a computer linked to the plant via a telephone line and modem.

Both power panel cabinet, computer cabinet and an eventual extra cabinet containing phase compensation equipment are based on the first floor of the tower base. At the bottom floor the high voltage transformer is located.

4.1.1 Power Panel Cabinet

The wind turbine control components are located inside the power cabinet. The front cover of the power panel cabinet includes an emergency stop button and a reset button, which must be activated after an emergency stop before the wind turbine can be restarted. A circuit to trip or engage the main supply from the grid is located on the power panel front cover breaker (lower left).

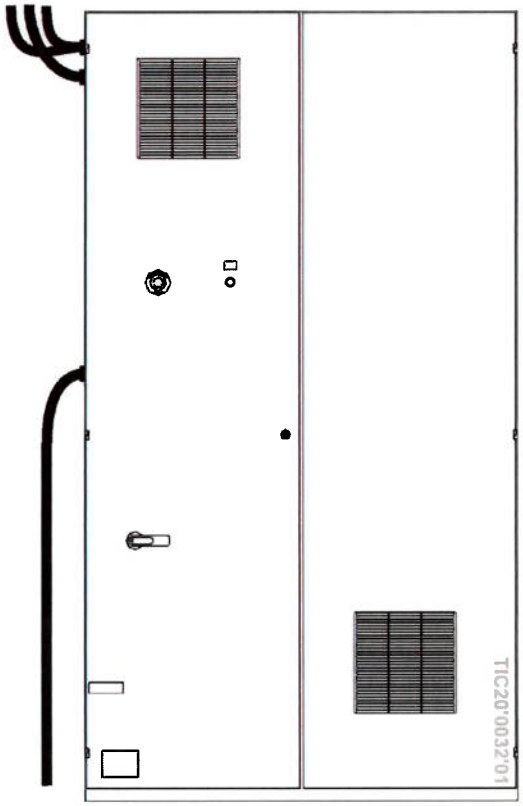
The doors cannot be opened without tripping the circuit breaker. This action will not cut the power supply to the computer panel, tower light or power sockets.

CAUTION: The incoming main cables from the grid and the bottom termination bus will still be live.

They will be dead only if the main circuit breaker in the high voltage transformer station is tripped.

The cabinet is equipped with an emergency stop button and a CE-power socket.

Power Panel Cabinet



4.1.1.1 Arctic equipment

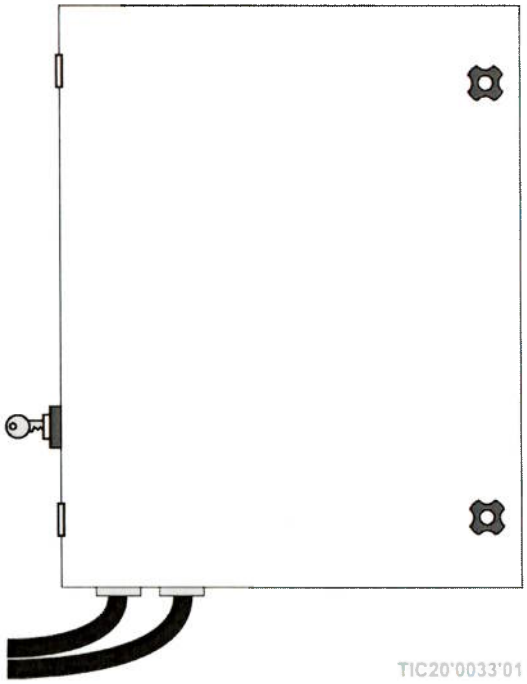
The arctic version of the wind turbine is equipped with 2 heating elements of 400 W each placed inside the power panel to ensure that the temperature is kept above -20°C. The heating elements will be switched on or off automatically according to the pre-set temperature parameter levels. Normally the power panel gear and transformers will keep up the temperature internally DURING operation.

4.1.2 Computer Cabinet

The computer cabinet is placed on the tower wall next to the power panel. Inside are the TAC computer with operation keys, and a TOI panel with light emitting diodes.

A servicing key is mounted on the cabinet.

Computer Cabinet



4.2 Operation

4.2.1 Emergency stop button.

Activating the EMERGENCY STOP button will instantly break the safety circuit, cutting off power to all relays in the control system. This will result in the wind turbine immediately coming to a halt. The wind turbine will stop by means of simultaneous operation of the air brakes and the mechanical brake. However, it will take a few seconds for the blade tip air brakes to become fully deployed after the mechanical brake has been applied. The E-button is released by turned clock wise unto pop out with a click. The start-button must be activated twice to resume automatic operation immediately after use of the E-button.

Emergency stop button



4.2.2 Servicing key

The servicing key acts as a lock, which at activation into "1" prevents remote operation of the wind turbine via modem or wind farm monitoring system. The control system registers the activation of the servicing key. Normal registration of errors and events in the control system's error stack will not take place during servicing of the wind turbine functions or safety system testing. After servicing is complete the key should be turned back to its original position "0".

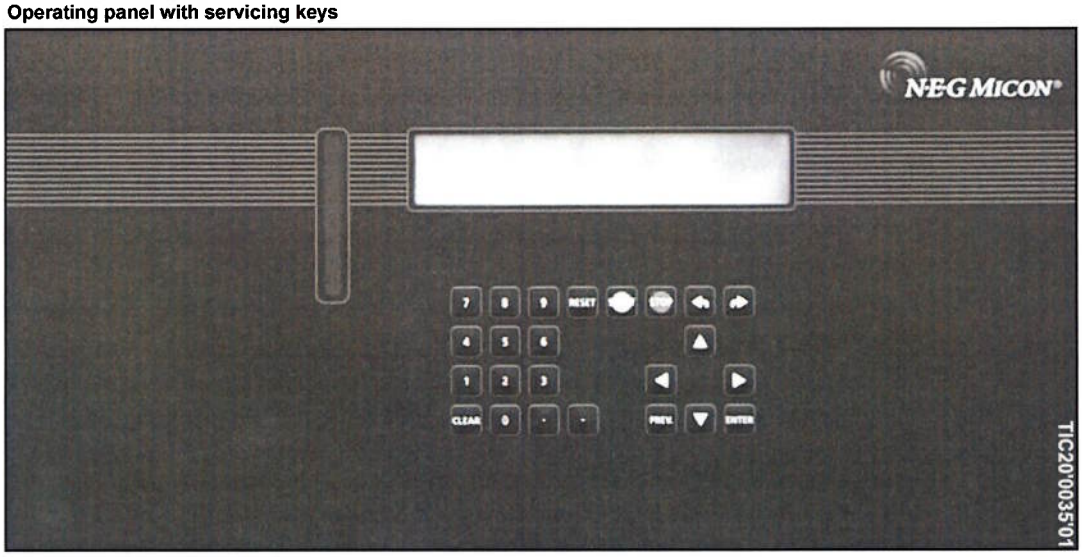
Service Key



4.2.3 Control panel

The power cabinet in the base of the tower has a control panel with display. The computer is often called a "TAC computer". Inside the nacelle power cabinet is an information panel with light diodes called TOI. The operating panel is divided into control buttons, number keys, arrow buttons and an enter key. Operating the control buttons allows the plant to be manually controlled. Status, errors and historical data can be retrieved and parameters viewed in the menu system.

Operating panel with servicing keys



Manual operation is carried out with the keys under the display. By pressing them it is possible to start or stop automatic operation, to yaw to left or right and to reset the turbine after an error situation. The arrow keys, the enter key and the numerical keyboard are used to move round the menu system.

On the left-hand side of the operating panel (TAC Computer) is a vertical row of 8 LED's. They flash every time impulses are received from important sensors. Not all are in use.

The top three diodes light when:

- data is received from one of the communication channels
- data is sent to one of the communication channels
- the modem is connected to another modem (remote calling)

The bottom three diodes light when

- impulses are received from the generator shaft RPM sensor
- impulses are received from the rotor shaft RPM sensor
- impulses are received from the anemometer

4.2.3.1 Starting the wind turbine

Switching on all main contactors followed by a start command, or automatic start-up after power failure will activate the turbine's control system to prepare for automatic operation. After the start-up routine has been run through, including a 60-second interval for data to stabilise, the turbine will be released for automatic operation. In the case of grid failure where automatic operation is otherwise error-free, the computer will automatically carry out start-up as soon as measured data is found to be correct again.

If the turbine has stopped due to an error, which is not automatically reset by the computer when conditions are once more registered as normal, a manual reset must be carried out. Manual reset and restarting can also be carried out remotely.

The function keys

➢ START

This key is used to start automatic operation of the wind turbine. However, if after pressing the start button an error is detected, the wind turbine controller will discontinue the start-up procedure, and the display will show the error in question.

The first time the key is pressed, the computer will reset all errors, if any. The wind turbine will start operating after a parameter-defined start-up interval, in which any necessary yaw of the nacelle into the wind will be made before release of brakes. If the key is pressed twice the wind turbine will start without any delay.

The third time the button is pressed the computer will carry out a command as follows (depending on the circumstances):

1. Perform motor start-up if the turbine has been started from stand still or if a generator was previously selected from the Service menu.
2. When the motor start procedure is activated, the generator will act as a motor. The thyristors will limit the power to the generator and to give a soft and gradually increasing start. The motor start will be interrupted after 15 seconds or at a generator shaft speed of 500 RPM regardless of whether generator "g" (small generator) or "G" (main generator) is used. Thereafter the wind alone will continue to accelerate the rotor unto the generator cuts into the grid.
3. If the small generator is already connected to the grid, the controller will switch from g to G. If G was connected, the computer will switch to g, but the operation will not take place unless the acceptance criteria for doing so are present.

4. Any motor start-up in progress will be de-activated, and the rotor will free wheel.

➢ STOP

When this key is activated the wind turbine will stop. The message "manual stop" will appear in the display, and an alarm call will be made, if selected in the parameter list.

A stop command activates the stop procedure. The rotor hydraulic pressure and the mechanical brake hydraulic pressure will be released simultaneously, and hydraulic oil fed back to the hydraulic tank. It takes a few seconds to deploy the air brakes while the generator is still connected to the grid and the mechanical brake is already active. The generator will cut out when the computer detects negative power production. Within 10-15 seconds, depending on wind speed, the rotational speed will be down to nil.

➢ YAW

The yaw keys turn the nacelle to the left or right.

➢ RESET

This key resets any error shown in the display. Recurring errors will not be shown unto a start-up procedure has been attempted with the start key.

➢ ENTER

The Enter key is used for confirming the parameters set by using the numeric keypad and for starting/stopping various test functions (see Service menu).

➢ PREV.

Press this key to return to the previous menu.

➢ CLEAR

To clear all data in the display line containing the cursor, first press the Clear key and then confirm by pressing the Enter key.

4.2.3.2 The arrow keys

There are four arrow keys on the front panel: ←, ↑, → and ↓. These keys are used to move through the TAC menu system. For further details, see the next chapter. A single press will move the cursor one line or one space. If the key is held down in a menu with many items, the cursor will accelerate through the items.

Key ←

On activation, the cursor will move one space to the left or return to a higher level in the menu system.

Key ↑

On activation the cursor will move one space up in the menu system or the current menu.

Key →

On activation the cursor will move one space to the right or transfer to a lower level in the menu system.

Key ↓

On activation the cursor will move one space down in the menu system or the current menu.

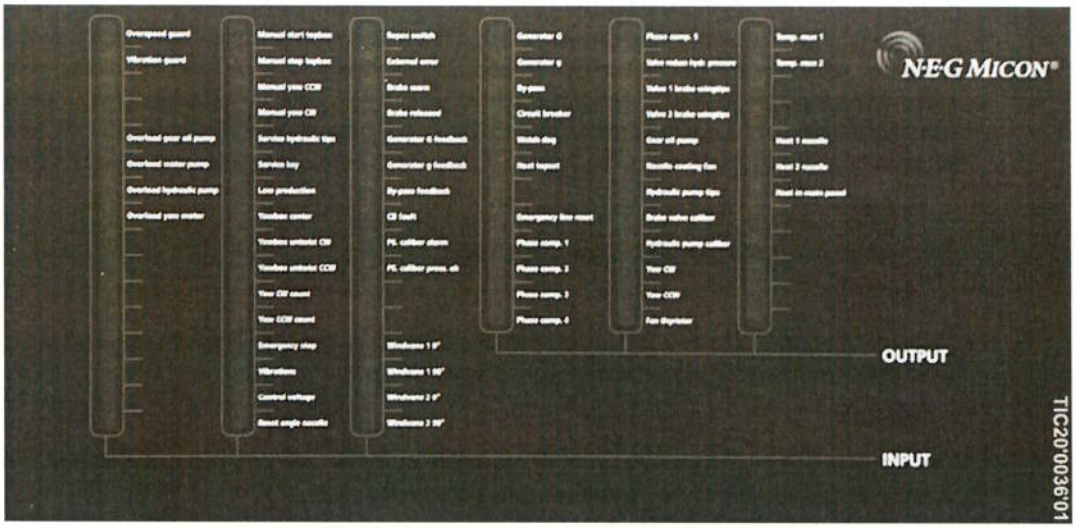
After start-up the computer will show a clear screen, on which are given details of the type and version of software installed in the computer.

Pressing the right-hand arrow key will access the main menu. See Chapter 5 Menu systems.

4.2.3.3 LED's on the TOI2 panel

Inside the turbine control power cabinet is an input/output panel, often referred to as the TOI2 panel, showing conformity between the computer and the various sensors or the foregoing commands.

Input and output panel



4.2.4 Control Top-box

In the nacelle compartment is a top box with four operational buttons to carry out start or stop commands, to yaw the nacelle left or right, mechanical brake release (for manual inspection during service), or for emergency stop.

Manual Control Top-box



4.2.4.1 Manual Start/Stop

This button has three positions: A spring-loaded start position (i.e. the button springs back to neutral), a neutral position and a stop position.

- Start position

The first time this position is activated, the computer will reset any errors. If the wind turbine is error-free it will restart after a parameter-defined start-up interval.

If an error has been detected, the computer will allow wind turbine operation after a parameter-defined start-up interval the second time this switch is activated. If no errors have been detected, the computer will perform wind turbine start-up instantly; i.e. the brake will be released without a start-up interval.

The third time the switch is activated, the computer will perform an instant wind turbine start-up. (In order to operate the motor start function, generator G or g must be selected from the service menu).

The start position switch is spring-activated, i.e. the switch automatically returns to neutral position.

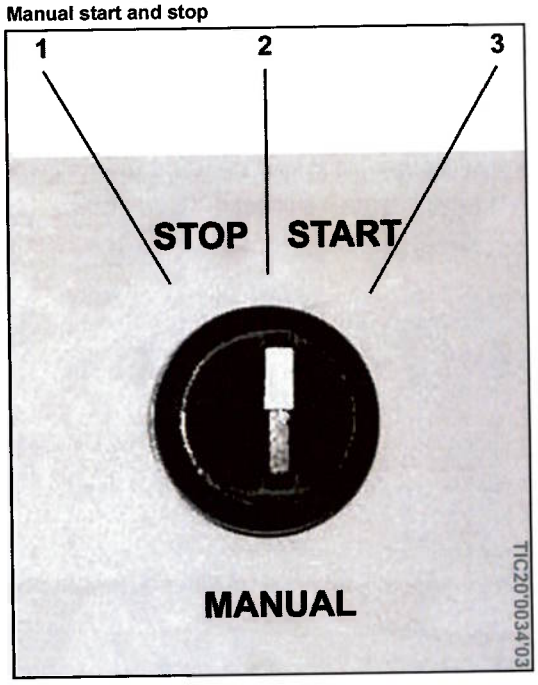
- Neutral position

The switch will remain in this position during normal turbine operation.

- Stop position

This position is used to cause a wind turbine stop. The stop position is not spring-loaded, and the switch will remain in this position unto turned back manually. When the switch is turned to stop position the turbine cannot be started, not even by a start command from the computer panel. Remember to turn the switch into neutral before leaving the nacelle after completion of the service or inspection job.

Manual start and stop



1. Stop position

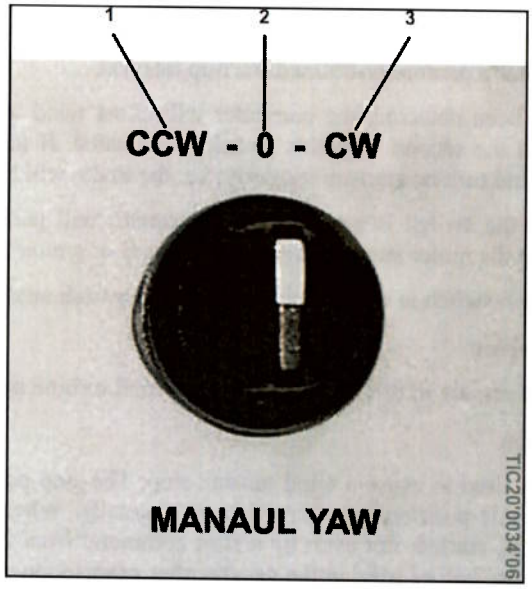
2. Neutral position

3. Start position

4.2.4.2 Yaw switch

In position YAW CCW, the turbine will yaw counter-clockwise, and in position YAW CW the turbine will yaw clockwise.

Yaw switch



1. Yaw counter clockwise

2. Neutral position

3. Yaw clockwise

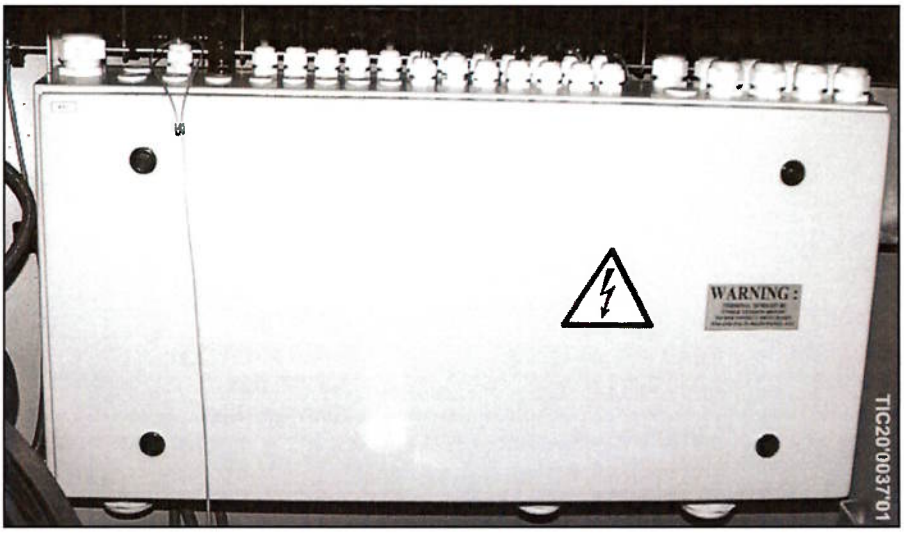
4.2.4.3 Release Brake

By activating this switch the mechanical brake is released and it is possible to turn the rotor by turning the brake disk. This is necessary for a number of service tasks.

4.2.5 Terminal top-box

Depending on the wind turbine type (number of yaw gear drives) the terminal top-box is placed either on the right wall or the left wall of the machine frame, directly above the yaw system. The cabinet contains central termination of all cables from the different nacelle sensors and indicators. The terminal top-box has multi cable connection to the power panel placed in the bottom of the tower. On the side of the terminal top-box a yaw switch is placed. The switch has the same function as the switch on the top-box.

Terminal top-box



4.2.6 Remote Control

The wind turbine can be supervised by a remote control system consisting of a personal computer with an appropriate program and a modem/telephone connection. The system also makes it possible to receive all important operational information, production figures and present status.

In the event of a stop the wind turbine controller will automatically call any pre-selected service computer and print the time and cause for stopping.

Besides remote control operation of the wind turbine, adjustment of limiting operational parameters can also be carried out.

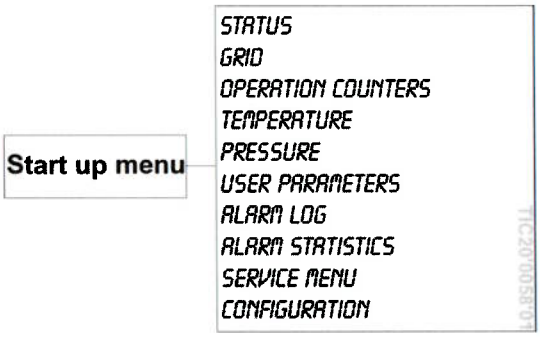
5 Menu System

5.1 Main menu

To switch between the different menus, use the arrow keys on the TAC computer.

On start-up the computer will display a start-up screen on which the software type and version number are shown. A press on the right-hand arrow key will switch to the main menu, on which the menu structure is as shown below.

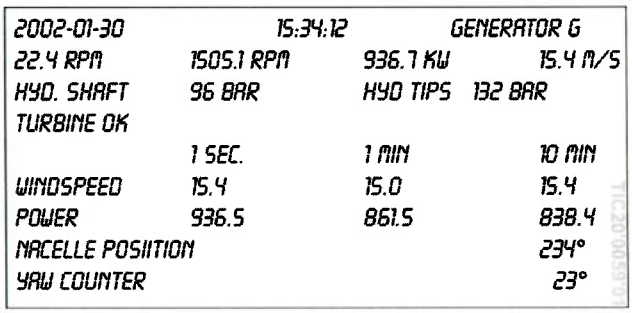
Main menu



5.2 Status menu

The status menu shows the status of the wind turbine:

Status menu



Toggle down to see all lines

Line number:

1. Date, time and current operating status of the turbine.
2. Rotor speed, generator speed, present production and pressent wind speed.
3. Hydraulic pressure for shaft brake and hydraulic pressure for the blade tips
4. Status line; this line describes the turbine status for the turbine, and shows any alarms recorded in the turbine.
5. Location of 1-second, one minute data and of 10-minute data.
6. This line shows the average wind speed for 1 second, one minute and for 10 minutes.
7. The line shows the average power output for 1 second, one minute and for 10 minutes.
8. This line shows the position of the nacelle.
9. The last line is the degree of cable twist.

5.3 Grid menu

Grid menu is electrical power measurement and currently registration of values

Grid menu

	L1	L2	L3
VOLTAGE	389	373	385
CURRENT	790	771	795
KW	304.2	284.7	303.0
KVAR	-5.1	-3.9	-4.7
COS PHI	0.99	0.99	0.99
QUAD	3	3	3
891.9 KW	-13.7 KVAR		50 HZ

The values in this menu are one second average values.

Line number:

1. L1, L2 and L3 describe the phase concerned.
2. Voltage for the three phases.
3. Current for the three phases.
4. Individual power output for the three phases.
5. Individual reactive power output for the three phases.
6. Power factor for the three phases.
7. Quadrant possition for the three phases.
8. Total power outoput, reactive power output and mains frequency.

5.4 Operation counters

This menu shows information of

1. Operation counters
2. Operation counters TOI input
3. Operation counters TOI output

5.4.1 Operation counters

Operation counters shows the accumulated data for the turbine.

Power produced is shown for the main generator G and the small generator g. Furthermore, the wind turbine consumption is shown, i.e. the current consumed by the power plant when not producing power.

Component counters and timers on all motors, major contactors, mechanical parts, hydraulic systems and the phase compensation show accumulated operation hours and activation times.

The availability figure for the turbine, which can also be found under "Operation counters", is stated as the percentage of time for which the turbine has been free of errors and available for production.

5.4.2 Operations counters TOI input

In this menu is shown hours and number of times an input signal to the TOI module have been active.

5.4.3 Operations counters TOI output

In this menu is shown hours and number of times an output signal from the TOI module have been active.

5.4.4 Calculation of availability

The availability calculation is based on two counters in the TAC computer. The two parameters are updated under the following criteria:

The T1 counter records the time during which the turbine brake is released and the wind speed lies between the minimum and maximum wind speed limits.

The T2 counter records the time during which the turbine measures wind speeds between the minimum, and maximum wind speed limits. The parameter for maximum and minimum wind speeds can be seen from the parameter list.

The parameter for maximum and minimum wind speeds can be seen in the parameter list.

$$\text{Availability [\%]} = \frac{T_1}{T_2} \cdot 100$$

The availability of each wind turbine is calculated with the above formula.

Counters T1 and T2 are summation counters, counting from the wind turbine's start-up.

5.5 Temperature

The temperature menu shows the different temperature points of interest. The menu contains many more input possibilities than actually used. Use the arrow keys to scroll down.

5.6 User parameters

The following points are given under the menu for "User parameters".

5.6.1 Set user parameter

This menu contains parameters for setting the display functions.

Show error (0/1): This parameter reveals/hides error messages in line 4 on the display. Pressing 0 will cause no errors to be shown on line 4 of the display. Pressing 1 will have the contrary effect.

Light time (sec): Time for which the display lights up after a key is pressed.

Sound time (sec): Time for which a sound will be heard after a key is pressed

Language UK/DK (0/1) Select language, English or Danish

5.6.2 Set date/time

Set date (YYMMDD): For entering the date.

Set time (HHMMSS): For entering the time.

5.6.3 Set communication protocol -> Select protocol type

DCE 1 com port channel 0: Selects first communications port for DCE 1 protocol

DCE 1 com port channel 1: Selects second communications port for DCE 1 protocol

DCE 2 com port channel 0: Selects first communications port for DCE 2 protocol

DCE 2 com port channel 1: Selects second communications port for DCE 2 protocol

DCE 3 com port channel 0: Selects first communications port for DCE 3 protocol

DCE 3 com port channel 1: Selects second communications port for DCE 3 protocol

FDV 2.00 channel 0: Selects first communications port for FDV 2.00 protocol

FDV 2.00 channel 1: Selects second communications port for FDV 2.00 protocol

Alarm call com port: Selects communications port for Alarm call

DCE 3 is an abbreviation for Vestas Control System protocol 3.

FDV 2.00 is an abbreviation for Forenede Danske Vindmølleproducenter joint protocol version 2.00.

5.6.4 Set communication parameters

Serial port com1: Selection of sub-menu, see description below

Serial port com2: Selection of sub-menu, see description below

Serial port com3: Selection of sub-menu, see description below

Combined description of items in serial port set-up.

Baud rate: The speed at which the computer receives/sends over the selected serial communications port.

Data bits (7/8): The number of data bits used on the selected serial channel. Option for 7 or 8 bits.

Parity (0/1/2): Selection of parity for the selected serial channel:

No parity = 0.

Odd parity = 1.

Even parity = 2.

Stop bit (1/2): Selects whether there should be one or two stop bits.

Modem control (0/1): By setting this to "1" you instruct the computer to send only if the modem is linked to another modem. This means that the modem must be able to see a DCD signal and, if not, will decline to send. (DCD = Data Carrier Detect).

Handshake : This parameter tells the computer whether there should be a handshake or not. Handshake means that the input/output control depends on input/output status.

Xoff (bytes): Software stop of transmission after the number of bytes specified in the line.

Xon (bytes): Software start of transmission after the number of bytes specified in the line.

Tone or pulse dial: Selects whether calls are to be made with tones or pulses

CCITT or BELL: The relevant telecommunication network standard

5.6.5 Set phone call

WTG Id. No.: This is the wind turbine's 8-digit identification number.

WTG telephone no.:	Wind turbine's telephone number.
Alarm call no. 1.:	The first number the wind turbine may ring if the turbine detects an error.
Alarm call no. 2.:	The second number the wind turbine may ring if the turbine detects an error.
Alarm call no. 3.:	The third number the wind turbine may ring if the turbine detects an error.
Alarm call no. 4.:	The fourth number the wind turbine may ring if the turbine detects an error.
Alarm call no. 5.:	The fifth number the wind turbine may ring if the turbine detects an error.
Service call no. 6:	The sixth number the wind turbine may ring if the turbine detects an error.
Service call no. 7:	The seventh number the wind turbine may ring if the turbine detects an error.
Start call 1:	The start time for when the turbine may ring to the first number
Stop call 1:	The stop time for when the turbine may not ring to the first number
Start call 2:	The start time for when the turbine may ring to the second number
Stop call 2:	The stop time for when the turbine may not ring to the second number
Start call 3:	The start time for when the turbine may ring to the third number
Stop call 3:	The stop time for when the turbine may not ring to the third number
Start call 4:	The start time for when the turbine may ring to the fourth number
Stop call 4:	The stop time for when the turbine may not ring to the fourth number
Start call 5:	The start time for when the turbine may ring to the fifth number
Stop call 5:	The stop time for when the turbine may not ring to the fifth number
Com number alarm call:	Selects the communications port for the alarm call

1* 98-01-11 14:30:34 Test comp. (current)

2* 98-01-11 14:30:34 Test comp. (kVar

3* 98-01-11 14:30:34 Test comp. (current)

4* 98-01-11 14:30:34 Test comp (kVar)

Communication silent:	Silence on the telephone line before an alarm call can be made
Call again:	The time between attempts to ring a particular number if connection cannot be obtained.
Retry times: obtained.	The number of attempts to ring a telephone number if connection cannot be
Wait for connection:	The number of seconds the turbine will wait for connection before breaking off the call if no connection is obtained.

It is only possible to decide the start and stop time for "Alarm call" numbers. The alarm call number is used for customers who, for instance, do not wished to be called at night.

The service number is used to ring up persons or companies who carry out servicing at the wind turbine.

5.7 Alarm log

The warning stack is used to show the 100 most recent warnings recorded by the computer. The warnings are displayed in the following way:

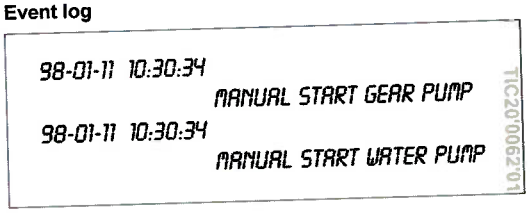
Stack no., date, time and warning text.

An asterisk "*" before the time indicates that the warning is active

5.8 Event log

The computer records the most important events and stores these in an internal log. The log messages are stored in the following way: date and time of the event, text describing what happened. Events are shown in chronological order.

Event log



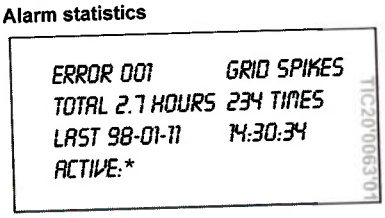
5.9 Alarm statistics

When the error statistics menu is chosen, all warnings and errors will be displayed, the number of occurrences and the most recent date and the total time recorded for the individual error/warning.

It is furthermore possible to see whether the error/warning is active. An asterisk in the last line indicates an active error/warning.

This is shown in the following example:

Alarm statistics



The error "Grid spikes" is active in this example.

5.10 Service

This function is accessible only be specially trained personnel, and only on entry of a password.

5.11 Configuration

This function is only accessible to specially trained personnel and only on entry of the relevant password.

6 Operating and error conditions

6.1 Automatic Operation

The wind turbine will operate automatically when the power panel circuit breaker is on and the grid is live. Further the STOP-button must not have been manually activated.

All information on wind turbine operation can be obtained from the controller and display. Please see chapter on the menu system.

At low wind speeds the rotor may be stationary without they're being any error. This will happen at wind speeds below 3-4 m/s, as the wind speed increases and no later than at 5 m/s the rotor will start turning or the controller will make an automatic motor start.

It is also possible to see the rotor turning at low wind speeds without the nacelle facing directly into the wind. This is because the controller only activates yaw drive trains at winds of over 3 m/s.

The wind turbine will automatically stop if the computer observes situations, which do not conform to the chosen operational parameters. The error(s) will be shown on the display. See Alarm List in Appendix.

6.2 Alarm Messages

During automatic operation it may happen that information from a sensor exceeds the chosen limits. The controller will then show an error with name and number on the display. Some errors will result in a turbine stop and others will just be for information or a warning.

An error may be temporary, old or permanent. If a permanent error has caused a stop, the reason for the error must be remedied before a restart can be made.

More than one error may occur in combination. The error stack will show these in order of emergence. Also, a faulty condition could lead to other errors, which must be called consequential errors, because they do not represent the real error cause.

6.3 Response to Alarm Messages

The response to error information depends on the type and character of the error. The following types of responses can be expected. (The Alarm List in the Appendix describes the appropriate response to possible error situations).

- No reaction. The error is information or a warning about the operational situation.
- Normal stop: activation of the air brakes and the mechanical brake simultaneously. The air brakes will be pulled back in line again after a stop.
- Safety stop: activation of the air brakes and the mechanical brake simultaneously. The stop sequence is similar to an emergency stop. The air brakes will stay in the active brake position unto restart command.
- A stop command will in some cases be followed by a 90 yaw of the nacelle.
- Certain errors disconnect yaw operations. In other cases the automatic yaw operation continues on the basis of information from the wind vane, keeping the nacelle 90 to the prevailing wind.
- Some of the errors do not accept an automatic restart, but require a manual command at the control keyboard or by a remote control keyboard.
- Please also note, that a stop sequence caused by a "major" error, which according to the Alarm List has a subsequent automatic restart, may be followed by other faults which do not have this feature.

This kind of event will result in a permanent stop even though the "major" error did not require such a stop. In that case a manual restart command must be made either on site or by remote control.

6.4 Start-up After an Error Message

The display will show "*" in the error line as long as the error is still present. When the sensor signal is no longer outside the chosen parameters, the "*" disappears.

The controller will often restart the wind turbine after a short delay, when the error is no longer present. See column "Automatic reset" for the various errors in the Alarm List in the Appendix.

However a reset and restart of the wind turbine can always be made from the controller keyboard or by remote control, provided the error is no longer present.

On very rare occasions the information signaller may be disrupted and confuse the operations. In this case the computer has to be turned off and on again, to provide a fresh start-up. Cut the power supply within the control cabinet, followed by direct cut-in and START-command on the keyboard.

The computer will never restart the wind turbine if just a single error is still present. After an unsuccessful restart the specific error will show with the "*" sign. Do the necessary repair or contact the Service Department at Vestas.

6.5 Monitoring of operations

A computer program monitors operations with the help of a number of signal emitters and sensors, which constantly send impulses for use in the data processing of the operating situation.

One of the most important parameters is the measurement of the generator's rotational speed, and an inductive sensor constantly checks this. The current temperature of many different components or areas is also measured continuously.

Other important measuring is grid voltage, phase sequence, frequency, active energy production and compliance with all threshold values for safe operation.

Hydraulic pressure levels are also measured. When the start and stop commands are given, the computers run through various routines and checking functions which accurately control the hydraulic systems for blade tip brakes and the mechanical brake on the gear box.

If a sensor measures values outside the selected operating parameter ranges, the computer will immediately provoke a stop. The cause of the stoppage will be shown on a text on the control display.

With many of the possible error types, an automatic restart procedure will be accepted when the operating parameters are normal again. In the case of other errors it will be necessary to carry out a manual restart on the control system or by remote control. In individual cases it may be necessary to adjust or replace parts in the nacelle before the plant can be restarted.

The control system will refuse to start the wind turbine if errors are still present.

6.5.1 Revolutions per minute (rpm)

Inductive sensors have been mounted on the wind turbine's rotor shaft and high-speed gear shaft and these send impulses to the computer which are translated into actual rpm figures. The STATUS-menu show the actual RPM values.

The rotor shaft sensor gets impulses from angle braces mounted on the backside of the main shaft flange or as an optional solution from the rotor-lock flange holes. The generator shaft speed is measured at the gearbox high-speed shaft, using impulse from the bolt heads of the brake disc flange. The primary use of the rotor shaft speed signal is to control that the generator shaft speed sensor is providing true reading.

Knowledge of the rotational speed makes it possible to undertake correct cut-in to the grid and to stop the plant if over-speed occurs.

6.5.2 Temperatures

Temperatures are measured by PT-100 sensors in the gear oil sump, gearbox high-speed shaft bearings, generator copper winding heads, control panel and ambient. The measurements are used, for example, to start and stop pumps, blowers and heating elements, in order to maintain operation within the set threshold values. If a temperature reading strays outside the permitted range, the braking system is activated. The wind turbine then waits unto the temperature is again within the permitted range. When this happens, the error is reset and the wind turbine resumes operation, providing that an automatic reset is permitted for the error in question.

The highest and lowest recorded temperatures for the different areas are kept in a register. The measured values can be zeroed as desired.

The specific wind turbine alarm list contains the parameter settings and limitations in force.

6.5.3 Grid quality

The wind turbine control system power cabinet contains a number of signal emitters for monitoring grid quality. The control system computer compares the continuously measured data with encoded threshold values relating to grid quality requirements. Where a threshold value is exceeded the computer decides which precautionary measures need to be taken.

Data is recorded for voltage, current, frequency, power factor and output. A digital signal processor (DSP) is used for measurement, in order to obtain an optimum and quick measurement. Other measurement areas not described here relate to e.g. motor protection, fuses, relays and switches.

6.5.3.1 Voltage

Voltage is measured in Volts on all three phases. Average values over different time intervals are stored. The measured values are used to calculate production and internal consumption. The measured voltage is also used to halt the plant in the case of voltage being too low or too high.

6.5.3.2 Current

Current is measured in Amps on all three phases. Average values over different time intervals are stored. The measured values of current, voltage and output are used to calculate production and consumption etc. Current measurements are also used to monitor the cutting-in of the generator to the grid. During cutting-in current measurement is used to check whether there are any short-circuits in the generator or in the thyristors. While the generator is connected to the grid, the current measurements are used to check that load is symmetrical in all three phases. If asymmetry between the three phases is too great, the wind turbine stops and an error message appears on the display. In addition the current measurement is used to check for any errors in one or more phases.

6.5.3.3 Frequency

Frequency is measured in Hertz on all three phases. The measured frequency values are stored and average values calculated using various factors. One function of frequency measurements is to stop the turbine in the case of frequency being too high or too low.

6.5.3.4 Power factor

The power factor is measured continuously on all three phases. The measured values are stored and the average calculated for various time intervals. Measurements of power factor, current and voltage are used

in part to calculate production and internal consumption. They are also used to calculate the turbine's consumption of reactive power (kVAr).

Measurement of power factor is used in switching in and out the capacitor batteries to compensate for reactive power consumption from the grid.

6.5.3.5 Power output

The output or generated power is calculated continuously for all three phases. On the basis of these values a total three-phase output is calculated. The output calculation is used to account for the wind turbine's total power production and internal consumption. The calculated output is used to change between the two generators in order to make best use of each generator's range.

The values are used when cutting out the generators in the case of production being too low and halting the plant in the case of overproduction.

6.5.4 Operation of hydraulic systems

The computer controls hydraulic pumps and valves. At start command the real start procedure will not be carried out unless the wind turbine is free from errors (self-test) and parameter-defined waiting time for start-up is looked over. At first the valves will be closed, secondly the hydraulic pumps started. They will be stopped, when the computer has received information of obtaining the accepted pressure level. The blade air brakes and the mechanical brake will then be in active (WTG ready for rotation).

If the pressure levels have not been reached within a pre-set time interval, the computer will refuse WTG-operation and report too long pump interval.

To initiate the stop procedure the computer will open hydraulic valves, which allows hydraulic oil to run back to the respective tanks and the brakes are activated. (Fail-safe). For further information of brake sequences, see 7.7 Brake System.

6.5.5 Mechanical brake system

The mechanical brake pads are equipped with wear indicators. When the pads are worn down to a pre-set level a warning will appear on the computer display that it is time for renewal.

After a stop sequence the brake will not be released unto the disc and pads have cooled down and are ready for re-use. Depending on the brake system used the cooling period is a built-in time-interval or actual brake pad temperature readings with a computer based threshold value to avoid re-start unto the temperature is below an acceptable level.

6.5.6 Cable twisting

The cable twisting system counts the number of times the nacelle has yawed. When the turbine has yawed a total of three times to one side, the turbine is braked and the cable automatically untwisted. The turbine then restarts.

The system is supplemented with an inductive sensor, which inform the computer about yawing direction and position.

6.5.7 Vibrations

At the rear right of the nacelle (under the generator bracket) is the vibration sensor (vibration ball). The ball lies in a ring and is connected by a chain to a micro-switch. In the case of imbalance the balls falls out of the ring and the computer causes a safety stop. The ball must be replaced prior to restart.

A sensor (TAC84 system) also located at the rear of the nacelle carries out detection of blade vibrations. The turbine will stop and restart automatically after ten minutes if wind speed permits.

6.5.8 Anemometer

An anemometer on the nacelle mast measures wind speed. The anemometer, placed as it is behind the rotor, is not a precise instrument. It is used to indicate wind speed so that the operation of the wind turbine can be carried on within fixed threshold values, but it cannot be used for precise calculation of the power curve.

The wind turbine stops automatically if wind speed exceeds 20 m/s or 25 m/s measured as an average over 10 minutes or for a 2 second period over 30 m/s or 35 m/s. The parameter list for the specific wind turbine gives the values.

6.5.8.1 Arctic version

The function is as standard, but the anemometer and wind vanes are heated version for arctic operation. Please see section 1.5.4

6.5.9 Wind vanes and yawing

Wind direction is recorded in relation to the nacelle centre line by two wind vanes on top of the nacelle mast.

To eliminate the risk of oblique wind incidence on the rotor, the measurements from the two wind vanes are continuously compared.

Yawing occurs automatically on the basis of information from the wind vanes. Yawing occurs in shorter or longer steps depending on the computer's interpretation of the wind vane signals. In the case of wind vane failure, automatic yawing function is suspended.

The turbine will not yaw into the wind if wind speed is recorded at less than 3 m/s.

7 Wind Turbine Description

The wind turbine range, has been developed on the basis of experience from the construction and operation of several thousand wind turbines since 1980.

It is the special philosophy of Vestas constructions to make the design as simple and strong as possible with no use of complicated equipment or superfluous components which could have a negative influence on the reliability or the availability factor of the wind turbine operation.

Vestas NM52/900 & NM52 is based on a cast manufactured, tub-like machine frame specifically engineered to maximise support stiffness and strength, and to withstand all fatigue loads for more than 20 years. The gunwales of the frame form a strong internal flange to which all of the main components are bolted. The primary design advantage of this approach is that all major components (rotor, drive train and generator) are along the same centreline through the nacelle.

The yaw system is installed directly underneath the machine frame floor. The complete nacelle is then attached to the top of the tower by means of a solid slewing ring with friction bearings. The entire construction demonstrates attention to reliable design and careful use of all materials. The resulting nacelle base unit with its unique design has a superior ability to distribute the dynamic forces and fatigue loads from the rotor to the tower. The nacelle construction is welded from certified steel of specified grade.

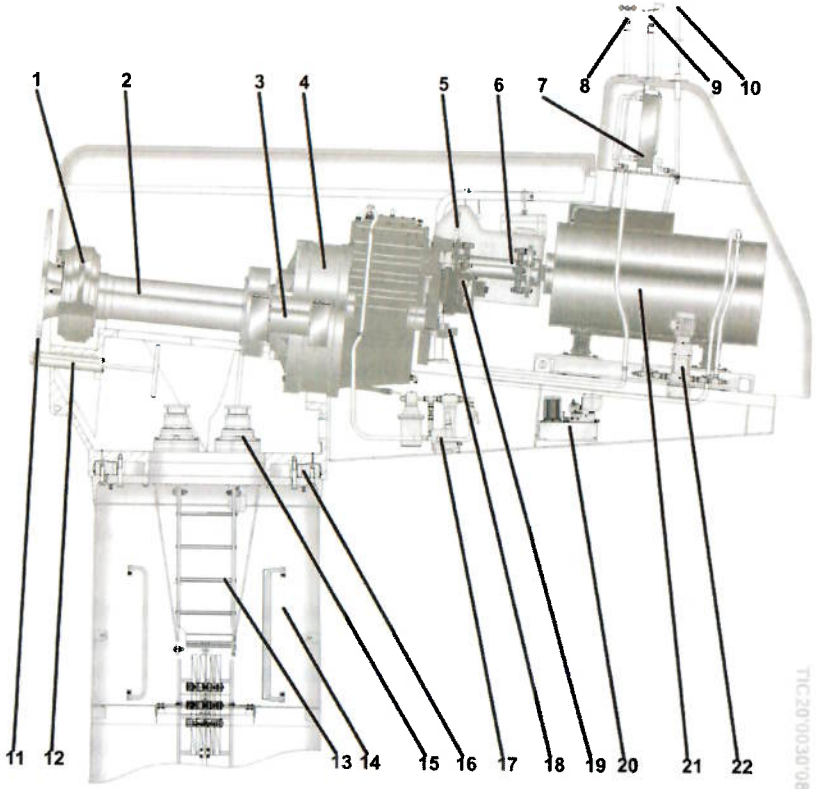
The nacelle machine frame is covered by a fibreglass enclosure, which effectively seals and protects all parts in the nacelle compartment from the environment (rain, humidity, salt, dust etc.) On top of the enclosure is a radiator (for cooling the generator and gear) and also a mast with anemometer and wind vanes, while a lightning rod affords excellent protection against lightning strikes.

All machine frame areas are machined to close tolerances prior to mounting the rotor shaft and drive train unit, the generator and the yaw system. With this set-up, the proper alignment of all components to the same tight tolerances every time is ensured.

The production of the Vestas wind turbines is certified in accordance with the International IEC 61400-1; 1999 Quality Standards. Construction is carefully executed, and follows a written detailed description of all manufacturing and working routines, and final quality control and operational tests and reports are conducted on each and every wind turbine. The source and identification of all major parts are documented in accordance with Quality Standards. The purchaser of a Vestas wind turbine will always receive products of an identical and supreme quality.

Vestas maintains a large inventory of spare parts for each model wind turbine it manufactures. Turbine users will therefore always be able to order the specific and correct spare part with exactly the same tolerances as used at the original construction of the wind turbine.

Nacelle NM52/900 & NM52



1. *Main bearing housing*
2. *Main shaft*
3. *Gear stay*
4. *Gear box*
5. *Brake disc*
6. *Coupling*
7. *Cooling radiator*
8. *Anemometer*
9. *Wind vane*
10. *Lightning receptor*
11. *Rotor locking disc (optional)*
12. *Guide pin for rotor lock (optional)*
13. *Nacelle ladder*
14. *Tower*
15. *Yaw gear and motors*
16. *Yaw system*
17. *Oil pump and filter for gear oil*
18. *Collector ring*
19. *Brake calliper*
20. *Hydraulic unit for mechanical brake*
21. *Generator*
22. *Circulation pump and heat exchanger for liquid cooling*

7.1 Nacelle and Layout

The machine frame is made of two steel parts, which are bolted together. In the front a tub-shaped cast construction, on top of the tower flange, carry the wind turbine rotor, rotor shaft and gearbox. The bottom is made with a centre access hole. The rear part is a bent and welded steel construction with internal steel support and longitudinal members to carry the generator. The complete machine frame forms the bottom part of the nacelle compartment. The top nacelle cover is made of GRP.

The machine frame design and construction is quite simple and results in a frame which is strong, stiff and lightweight. The layout provides for the optimised use of all materials at the lowest possible weight, while maintaining strength and stiffness.

The machine frame top is machined and prepared for mounting of the rotor shaft and drive train unit. The bottom is machined and prepared for mounting of the yaw system. This ensures the perfect, precise and uncomplicated mounting of all major parts.

7.1.1 Rotating Parts

All high-speed rotating parts are carefully screened for safety reasons. The brake disc, flanges and the coupling between the gearbox and the generator are protected by a complete fibre glass enclosure.

7.1.2 Nacelle Compartment

7.1.2.1 Standard and arctic climate conditions

The upper part of the nacelle is completely enclosed and sealed by a fibreglass cover. The top part has two long hatches, equipped with gas actuators for easy opening. The hatches closely seal to the frame edge with rubber edging when closed, thus providing effective protection against the environment.

At the rear end of the nacelle compartment the fibreglass-raised area provides protection for a radiator, which supplies cooled liquid for cooling the generator and gear oil (by means of a heat exchange unit). On top of the nacelle short masts are mounted to support the anemometer and the two wind vanes. Further, a lightning rod is mounted as a part of the entire lightning conducting system.

Please see separate description regarding cooling of gearbox and generator.

7.1.2.2 Tropical wind turbine version

For installation in extremely hot climate the radiator on top of the nacelle cools the generator only. A separate oil-cooling radiator supplied with a fan replaces the heat exchange unit. It is mounted on the nacelle wall rear, right side. The air going in for cooling is passing through the service hatch in the nacelle bottom, which is equipped with a grate landing.

7.1.3 Protection

As an effective protection against corrosion the whole basic machine frame is surface-treated.

7.1.4 Sound Absorption

The complete nacelle housing is constructed as one long sound box to absorb noise and provide effective sound insulation. The fibreglass enclosure is of a sandwich construction. In addition, rubber suspension minimises noise transmission from the wind turbine gearbox down the tower.

7.2 Rotor

The rotor is a solid steel hub with 3 rotor blades. The blades have fixed pitch. When the blades are attached to the hub, each tip angle is adjusted and optimised according to the specific wind turbine and site terrain.

7.2.1 Power Regulation

Stalling controls the power output. Stalling is a physical aerodynamic phenomenon that occurs gradually to the blades when the wind speed reaches a level of 13-14 m/s and above. This form of regulation is the

most effective and simplest way of controlling power output, because it functions instantaneously and without the interaction of any complex hydraulic and mechanical equipment.

For further description, please see Generator.

7.2.2 Rotor Blades

The rotor blades are LM25.5 supplied from LM Glasfiber A/S.

For further detailed data please see Main Specifications in the Appendix.

The LM blades are made from fibreglass reinforced polyester with a through-running fibreglass supporting spar. The blade root has integral steel bars with internal thread holes for the blade bolts. The outer part of the blade structure has rotating blade tips. Activation of the blade tip air brakes slows down the rotation immediately and keeps it well below the nominal speed at all circumstances. Please see the description of blade tip air brakes immediately below.

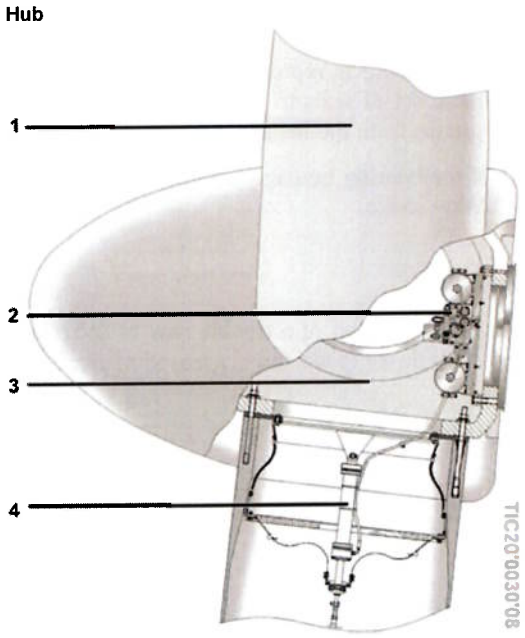
The blades are made with a lightning protection system. See separate description.

7.2.3 Blade Tip Air Brakes

Each blade is built with a rotating blade tip, which when activated rotates approxiamte 75° compared to the main blade, slowing the rotor's rotation immediately. The blade tip is mounted on a carbon fibre shaft, which is an integral part of the blade tip. The carbon shaft is supported by bearings in the main blade and spar structure. The individual air brake is maintained in inactive position by a stainless steel cable from a hydraulic cylinder at each blade root. The tip brakes will, when deployed, keep the rotor speed at well below the nominal design speed. The activation system is fail-safe. For further description of braking procedures please see Brake System.

7.2.4 Hub

The hub is cast in SG iron and mounted directly on the rotor shaft. The blade bolt flange is made with slotted holes for fine adjustment of the blade pitch to optimise each turbine at its individual site. A hatch in the hub spinner and an opening in front of the hub provides access for inside inspection and re-tightening of the blade bolts. The hydraulic cylinders and the hydraulic hoses at the bottom of each rotor blade, and the hydraulic power unit placed at the rotor shaft front end can also be inspected from the inside of the hub. The hydraulic power unit controls the blade tip air brakes on basis of information from the wind turbine computer.



1. Blade

2. Hydraulic power unit for tip brake

3. Hub

4. Hydraulic actuator for tip brake

7.2.5 Spinner

The hub is completely covered by a spinner in the front. It protects the hub and hub access hole. The spinner is fabricated from fibreglass.

7.2.6 Protection

The colour of the blades and the spinner is contained in the outer layer of the gel-coat, making the surface essentially maintenance free. The hub is surface-treated.

The blade tips are fitted with lightning receptors, which ensure that lightning strikes are conducted via the steel wires of the blade tip brakes through the blades and hub to the tower wall, leading to earth in a controlled and safe manner. A metal brush is mounted on the rotor shaft to avoid lightning passing through the main bearings. (See also description of lightning protection).

7.3 Rotor Shaft

The purpose of the main shaft is to transmit the rotational torque from the rotor blades to the gearbox. The rotor shaft is manufactured with a front flange for mounting the hub and rotor. It is made of high quality steel and supported at two locations, by the main bearing located in the front of the nacelle, and by the gearbox in the centre of the nacelle. Rubber suspension fixed to either side of the machine frame gunwale provides flexible support of the gearbox. The main shaft is connected to the gearbox low-speed tubular shaft by means of a high capacity split bushing, which ensures perfect joining and alignment and maintenance-free operation. The simple and robust three-point suspension from a main bearing capable of absorbing rotor strain and two flexible gear mounts reduces peak loads in the gear transmission.

7.3.1 Bearing Housing

The front main shaft bearing is mounted in a housing of high strength cast iron. The bearing cover is provided with a double set of seals to prevent the intrusion of dust or dirt from the outside and to secure against leakage of grease from the inside.

On the front part of the bearing housing is mounted a metal brush to protect the main bearing rollers and raceway from lightning strike.

7.3.2 Main Bearing

The main bearing is constructed of a double row of spherical roller bearings of the highest quality. The main bearing carries all thrust loads and is greased manually at each half-year service visit.

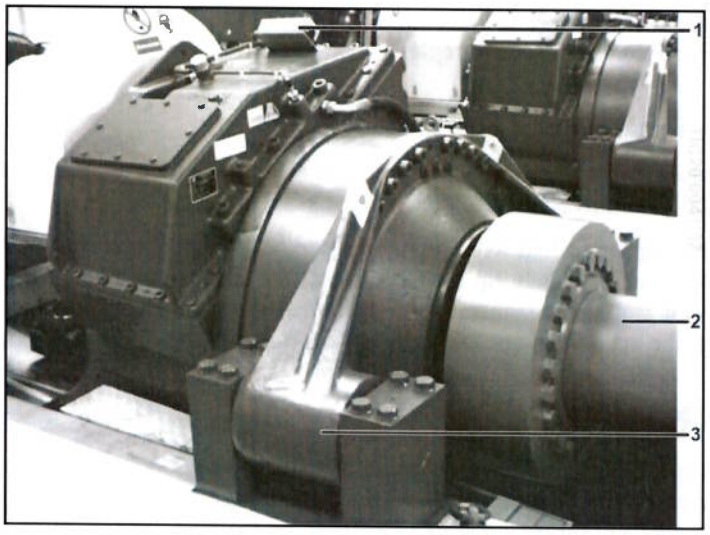
7.3.3 Rotor Lock Device

Please see Chapter 2 of this manual.

7.4 Gearbox

Vestas uses specially developed gearboxes manufactured for wind turbine applications. In any wind turbine, large loads are placed on the gearbox, requiring careful design and strict attention to applicable safety factors. The general layout and design of the gearbox housing has been made in close co-operation with the specific gear manufacturer, who is a specialist in design, calculation, construction and production of gears. The gear is designed as a triple stage gearbox of which the first stage is planetary and the following stages of helical types with parallel shafts.

Gearbox



1.Manual top-box with emergency stop

2. Main shaft

3. Gear stay

The gearbox ratio is chosen to get the low speed shaft revolution to match the most optimal tip speed for the blades, when the generator is rotating at synchronous speed (50 Hz: 1500 RPM; 60 Hz: 1800 RPM). The combination of blade tip speed and tip angle secure that the wind turbine automatically carry out power control by stalling, when the rated output is achieved round 15-16 m/s and above.

For further details please see Main Specification for the specific wind turbine.

7.4.1 Gearbox Housing

The gearbox housing is cast or welded depending on the make. The design is made in the most efficient and economic way in accordance with Vestas's requirements and specifications. The loads and forces from the gearbox are transmitted to the machine foundation by the two supports, one on each side of the gearbox. These supports have strong rubber bushings to further reduce noise and vibrations from the turbine. The mechanical disk brake is mounted on the rear side of the gearbox and on the topside is located an inspection hatch.

7.4.2 Shafts and Gear Wheels

The low speed main shaft of the gearbox is hollow. It encloses the rear end of the rotor shaft, which is secured with a strong split bushing. This special connection of rotor shaft and gearbox, forming a single unit in a three-point suspension (a single rotor main bearing and the gearbox providing the rear rotor shaft suspension) eliminates alignment problems.

The mechanical brake disc is mounted to the high-speed shaft by a split bushing. The shaft is connected to the generator shaft by a flexible coupling.

7.4.3 Roller Bearings

All bearings in the gearbox are of the highest quality and selected carefully to the application. The bearings maintain shaft paralellism at all operating conditions and allow compensation of thermal growth in axial direction. No axial clearance adjustment is ever required. The bearings of the high-speed-shaft are supplied with a PT-100 sensor, which provides information about the bearing temperature (outer race of the bearing).

7.4.4 Bearing Caps and Seals

The bearing covers and seals are of special maintenance-free labyrinth types, which effectively prevent oil leakage.

7.4.5 Lubricating System

All the gearbox bearings and wheels are continuously lubricated by injection of oil from the oil sump. The large low speed gear wheels splash-lubricate the entire gear housing. Additionally oil is led through channels to the bearings, which are fitted with oil cups.

7.4.6 Gear lubrication, Oil, Temperature and Cooling

The gearbox oil sump contains lubricating oil specially selected for wind turbine use. The oil has a highly advantageous viscosity index, which allows easy start-up of the turbine even at extremely low temperatures. Oil samples are taken for laboratory testing as part of the servicing routines. These tests show when the oil should be changed. The servicing manual describes the oil sampling intervals and the sampling procedures. Connected to the oil sump is a temperature sensor (PT100), which passes oil temperature information to the control system. In the case of abnormal oil temperature the control system stops the turbine immediately.

The gearbox has a special oil circulating system, which include an in-line filter system. The main purpose is to secure a steady and relatively low oil temperature at all conditions, as well as to lead freshly filtered and colder oil into all hot temperature generating areas in the gearbox. When the oil reaches the temperature for pump start, measured at the oil sump or high speed bearing, the gear oil is circulated through the system. The oil pump stops again when the temperature falls below the stop threshold. Other pump intervals are arranged in the control system to circulate oil regularly.

The amount of oil in the gear sump depends on the gearbox type and size. Please see the Main Specifications.

The oil circulation system includes oil pump; filter and by-pass arrangement; a filter alarm; and a cooling unit (heat exchanger) with thermo-bypass.

7.4.6.1 Filter and by-pass arrangement

At very cold conditions the oil in the pipes and filter can be of a viscosity so low (thicker oil), that it is very hard for the pump and motor to operate unto warm oil has passed through. To avoid a trip of the motor thermal relay the by-pass pressure valve will open to let the pump run oil through the by-pass circuit. When the oil viscosity has become higher and the pressure is reduced, the valve will gradually close and finally all oil passes through the filter.

7.4.6.2 Filter alarm

The oil pressure is measured on both sides of the filter. If the pressure levels are recorded to an unacceptable difference the wind turbine stops. Parameters of simultaneous oil temperature levels are used to detect incorrect oil pressure levels. If the filter alarm becomes active the filter must be renewed and the old one investigated for any debris. As a standard procedure the filter is renewed 3 months after start of operation, and then at each half-year regular service visit.

7.4.6.3 Heat exchange thermal-bypass

The heat exchange unit is equipped with a by-pass system operated by thermal valves. This is to secure that oil is not cooled unnecessary during oil pump and filtering operations.

7.4.7 Tropical version

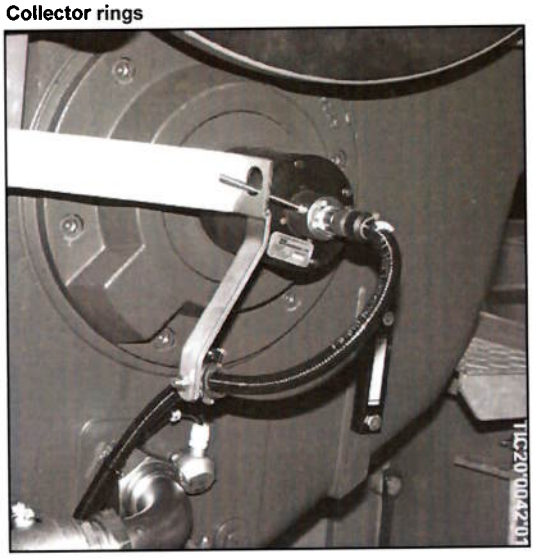
A variation of the cooling system is used at high temperature environment. The tropical cooling system has an additional fan operated oil cooler. The unit is mounted on the left side on the nacelle front end. The air inlet for cooling is placed at the rear end of the nacelle. The additional cooler is only activated when oil temperature is high.

Further, a special tropical version for 60 Hz grid-conditions has a temperature interval of -20° C to +40° C (optional on 50 Hz tropical versions). As to operate at these low ambient temperatures the gearbox is equipped with an electrical heating rod placed in the oil sump. The wind vanes and anemometer are of the same type as for the arctic version.

7.5 Collector Rings

The low-speed gear shaft is extended through the rear of the gearbox housing. On the extended shaft the collector ring system is located with its slip rings with carbon brushes. The collector system bridges between the stationery gear housing and the rotating low-speed-shaft, and provides the necessary power supply and control signals to the air brake hydraulic power unit at the hub. The electrical connections have multi-pole sockets at both ends and a cable through the hollow gear and main shaft.

Collector rings



7.6 Brake System

The brake system is designed for fail-safe operation. This means that active hydraulic pressure is required to keep the wind turbine brakes inactive. When the turbine controller gives the stop command or the electric supply drops out, the brakes are released and the wind turbine stopped. The brake system has two main elements: the blade tip air brakes on the rotor and a mechanical brake placed on the gearbox. Two separate hydraulic power units supports each system.

7.6.1 Mechanical Brake

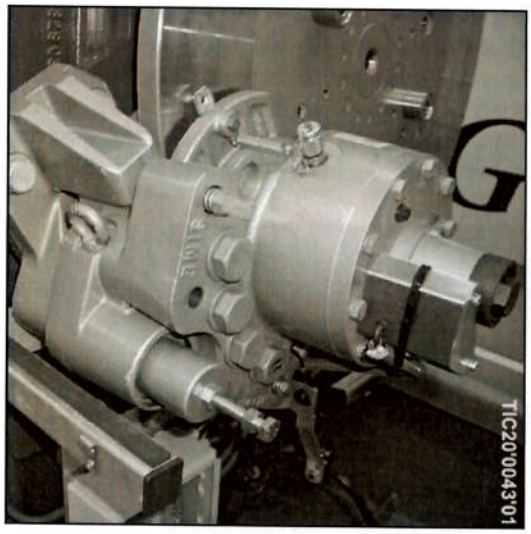
A shrink disc connects the brake disk to the high-speed shaft of the gearbox. A brake calliper is mounted on a steel bracket bolted to the gearbox housing. The calliper has a built-in spring-loaded brake force. The hydraulic power unit keeps the mechanical brake system open and in-active by oil pressure.

On the gearbox housing rear side a rpm-sensor is placed. It uses 6 bolt heads on the brake disc as revolution impulses.

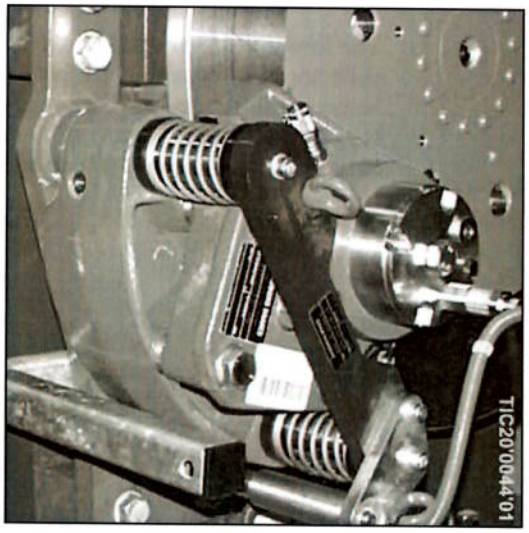
The brake pads have built-in temperature sensors and an indicator to provide information to the controller about the pad thickness. The brake pads are self-aligning and do not contain asbestos.

The brake sequence is two-step. At first a lower brake pressure level makes the stop of rotation. After full stop, or no later than 30 seconds after initiating the stop sequence, additional brake pressure is released. This increased brake force at stand still will secure the wind turbine to remain stopped even at very extreme wind conditions.

Mechanical brake SIME



Mechanical brake SVENDBORG

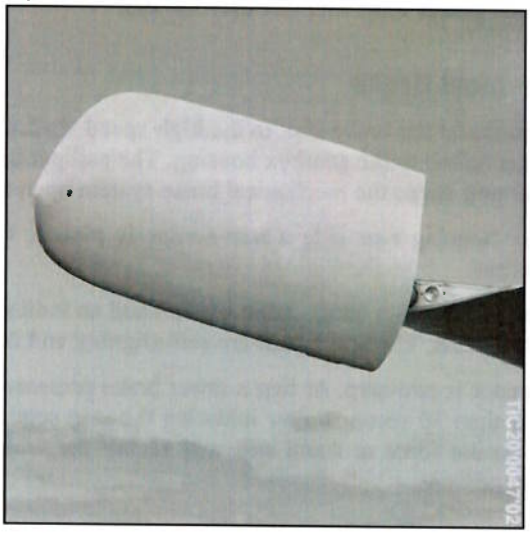


7.6.2 Blade Tip Air Brakes

The air brakes rotate approxiamte 75° out of the rotor plane when activated. The blade tip is kept in the normal, deactivated position by a stainless steel cable connected to a hydraulic cylinder inside each blade root. When the cylinders are pressurised from the hydraulic power unit, the cables are in tension and this keeps the blade air brakes inactive. As the rotor spins, the blade tips pull on the wires and hydraulic pistons through centrifugal force. When the magnetic valves in the hydraulic station are opened the blade air brakes are activated by means of centrifugal force, thus braking the rotor.

The three blade tip air brakes are not interconnected. However, the computer command to release hydraulic pressure and activate the air brakes applies to all blades. When hydraulic pressure is re-established, tension in the cable is restored and each blade tip will turn back into the normal operating position.

Tip brake



7.7 Stop Procedure

A distinction is made between "Normal Stop" and "Safety Stop".

When the air brakes and the mechanical brake are activated, the hydraulic pressure in the two systems is released as the magnetic valves are opened. This causes the hydraulic oil to flow back to the respective tank reservoirs and the air brakes will be deployed and the mechanical brake applied. Both systems are working fail-safe.

7.7.1 Normal Stop

At normal stop the air brakes are activated as the first step. While this is happening, the generator is still connected to the grid and is keeping the rotor to the nominal speed. The generator cuts out when the computer detects negative power production. It takes 2 to 2.5 seconds unto the air brakes are deployed fully, which dramatically will decrease rotation, but in fact speed reduction commence within 1 second. When the rotational speeds has dropped to a pre-set level, or at expire of a pre-set time interval, whichever comes first, the mechanical brake is engaged. Within a few seconds, regardless of the wind speed, the rotational speed is down to a complete stop. After full stop the air brakes will be pulled back and deactivated.

7.7.2 Safety Stop

The stop procedure has simultaneous activation of air brakes and the mechanical brake. The generator will be cutout instantly. After a "safety stop" the air brakes stay deployed unto a re-set command is made.

The air brakes have a special spring, which keep the air brakes applied unto a reset command is received.

7.7.3 Emergency Stop

Emergency stop functions like a safety stop command, but unlike the latter, the emergency current circuit is interrupted. This results in all contactors in the power panel being disconnected, and consequently the generator, operating motors and pumps are also cut off at the same time. However, lights and hand tool power sockets will still be live.

7.7.4 Stop at Overspeed

The wind turbine controller checks continuously the generator rotational speed. During power production the speed is between synchronous 1500 rpm (100%) and 101% at maximum load (main generator; at 50 Hz grid-conditions. At 60 Hz the synchronous speed is 1800 rpm). The TAC 85 and TAC 84 systems carry out continuous control of the generator rotational speed and nacelle frequency levels. A stop because of overspeed is made in case of the following circumstances:

7.7.4.1 Generator overspeed

If the wind turbine controller, through the rpm-sensor, detect a generator speed 103 % of synchronous speed an emergency stop will be carried out.

7.7.4.2 Overspeed guard (TAC85)

The TAC85 system is independent of the wind turbine computer. If the TAC85 unit detect a generator speed 105 % of synchronous speed an emergency stop will be carried out.

7.7.4.3 Overspeed guard (TAC84)

If the TAC84 unit detect a generator speed 113 % of synchronous speed an emergency stop will be carried out.

7.7.5 Stop in Case of Grid Drop-Out

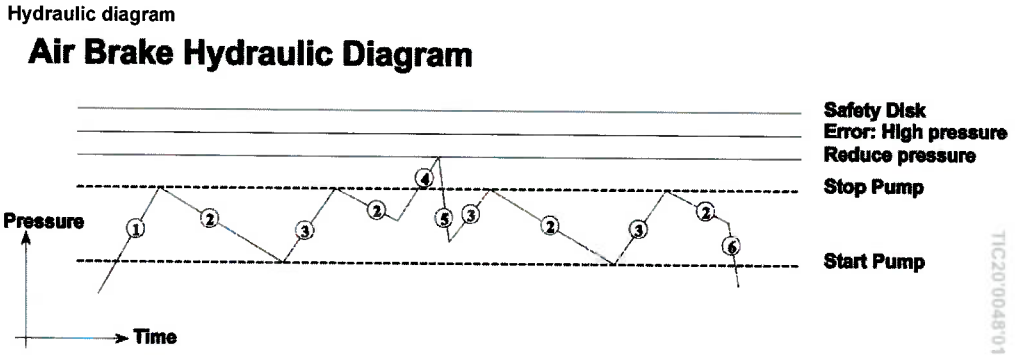
The wind turbine cannot operate without electric supply from the grid. Should the grid supply be lost, the pumped-up active oil pressure in the hydraulic systems will immediately vanish because the power to keep the magnetic valves closed will be gone, activating both the mechanical and rotor tip air brakes. The stop procedure resembles an emergency stop, except that the lights and power sockets will be dead also. However, lights in the nacelle and tower will remain lit for a further 15-20 minutes to permit evacuation, (if optional emergency systems are fitted in each lighting fixture). The wind turbine will automatically resume operation when the grid power supply has been restored and has proved to be normal for 10 minutes.

7.7.6 Hydraulic Operation

The computer operates the electrically driven hydraulic pump and pressure valves on the basis of information from the pressure transmitters. The signal to run the pump will be given after a start command provided the wind turbine is free from errors and the defined waiting time prior to start-up has expired. The pump will stop again when the computer receives the signal from the pressure transmitter that the pre-set pressure level has been reached. If the pressure exceeds pre-set values the turbine will be halted.

7.7.6.1 Hydraulic operation sequences – Blade Tip Air brake

Hydraulic diagram



1. Start of pump. (Start of Turbine)

2. Restart of pump

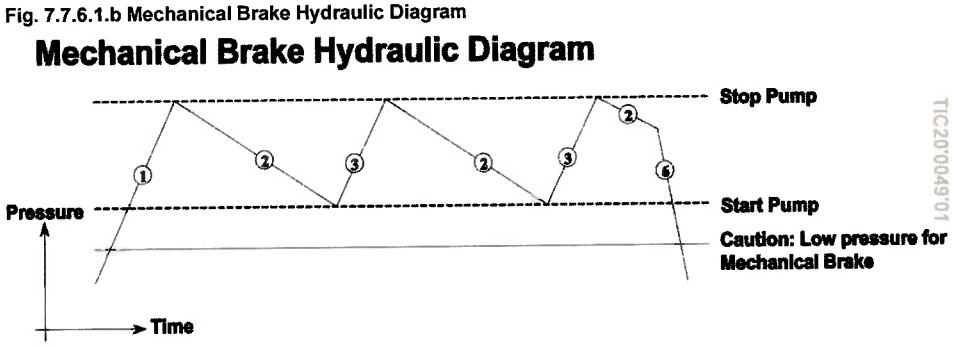
3. Short term activation of solenoid valve to reduce pressure.

4. Long term decrease of pressure because of internal seep at the valves

5. Increase of pressure because of temperature rise

6. Activation of solenoid valve (opening to stop the wind turbine)

Fig. 7.7.6.1.b Mechanical Brake Hydraulic Diagram



7.8 Generator

7.8.1 Generator Mounting

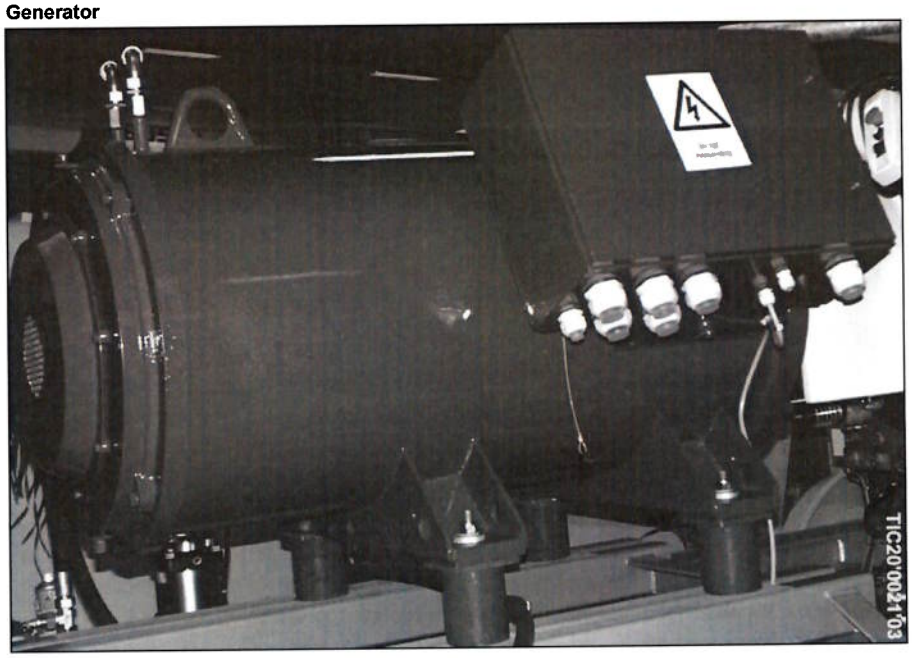
Two double, longitudinal, box steel members support the four generator feet. A flexible coupling connects the gear high-speed shaft with the generator shaft.

7.8.2 Generator Type

The generator is a highly efficient asynchronous two-speed, water-cooled engine, fully enclosed and designed and built specifically for wind turbine applications. The generator is particularly efficient at relatively low loads.

The two generator sizes are integrated into the same housing. One set of copper windings forms a 4 pole main generator "G" with a synchronous speed of 1500 RPM/50 Hz or 1800 RPM/60 Hz. Another set of windings forms a 6 pole low wind speed (small) generator "g" at 1000 RPM/50 HZ or 1200 RPM/60 Hz. The specific power ratings are shown in the Main Specifications.

Generator



7.8.3 Insulation Class and Maximum Output

The nameplate rating of the generator refers to "Class B" specified temperature rise. However, the generator is built to "Class F" insulation and temperature rise specifications (Class F = Class B + 20°C). This adds an extra margin of safety and prevents turbine faults caused by high generator temperature as a result of extreme operational conditions. The specific data can be seen in the Main Specifications.

However, the actual maximum power output from the wind turbine depends on several factors in addition to wind speeds. Air-pressure, air temperature and air turbulence has considerable influence on a wind turbine's electricity production. Thus, wind turbines installed in different weather and environmental regimes do not produce the same power output even though they may be exposed to equal wind speeds.

It is quite normal for maximum output to be 30-50 kW above or below the average power curve shown in the Main Specifications (in the Appendix). This is due to the fact that stalling characteristics are ruled by the wind speed only, while the content of energy in the wind very much varies with air density. When temperature changes by ±10°C, relative wind energy will alter by ±3.6%

The power curve is shown for the standard conditions: 1.225 kg/m^3 air density and a maximum of 15% turbulence intensity.

7.8.4 Generator Temperature

For direct measurement and monitoring of the generator temperature a PT100 sensor is incorporated in the generator windings. In the event of temperatures above 155°C the wind turbine will stop. When the generator temperature has dropped 30°C the wind turbine will automatically restart provided that the wind speed is below 22 m/s. the temperature level will under standard conditions normally stabilise at 135-140°C after 5-6 hours of operation at the nominal power output.

The temperature limits and operating conditions can be changed in the parameter list.

7.8.5 Generator Coupling

The generator is connected to the high-speed shaft of the gearbox with a coupling, which transmits the drive torque force to the generator without adverse stress to the generator bearings. The coupling and shaft is enclosed for safety reasons and protected against unintended contact.

7.8.6 Cut-In and Cut-Out of the Generator

At wind speeds of about 3 m/s the rotor will start slowly rotating. Round 4 m/s the rotor torque will force the speed up to a level where the generator is automatically connected to the grid. Normally cut-in will be made on the small generator (g: 6-pole) and later, when the wind speed increases to about 6 m/s a switch over will be made to the main generator (G: 4-pole).

If the wind speed is above 8 m/s at wind turbine start-up, cut-in will be directly to the main generator (G).

A cut-in will be made gradually by means of thyristors, which are constantly connected (one per phase). When the power load generated exceed 50 kW the by-pass contactor will be switched on in parallel. In this way, the by-pass contactor will not experience any contact point sparks. At cutout the by-pass contactor will be switched off immediately, before the thyristors are disengaged.

The strategy for switching between the main and small generator as described below has been chosen to limit the number of generator connections to the grid. The listed power limits or number of seconds can be changed in the parameter list, but experience has shown that the described standard performance and the chosen parameters are the optimum mode of operation.

7.8.6.1 Soft cut-in procedure for both g and G

1. The pre-set acceleration starting point is reached. This point is below the synchronous speed.
2. The thyristors are "fired". This means that the thyristors are activated electronically, providing the connection between the generator and the grid without the use of a mechanical contactor. The firing angle increases as the generator speed come closer to the synchronous speed. The greater the firing angle, the more the rotational acceleration will be reduced.
3. When the synchronous speed has been reached, the thyristors will be fully active. As the generator runs over-synchronously it produces power for the grid.
4. The by-pass switch is cut in when the power produced exceeds 50 kW. If the thyristors temperature is over certain level, the by-pass switch will be cut in after a parameter-defined time instead. This to avoid stop caused by too high thyristor temperature.
5. The thyristors will be continuously fully open and conducting power from the generator to the grid. However, the bypass contactor will carry the majority of the power load because of its much lower resistance.

7.8.6.2 Switching from generator g to G

When the average production from generator g exceeds a chosen kW-value (over a pre-set time interval), it will be disengaged. The generator (and rotor) will then free wheel unto the synchronous speed for G is reached and a cut-in is made.

7.8.6.3 Switching down from generator G to g

If the average production from the large generator is less than a chosen kW-value (over a pre-set time interval), the air brakes will be activated to reduce rotational speed and the generator G cutout. When the generator shaft speed has decreased to a pre-set low rpm-level, the hydraulic unit will start and pull in the blade tip air brakes. Shortly afterwards the rotor will pick-up speed again and cut-in to generator g.

7.8.6.4 Cut-out of generator (g)

When the average production from generator g is less than ±4 kW over 30 seconds, or ±20 kW over 1 second, it will be disengaged and the rotational speed will drop down to slow freewheeling below the synchronous speed for g.

7.8.7 Generator Liquid Cooling

The generator housing is built with a cylindrical jacket and channels, which circulate cooling liquid around the generator internal stator housing. No air passes through the nacelle to cool the generator or gear.

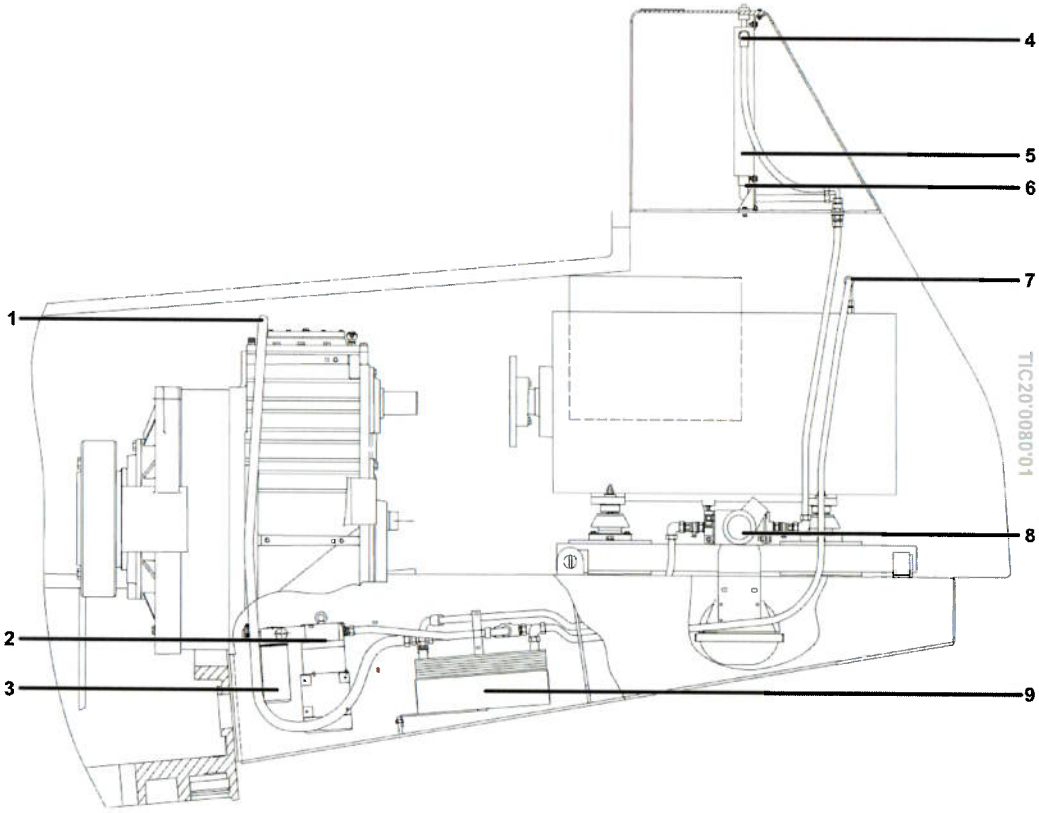
The cooling liquid remove heat from the generator for emission through a radiator placed on top of the nacelle housing, where the free air stream behind the rotor blades can effectively cool the liquid. Besides generator and radiator the circulating system include an electrical pump and a heat exchange unit to cool the gearbox oil.

The liquid cooling system has major advantages compared to direct air-cooling. Firstly, generator efficiency is increased considerably by using a low power consuming water pump compared to an ordinary air-cooled generator that use a big axial mounted ventilator. Secondly, the nacelle compartment is effectively closed and sealed against the environment, preventing the entry of moisture or air, which are often contaminated with salt, dirt or dust. The system is also advantageous in relation to noise reduction, as noise is not transmitted through airlocks.

The cooling liquid is an anti-freeze mixture (glycol/water – 50/50). The cooling pump is turned on when the temperature level for start is reached, and turned off when the temperature has dropped to a certain level, according to the chosen parameter setting.

Please see the following schematic drawings of generator cooling circuit and oil circulation used for standard, arctic and tropic versions.

Cooling system overwiev drawing



1. ***Inlet gearbox***
2. ***Oil pump***
3. ***Oil filter***
4. ***Outlet cooler***
5. ***Water cooler***
6. ***Inlet cooler***
7. ***In and outlets generator***
8. ***Water pump***
9. ***Heat exchanger***

7.9 Yaw System

The yaw system is very strong and simple using a solid yaw friction, ring without hydraulic or mechanical auxiliary yaw brake operations (apart from the necessary yawing gear and motors). This ensures the lowest possible maintenance and operating costs.

The yaw of the nacelle is performed automatically by the active electrical yaw gears, controlled by the wind turbine computer system, on basis of information from wind vanes on top of the nacelle.

Yawing takes place over shorter or longer periods depending on the computer interpretation of the signals. In case of a wind vane error the automatic yaw operations will be interrupted. Manual yawing can be carried out from the buttons on the control panel or top box.

The yaw system consists of a supporting slew ring with internal gearing, yaw gear motors, and integrated yaw friction for instant brake. The machine frame floor (both sides) and the tower top flange are machined and prepared for mounting of all components.

All components are placed inside and effectively protected against intrusion of water, dust or dirt. All kinds of servicing and maintenance can be carried out easily despite the weather conditions.

7.9.1 Yaw Ring

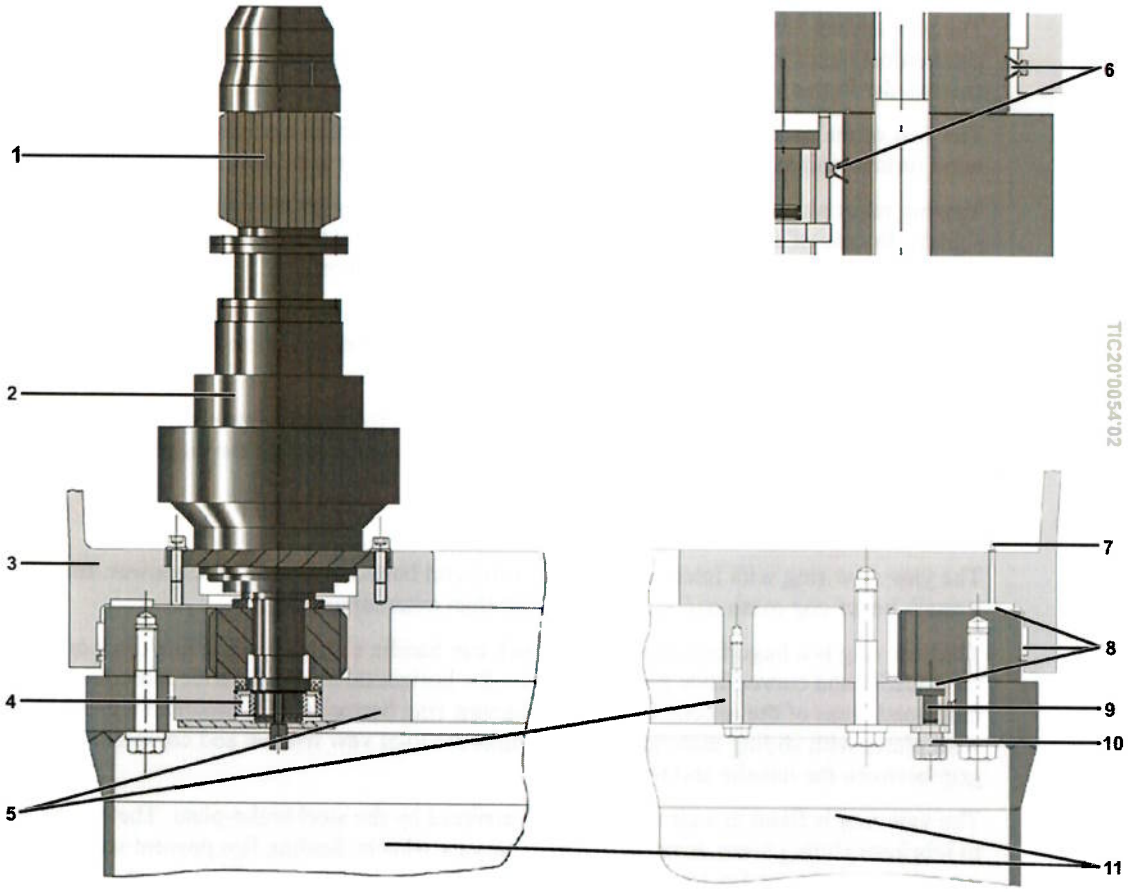
The yaw slew ring with internal gearing is solid and bolted to the top of the tower. Internal gearing gives a much better cog mesh and load distribution than external gearing.

The yaw ring is a huge friction bearing which can handle all yaw loads. Slide discs on the topside carries the nacelle, and curved slide plates distribute the horizontal loads. All slide material is recessed in machined areas of the nacelle bottom. At the yaw ring bottom side is mounted a number of spring applied steel plates with sliding material, which control the total yaw friction and complete the three-direction grip between the nacelle and tower.

The yaw ring is fixed in a circular chamber covered by the steel brake-plate. The chamber contain grease to lubricate sliding areas, internal gearing and yaw wheels. Sealing lips prevent seep of grease and intrusion of water or dirt from the outside.

7.9.2 Yaw Gear and Motors

Yaw gear and motors



1. *Motor*
2. *Yaw gear*
3. *Cast machine frame*
4. *Support bearing*
5. *Steel brake plate*
6. *Sealing lips*
7. *Grease nipple*
8. *Slide discs and plates*
9. *Spring*
10. *Bolt*
11. *Tower*

The yaw gears are vertically mounted with the yaw wheel just below the nacelle bottom. The gears are equipped with a long gear shaft with a supporting bearing placed in the steel brake-plate. Please see the Main Specifications for further information.

7.9.3 Yaw Friction System

The yaw gear motors are able to deliver a turning force to overcome the gyro-forces from the rotor and the total friction resistance.

The friction materials and total area is designed for the full life of the wind turbine, and will not require replacement.

7.9.4 Cable Twist Sensor and Nacelle Orientation

A cable twist sensor is mounted at one extended yaw drive shaft below the steel brake-plate to provide the terminal stop signal. At a total of three yaw turns to either side will result in an untwisting procedure, during which the rotor is stopped. After untwisting back to neutral position, the wind turbine will restart automatically.

In connection is mounted an inductive sensor to provide information to the controller of the nacelle orientation.

Cable twist sensor



7.9.5 Yaw Operation

At very low wind speeds the automatic yaw operation will be interrupted (below 3 m/s). The wind turbine will not be yawed into the wind direction unto the wind speed is high enough for power production to take place. This avoids unnecessary yaw operations and power consumption.

7.10 Tower

The tower is made of steel plate shaped and fabricated as a conical tube. The top ends with a bolt flange for mounting the yaw ring. The tower sections are assembled with bolt-flanges.

Tower access is through a lockable door. Immediate inside a short ladder leads up to a platform where the wind turbine controller and power panel is mounted. The tower bottom part is prepared for installation of the high voltage transformer.

7.10.1 Transformer

If the wind turbine is delivered including the transformer it will be installed at the tower base. Special education as high voltage engineer (Over 1000 V) is mandatory to work or inspect the high voltage installation.

7.10.2 Ladder

The ladder is made in sections and bolted together in one piece leading from the tower bottom to the platform below the yaw system. With adequate distance is mounted small resting platforms, which can be toted for use. The ladder is equipped with a fall-arrest safety harness system.

7.10.3 Plat-forms

At each tower flange assembly level a platform is placed from which the bolts can be checked and re-tightened. The top platform provides adequate standing height below the yaw system. From here there is internal access to the nacelle compartment. All platforms have a hatch in the ladder-well.

The hatch in the first platform above the wind turbine controller is equipped with a micro-switch. When the hatch is opened, the wind turbine is stopped for safety reasons.

Tower, transformer and panels



7.10.4 Lights

The tower and nacelle compartment are illuminated by means of light fixtures. The wiring includes plug sockets for electrical hand tools. In case of a grid dropout an integral emergency power support system (optional) will keep lights on for approximately 15 minutes.

7.10.5 Surface treatment

The tower is sandblasted and effectively surface-treated with several coats of paint. The standard colour is grey-white, similar to the colour of the nacelle and blades.

8 Electrical system protection

8.1 Over-Voltage Protection

The turbine controller is protected from transients entering the power panel through the main cables. The surge protection system is mounted inside the power panel at the 690 V line and has a nominal discharge current capacity of 15 kA, and a maximum discharge current of 40 kA per conductor. The voltage protection level is 3 kV at a transient current of 15 kA. The transient voltage is further reduced to below 1 kA by a 690/230V step down transformer used to supply the wind turbine controller. Additional isolation barriers built into the wind turbine controller discharge the remaining voltage. The wind turbine controller has a protection level of 1 kA / 2 kV at the power input. The wind turbine controller is tested in accordance with the EMC standard EN/IEC 61000-6-2 1999.

8.1.1 Induced Transients

The thyristors are protected against induced transient over-voltages by a barrier (RC-coupling) parallel on the thyristors. The protection level is 550 V nominal. The thyristors can withstand a voltage of 2200 V. The distribution lines for the internal power transformers are protected against induced differential transient over-voltages. The protection level is 460 V nominal (different-al). The secondary supplies for computer and sensors are protected against longitudinal voltages at nominal 130 V level (line to earth).

The computer is protected against transient input over-voltage from the nacelle multi-cable by barriers installed in the nacelle junction box for sensor inputs. The barriers clamp transient over-voltages to the earth terminal of the junction box. Protection level is 60 V DC nominal. When equipped with an internal modem or current loop serial inter-face, barriers on the communication cable in the computer enclosure will protect the computer. The barriers clamp differential and common-mode transient over voltages to the earth terminal of the computer enclosure. Protection level is 175 V nominal.

Isolation barriers are built-into the control computer by isolating its input and output signals from the measuring points using transformer or optic-electric barriers. These barriers are designed to withstand a 2 kV potential.

8.2 Lightning Protection

The principle of the protection system is to have all components potentially balanced and provide an easy way down to earth for the lightning energy. This avoids the accumulation of a high energy level, which otherwise could cause devastating damage.

Experience has shown that the system is able to carry very high voltage and current without affecting wind turbine operation.

8.2.1 Protection of the nacelle

The steel machine frame provides the basic protection for the components in the nacelle. All components not directly connected to the machine frame are connected with earthing cables. Further, a lightning rod is placed in the rear end of the nacelle housing, projecting substantially higher than the anemometer and wind vane.

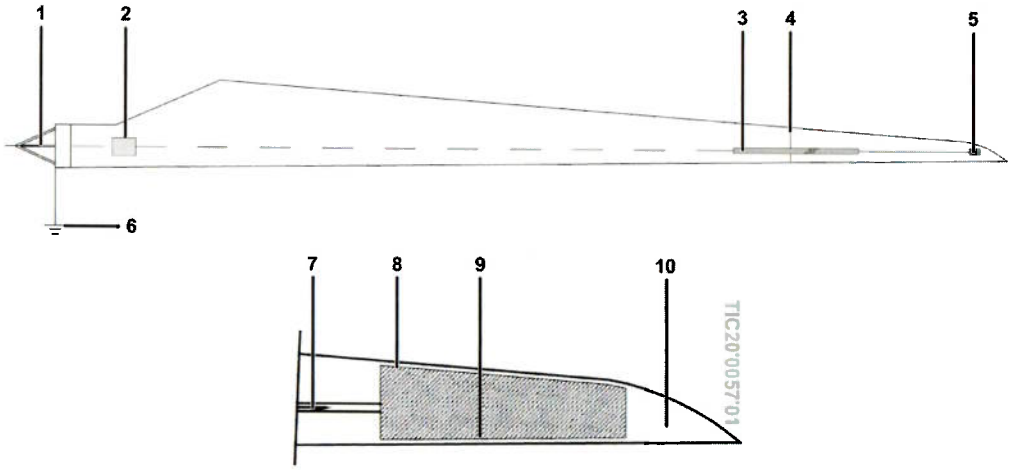
The nacelle and machine frame is cable-connected to the tower wall. At the bottom both the tower wall and power panel are cable-connected to the buried earthing system, which is build in connection with the tower foundation.

8.2.2 Protection of the rotor blades

The protection of the blades is carried out by lightning receptors placed on both sides of the blade tip, and a conduction system, which diverts energy discharge through the blade in a controlled manner.

Conduction connection of the rotor to the machine frame is made by a metal brush and spark gap placed on the main bearing housing. When lightning strikes, an electric arc will occur over the gap. The voltage surge is transmitted by a metal brush, which connects the shaft and the housing. As a result, the lightning is conducted to the machine frame without the risk of damaging the rotor shaft spherical bearings.

Lightning protection of blades



1. *Hydraulic cylinder*
2. *Lightning register card*
3. *Tip system*
4. *Tip brake*
5. *Cast aluminium core*
6. *Lightning is transmitted to earth through bolt connection*
7. *Stainless steel beam ø 10 mm.*
8. *Cast aluminium core*
9. *Lightning receptor*
10. *Blade shell*

8.2.3 Lightning registration card

Each blade has a lightning registration card with a magnetic band. The card is able to register and measure the current of a lightning strike, which has passed through the lightning conductor. The highest power reading only will be kept.

The card retainer is mounted on the lightning conductor inside the blade root. To release the card from the retainer: use your thumb and forefinger and twist (with force) the card clock wise to remove it from the retainer lock before final dismount. If you try to pull out the card directly, the retainer will break and be unable lock the card again.

8.2.4 Earthing (grounding) System

The standard wind turbine installation has an earthing system with a transition resistance of less than 10 ohm.

The earthing system is established when the foundation is constructed, and consists of a 50 mm2 solid copper ring conductor horizontally arranged at a distance to the foundation pillar (tower) and a depth below finished terrain of 1 metre.

Two solid 50 mm2 vertical copper conductors are attached to the ring conductor. They are both a minimum of 6 metres long and are arranged diagonally. The vertical conductors are prolonged as necessary to establish the required transition resistance.

The tower is connected to the ring conductor with two solid 50 mm2 copper conductors at the vertical conductor points.

The earthing system for lightning protection is installed in accordance with IEC standard 1024-1.

Appendix

- Main specification
- Alarm List
- Service Plan
- Installation & Service Data

Tullacondra Turbine Awareness Committee

Planning Application No. 24/5503 by Tullacondra Wind Energy Ltd.

Appeal to An Bord Pleanála

List of Enclosures

Binder 1 of 2
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1. Receipt from Cork County Council, 12th September 2024
2. Report of Pascal Sweeney of Sweeney Consultancy on Aquatic Ecology
3. Report of Bruno Teillard Aqua GeoServices Ltd on Hydrogeology, 16th May 2025
4. Dr Desmond Leadon, Irish Equine Centre, Expert Opinion Report, 9th September 2024, and Supplemental Expert Opinion Report, 13th June 2025.
5. Group Member Submissions on Specific Topics

5a. Submission on interference with Saorview Television Service

6. Set of Signatures supporting the Committee
7. Submission by Mr William McSweeney BSc MSc MUB to Cork County Council
8. *Webster and Rollo & Shorten and Carty v Meenacloghspar (Wind) Ltd* [2024] IEHC 136
9. *Webster and Rollo & Shorten and Carty v Meenacloghspar (Wind) Ltd (No.2)* [2025] IEHC 300
10. *Byrne & Moorhead v ABO* [2025] IEHC 330
11. Email from Carol Nolan Veterinary Inspector Cork County Council 20 May 2025.
12. Evidence of individual objections and absence of consent:
    a. Land Owner Objections to Turbine Delivery Route Works Option 1
    b. Land Owner Objections to Grid Connection Route Works Option 1
    c. Additional "Dilapidated and Uninhabited" Properties plus New Builds in the area
    d. Letters re surveyed buildings having not consented
    e. Letter from Margaret M. O'Connell re not consented to use of vantage point
    f. Letter from Tim Cronin re planning condition and not consenting
    g. Letter from Francis & Rose Lombard re turbine delivery route
13. Specification from manufacturers of noise monitoring equipment
14. Technical Note prepared by Sarah Large, Acoustic Consultant, Walker Beak Mason Limited, Acoustic Consultants, dated 20th June 2024
15. Dick Bowdler, ETSU-R-147: Why it is wrong
16. Audible Amplitude Modulation – 5th International Conference – Stigwood and others, Denver 2013
17. Noise Control for Quality of Life, Fukushima and others, Innsbruck, 2013

APPENDIX O

OPERATION AND MAINTENANCE PLAN

Class II
Item no.: 964106.R00
2007-06-29

Mechanical Operating and Maintenance Manual

V90 – 3.0 MW, VCRS 60 Hz

Onshore/Offshore (Mk 7)

T09 /964106 Ver 00 - Approved - Class II - Exported from ı . 28.06.2007 by JANOM

History of this Document

Rev. no.	Date	Description of changes
00	2007-06-29	First edition

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2 Updating of the Manual 3
3 The Header 3
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Please see Mechanical Drawings & Parts List

T09 /964106 Ver 00 - Approved - Class II - Exported from DMS: 28.06.2007 by JANOM

1 Preface

This manual applies to the wind turbine **V90 - 3.0MW, VCRS 60 Hz, Mk-7.**

It is the turbine owner's responsibility that only qualified persons operate the turbine.

Do not operate the turbine before, as a minimum, having studied the following carefully:

- ✓ 960314 Safety Regulations for Operators and Technicians
- ✓ 950173 User Guide

Do not hesitate to contact your plant manager or Vestas' Service Department if you need more detailed explanations.

Vestas Wind Systems A/S

Alsvej 21

DK-8900 Randers

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2 Updating of the Manual

The manual will continuously be brought up to date. Corrections to each specific chapter are listed for the past year under the heading of "History of this Document".

3 The Header

The latest revision date of a specific chapter is stated in the header of the chapter. Class II indicates that the document is only handed out according to agreement with Vestas' Technology Department.

Each specific chapter has its own item number followed by a revision number (Rx).

First editions have revision number R0.

T09 /964106 Ver 00 - Approved - Class II - Exported from L 28.06.2007 by JANOM

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Safety Regulations for Operators and Technicians, V90-3MW/V100-2.75MW

History of this Document

Rev. no.:	Date:	Description of change
0	2005-06-23	First edition
1	2005-09-19	947554 replaced by 959055; Chap. 9: "However, the capacitors in the converter and AGO2 section might be energized." inserted Chapter 10 Converter and AGO2 Sections Figure numbers updated
2	2006-01-17	Reference to 947554 added again page 12
3	2006-03-03	Chapter 18.1.1. New wind speed limit 23m/s
4	2006-05-08	Language revision. Inserted: section 14.2 Access to roof, text and picture.
5	2006-09-11	Reference to V100 added Section 19 updated with new pictures and new text.

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1. Introduction

A turbine connected to the grid implies certain elements of danger if it is handled without exercising proper caution.

For safety reasons, at least two persons have to be present during a work procedure.

The work must be properly carried out in accordance with this manual and other related manuals. This implies, among other things that personnel must be instructed in and familiar with relevant parts of this manual.

Furthermore, personnel must be familiar with the contents of the "Substances and Materials" regulations.

Caution must especially be exerted in situations where measurement and work is done in junction boxes that can be connected to power.

Consequently the following safety regulations must be observed.

2. Stay and Traffic by the Turbine

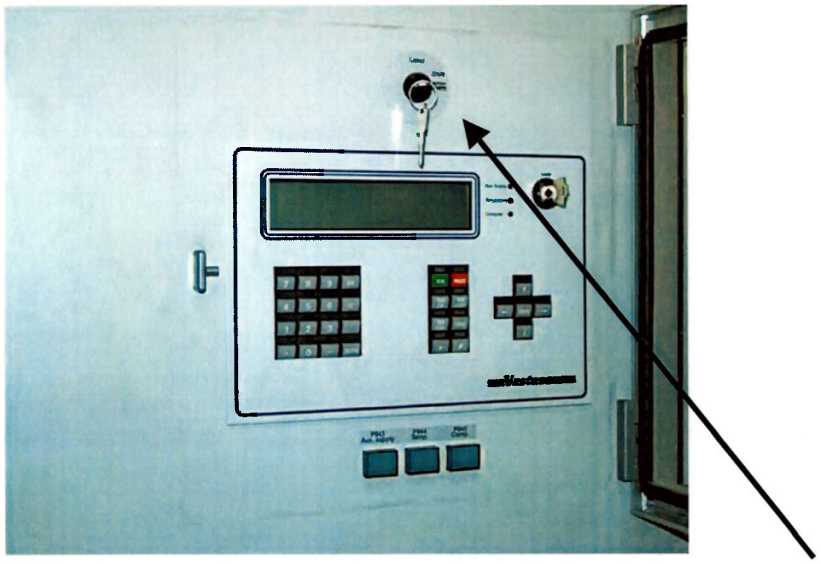
Do not stay within a radius of 400m (1300ft) from the turbine unless it is necessary. If you have to inspect an operating turbine from the ground, do not stay under the rotor plane but observe the rotor from the front.
Make sure that children do not stay by or play nearby the turbine. If necessary, fence the foundation. The access door to the turbine must be locked in order to prevent unauthorised persons from stopping or damaging the turbine due to mal-operation of the controller.

3. Address and Phone Number of the Turbine

Note the address and the access road of the turbine in case an emergency situation should arise. The address of the turbine can often be found in the service reports in the ring binders next to the ground controller .Find the phone number of the local life-saving service.

4. Controller and Operating Panel

Only authorised or instructed persons are allowed to open the doors of the controller cabinet.



Picture 1

Before inspecting or working on the turbine, the remote control MUST be deactivated. Use the breaker-key and set it in position "local".
Remember to activate the remote control when the inspection or the work has been completed.

5. Emergency Stop Buttons

For safety reasons please note the location of the 4 emergency stop buttons. The buttons are located (Figure 1 Locations of emergency stop buttons and trip F60 in nacelle) at:

- Ground controller (at the bottom of the turbine).
- Gearbox (pos. 1).
- Yaw ring (pos. 2).
- Nose cone (pos. 3, only local stopping function)
- Nacelle controller (pos. 4).
- Trip F60 (pos. 5).

The emergency stop buttons are red with a yellow background. An emergency stop is activated by pressing one of the red buttons. When an emergency stop is activated, the controller switches to "EMERGENCY STOP" mode meaning that no power will be supplied to the contactor solenoids, the blades will pitch (full feathering), the brake will be applied and the turbine will stop. The yaw system, the hydraulic pump, the gear oil pump and the nacelle ventilator will also stop. Consequently, all moving parts will be brought to a standstill.
However, the power supply to the light, the nacelle, the hub and the ground controllers will still be on. The stop button in pos. 3 is not an emergency stop button but a local stopping function.

Remember: The hydraulic system is still under pressure. Due to the accumulators, up to 6 litres of hot oil will pour out, if the hydraulic system is intervened.

Please note: When the emergency stop buttons are activated, the brake is activated.

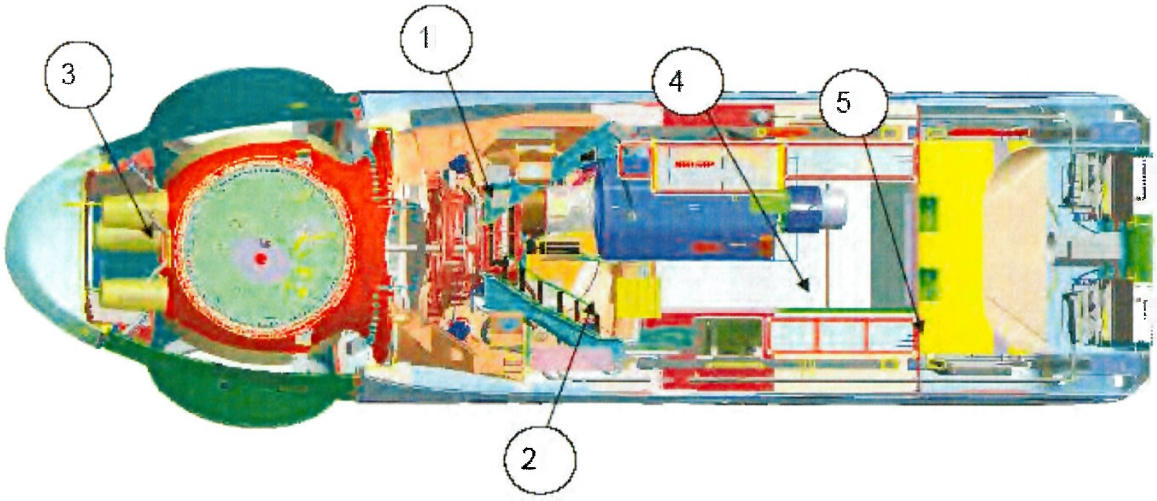
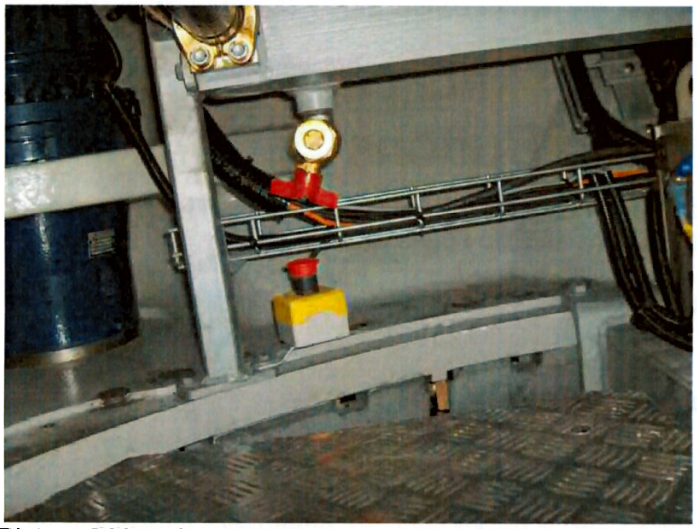
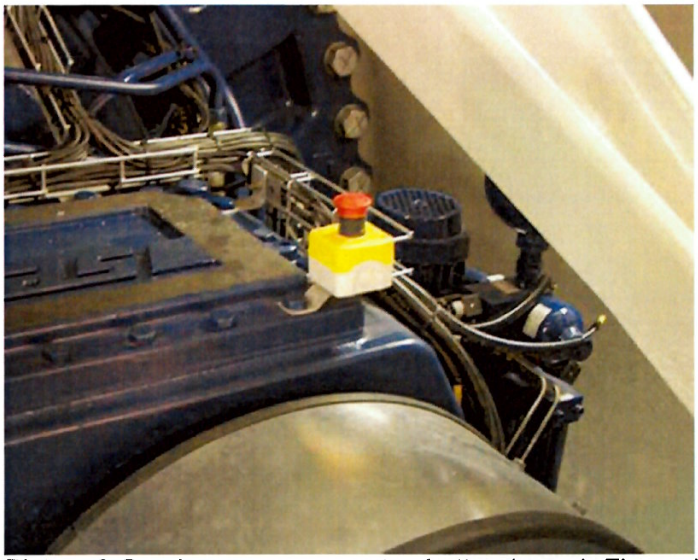


Figure 1 Locations of emergency stop buttons and trip F60 in nacelle



Picture 2 Yaw ring emergency stop button (pos. 2, Figure 1)



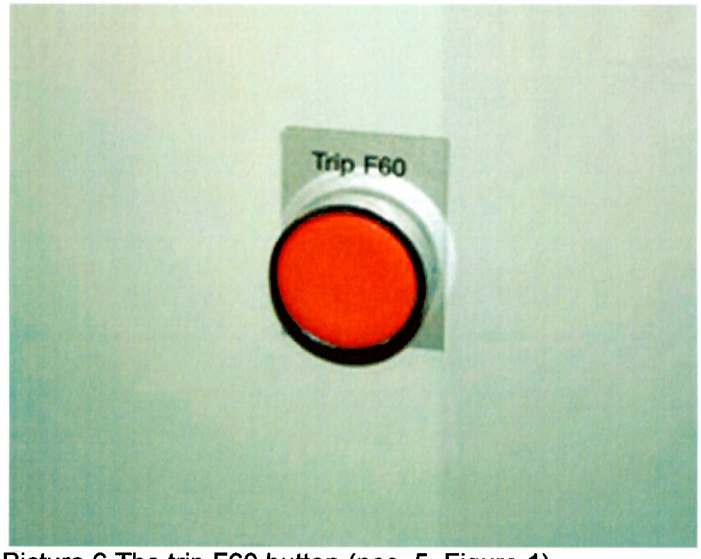
Picture 3 Gearbox emergency stop button (pos. 1, Figure 1)



Picture 4 Emergency stop button at nacelle controller (pos. 4, Figure 1)



Picture 5 Emergency stop button in hub (pos. 3, Figure 1)



Picture 6 The trip F60 button (pos. 5, Figure 1)

5.1 Trip F60

Trip F60 is situated on the nacelle controller (pos. 4). Trip F60 disconnects the high voltage supply for the turbine. When disconnected, only the control system in the turbine is supplied from the UPS for approx. 6 hours. Usually, the local power station must take part when the turbine is connected to the grid.

5.2 Lift (Optional)

If a lift is installed, it has several emergency stop buttons.
Note: These buttons only stop the lift; emergency stop buttons for turbine do not apply to the lift.

5.3 Internal Crane

The crane is equipped with an emergency stop button. This only applies to the crane and otherwise the emergency stop buttons in the turbine do not apply to the crane.

6. Practical Advice at Inspection

When inspecting the machinery, always look very closely for oil spills and loose bolts. Dirt must be wiped off, otherwise it can be difficult to determine whether there is a significant leak.
Loose bolts in the structure mean danger. They must be tightened immediately. If it is a matter of several bolts or repetitions, please contact Vestas Wind Systems A/S service department.

7. Influence by Lubricants



The lubricants used in the turbine can be aggressive. Lubricants must not get in contact with skin or clothes.
At inspection of a gearbox if removing a cap while the oil is still hot, be careful not to breathe in the hot oil vapours.

8. High Voltage Installations

As a basic rule it is not allowed to dismount cover or open locked doors to the high voltage installations.
An operator/service technician is only allowed to move around behind the covering when the high voltage is disconnected, locked and visibly earthed. The work must be carried out and approved by authorised personnel only (power station or selected coupling leader). One of these persons must give permission to access the HV installation.
Work done on high voltage installations must be carried out in accordance with national regulations and related Vestas Wind Systems A/S manuals.

9. Grid Drop-Out

A grid drop-out causes an EMERGENCY STOP. The blades pitch out of the wind (full feathering); the yaw system, the hydraulic pump and the nacelle ventilator stop. Consequently, all moving parts will be brought to a standstill except for emergency lubrication system for the gearbox. The power supply for the light and the nacelle, hub and ground controllers is partly off. However, the capacitors in the converter and AGO2 section might be energized.

10. Converter and AGO2 Sections

WARNING:
If working on the converter section or AGO2 section, note that the capacitors inside can be charged to 800 V and those in the filters can be charged to 690 V. The capacitors are discharged to below 50 V in 5 minutes after disconnection from the grid. Switch Q7 and Q8 must be turned off.
Before opening the cabinet, check the DC-link-voltage in picture 17.
Before working on the converter/AGO2, check the DC-link-voltage with a Fluke multimeter.

11. Turbine Standstill

After a period of maximum 14 days without grid connection, necessary equipment for humidity- and temperature control must be installed in the turbine in order to fulfil the following requirements:

- For 90 % of the shutdown period, the relative humidity (RH) must not exceed 45 %.
- The RH must be between 45% and 60% for max. 10% of the shutdown period only.
- Within a period of 12 hours, the temperature in the turbine must not drop more than 10° C.
- The temperature and humidity must be logged.

During a period without grid connection, the following inspections must be carried out on a monthly basis:

- Check the functionality of the equipment as regards humidity and temperature.
- Check the RH and temperature logging in accordance with the requirements mentioned above.
- Check the emergency lubrication.
- Recharge emergency lubrication batteries (only every 3 months).
- Check the blade locking system.
- Check that the brake is released and without pressure.

12. Overspeed Guard

If the turbine rotation exceeds its limit, the overspeed guard (VOG) is activated, and the turbine will go into EMERGENCY STOP mode. The state of failure cannot be reset until the VOG has been de-energized.

13. Inspection of the Turbine

At inspection of the turbine, the following procedure must be followed.

When inspecting the turbine there must always be at least two persons present.
Full feathering of the blades is done by pressing <PAUSE>. When the rotor comes to a standstill or rotates slowly, activate the <Emergency stop button> to stop the turbine.

It is now possible to climb the turbine but remember as a minimum to wear:

- Safety footwear suitable for climbing towers.
- H-belt with fall protection device fastened directly to the H-belts D-ring on your chest.
- Safety helmet.

Always make sure that there is nobody above you in the turbine when you start the ascent.
If you bring tools, lubricants etc. with you, keep these in a rucksack or a bag which is attached to the safety belt.

During the ascent the fall protection and the supporting strap **MUST** be mounted. Do not mount the fall protection hook on the aluminium ladder rungs or on the fittings for the ladder, as they might brake in case of falling. Instead the swivel eye plate (yellow) must be used.
Close the trap doors of the landings when passing them.
Please notice the location of the emergency stop buttons and Trip F60 in the nacelle.

When working on the electrical part of the controller, the controller must be disconnected by the circuit breaker (marked Q7, Q26 and Q27) in the board arrangement and locked by means of a padlock. Only authorised personnel must have access to the key/keys.
When working on the terminal of the generator, inspecting the generator cables or the controlling as such, the generator must be disconnected by the circuit breaker (Q8 and Q23) in the board arrangement and locked by means of a padlock. Only authorised personnel must have access to the key/keys.

When working on the yaw system, the yaw motors must be disconnected in the control panel at the contactors F35.1 and F35.2.

Always make sure that there is nobody below the turbine while you are working in the nacelle. Even a small screw is highly dangerous when falling from a height of 60m or more.
Unauthorised persons must under no circumstances move the covering plates which cover rotating or electrical parts, especially the high voltage installation. Be cautious that safety straps are not caught on any rotating shafts during stay in the nacelle while the turbine is in operation.

Before entering the hub or working on rotating parts in the nacelle, make sure that the rotor is locked and that the blades are fully feathered. See section "Operating the Rotor Locking System" on how to activate the rotor locking system.
Before descent, close the nacelle skylights and the service hatch. Make sure that you have gathered all tools and remember that the red emergency stop buttons must be off.
If the blades are iced up, it is highly dangerous to stay below or close to the rotor. If the turbine is to be restarted with iced up blades, the operator must be very careful and make sure that no persons are nearby because of the risk of falling pieces of ice.

Do not stay in the nacelle while the turbine is in operation, unless if checking for gear and generator noise.

Any oil or grease spills must be cleaned up because of the risk of slipping.
Make sure that the covering and the locking of the high voltage installations are undamaged.
Make sure that the high voltage cable between the high voltage installations in the nacelle and the bottom are undamaged and do not have any visible mechanical damages, such as having been squeezed/cut by cable binders, mechanical parts etc.

When working in the nacelle, spinner or roof, please pay attention to safety hooking points. See figure 3.

When working on the roof of the nacelle, secure a safety line on the roof rail. See Picture 11 Hooking points on the roof.

Special caution must be taken when climbing lattice towers when it is wet or icy. Moreover special cautions must be taken when climbing on the outside of the lattice tower, since the back of the blade is close to the lattice tower when the blade is turning around its longitudinal axis. This happens if anyone pushes <PAUSE> or <EMERGENCY STOP> and also at an unintended EMERGENCY STOP.

14. Safety Equipment

See Figure 2 Safety Equipment

1. Safety helmet.
2. H-belt (delivered by Vestas).
3. Lanyards: one line with a fall damper device, one line with a shortening device (delivered by Vestas).
4. Fall protection device (delivered by Vestas).
5. Rubber-soled footwear properly tightened.

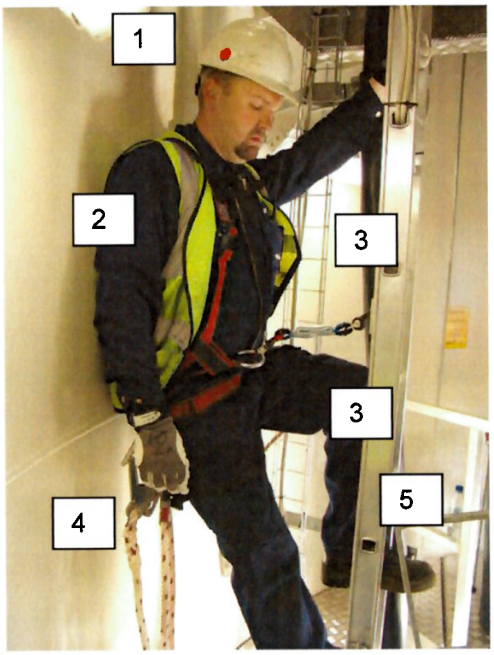


Figure 2 Safety Equipment

When climbing the tower, fasten the fall protection device directly to the H-belt's D-ring. Only one person is allowed on each ladder section at a time.

If a service lift is installed in the turbine, bring along the safety equipment in it.

14.1 ResQ Emergency Rescue Equipment

In case the escape route via the tower should be cut off by fire or other unforeseen events, a rescue and descent device is located in the nacelle behind the main controller section in an aluminium box. Please see user manual for rescue equipment, item number 959055 (VCS, 50 Hz turbines) or 947554 (VCRS, 60 Hz turbines).



Picture 7 Fixing Point for ResQdescent device

- Fixing point for ResQ descent device.
- Open the left service hatch.
- Lift the arm above the opening.
- Fasten the ResQ descent device to the arm.
- Ready for lowering, SWL 2000kg.

14.2 Access to Roof

Place the ladder on machine foundation at the rear of the nacelle to gain access to nacelle roof as shown in the picture below.



Picture 8 Ladder to roof

15. Hooking Points and Safety Chains

A number of hooking points is installed at different locations in the nacelle. A hooking point is shown in Picture 9 Hooking point.

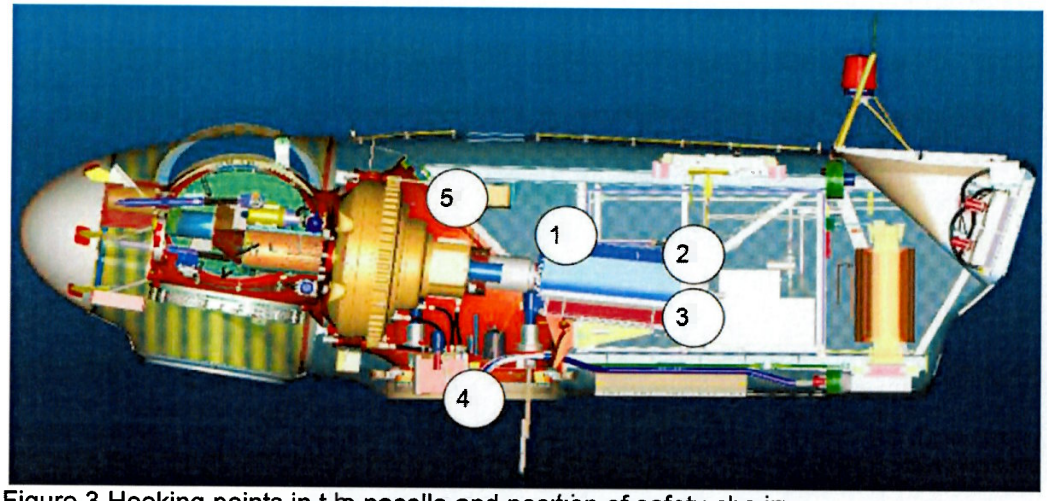


Figure 3 Hooking points in t he nacelle and position of safety cha ins



Picture 9 Hooking point



Picture 10 Safety chains must be mounted when the bottom hatch is open (Figure 3)



Picture 11 Hooking points on the roof

16. Precautions in Case of Fire

At any type of fire in or near a turbine, the power to the turbine must always be disconnected at the main high voltage circuit breaker. To disconnect supply, switch off by pushing the red button (marked TRIP F60) on the nacelle controller in the nacelle. In the tower bottom the power supply is switched off by pushing the red button situated on the breaker in the high voltage section. If it is impossible to get to the main circuit breaker, contact the power station for a disconnection of the grid.

In case of a fire during an uncontrolled operation, do under no circumstances approach the turbine. Evacuate and rope off the turbine in a radius of minimum 400m (1300ft). In case of a fire in a non-operating turbine, the fire can be put out by means of a powder extinguisher.

⚠ CAUTION **Use of a CO_2 extinguisher in a closed room can result in lack of oxygen.**

17. Directions for Use of Rotor Lock

To avoid accidents and near-accidents, which can be prevented via mechanical locking of the rotor, the following guidelines must be followed:

IN GENERAL:
Besides following the requirements listed in this document, it is important also to use ones common sense and assess the specific situations.

When the wind speed exceeds the values of the mechanical design of the locking system, it is not allowed to work in a turbine as listed below.

A technical solution must be prepared before starting work on a turbine that cannot be locked mechanically.

The work listed below must not be carried out before the turbine has been mechanically locked.

Mechanical rotor locking must be used in connection with:

1. Hub and blades:
   a. stay in hub and nose cone
   b. stay on/near the blade is not allowed unless both the rotor and the blade has been locked

2. Work on gearbox and gear oil system if this involves:
   a. disassembly and adjustment of mechanical parts
   b. tensioning
   c. activation of shrink disc
   d. internal inspection – unless it is a visual inspection

3. Work on coupling and braking system if this involves:
   a. disassembly and adjustment of mechanical parts

b. tensioning
c. inspection of coupling
d. lubrication

4. Work on generator if this involves:
   a. disassembly and adjustment of mechanical parts
   b. tensioning
   c. work on slip ring systems/units

5. Work on yaw system
   In addition to rotor locking, the turbine must be secured against unintentional yawing, if this involves:
   a. disassembly of mechanical parts
   b. yaw brakes cannot be activated

6. Work on electricity in the nacelle, if this involves:
   a. that the turbine controller is switched off and work at rotating parts of the drive train has to be carried out.

7. Work on hydraulics for pitch as well as brake system, if this involves
   a. disassembly of mechanical parts
   b. that the pumps are out of operation

8. Work on the turbine's exterior
   In addition to rotor locking, the turbine must be secured against yawing, if this involves:
   a. use of crane
   b. use of front lift
   c. use of other lifts or scaffold systems

9. Replacement of components, if this involves:
   a. replacement of components, sensors, etc. close to unshielded rotating parts of the drive train.

18. Operating the Rotor Locking System

The rotor must not be locked unless it is necessary, however always when servicing the hub and it must be unlocked as soon as possible after the service operation, which caused the locking.

If the rotor has to be locked for more than 48 hours, it must be bolted to the main foundation, following the procedure description in section 18.2.

18.1.1 Operating the hydraulic rotor locking system for normal service

The rotor locking system must not be set or used at wind speeds exceeding 23 m/s.

The rotor locking system must not be used while the rotor is rotating.

Pitching of blades is not allowed while the rotor is locked, except at wind speeds below 15 m/s. In this case only one blade may be pitched at a time.

The rotor locking system is located at the upper right hand side of the main gear, see Picture 12 Rotor locking system.

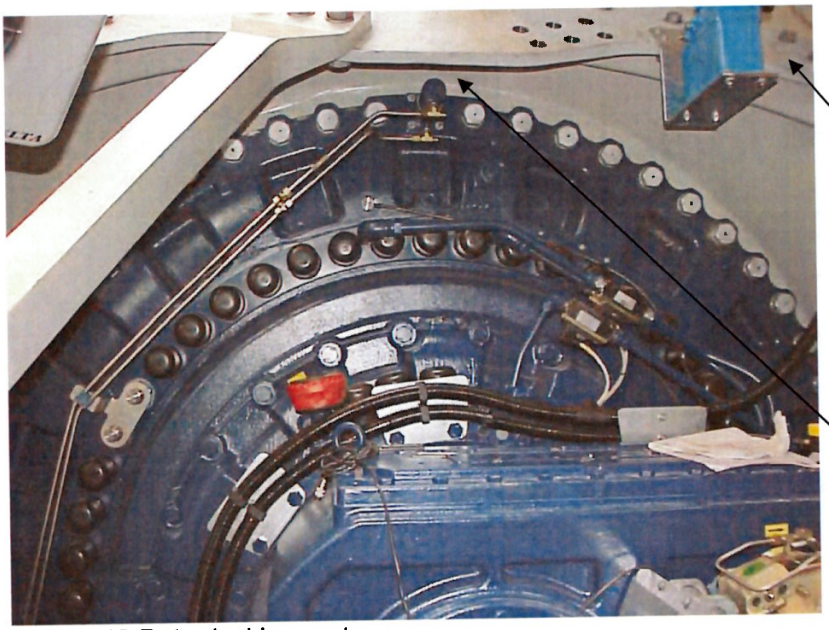
1. Set the turbine to PAUSE mode and select test picture 11.7 (Manual Pitch and Brake), where the brake can be activated.

2. Align the locking system position holes in the hub with the locking system mandrels by "manoeuvring" the brake (press [*]) until the V-notch marking (pos. 1) on the hub is aligned with pointer on machine foundation (see pos. 2). See Picture 13.

3. At the correct position set the handle in "+" position and pump the locking system mandrels out. Observe at the right side during the pumping! See Figure 4.

4. The locking takes place with the hydraulic hand pump located above the main gear on right hand side. The locked position of the handle is 45°. When locking set the handle in "+" position (the handle perpendicular to the gearbox centre shaft). When unlocking set the handle in "-" position and pump in the locking system mandrels.

5. When the mandrels are fully out or in, set the handle in "lock" position, see Figure 4. Verify the fully in or out position by looking at picture 11.7.B at the operator panel.



Picture 12 Rotor locking system



Picture 13 Alignment markings seen from machine foundation side

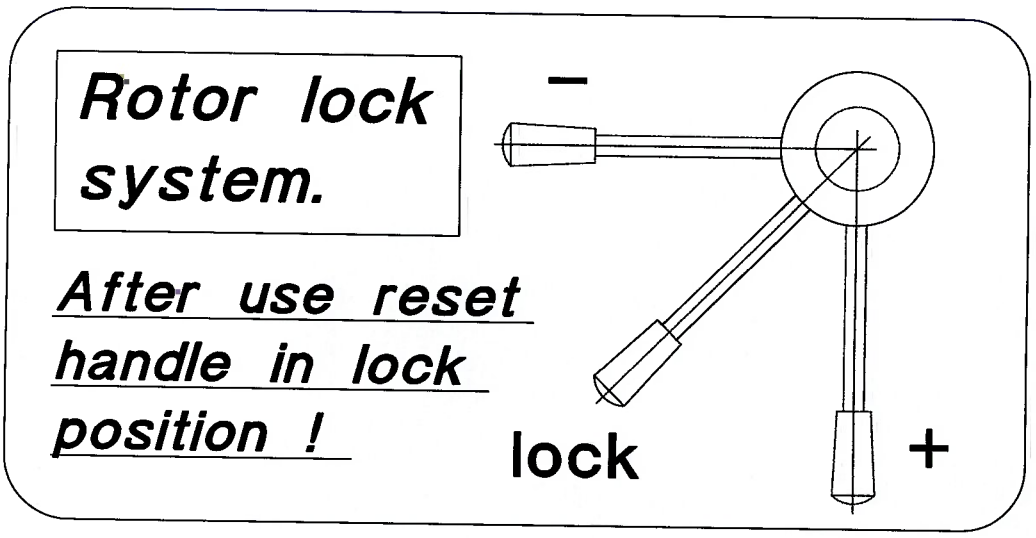


Figure 4 Handle positions

18.2 Operating the Manual Rotor Locking System with Bolts

The manual rotor locking system is used in case of servicing:

- Gearbox repairs
- Gearbox replacements
- Transport of nacelle
- Turbine standstill for long period of time: > 48 hours

The manual rotor lock must be used as an alternative to the hydraulic rotor lock
The following components must be used when operating the manual rotor lock.

Item number	Description	Quantity
950461	Centering mandrels	3
782137	M42 special nut	16
782138	Washer	16
782139	M42 special bolt	16
782142	Shim for rotor lock	16
782141	Hex.soc.h.scr.M16x60 yellow	16x8 = 128

Prior to mounting the manual rotor lock:

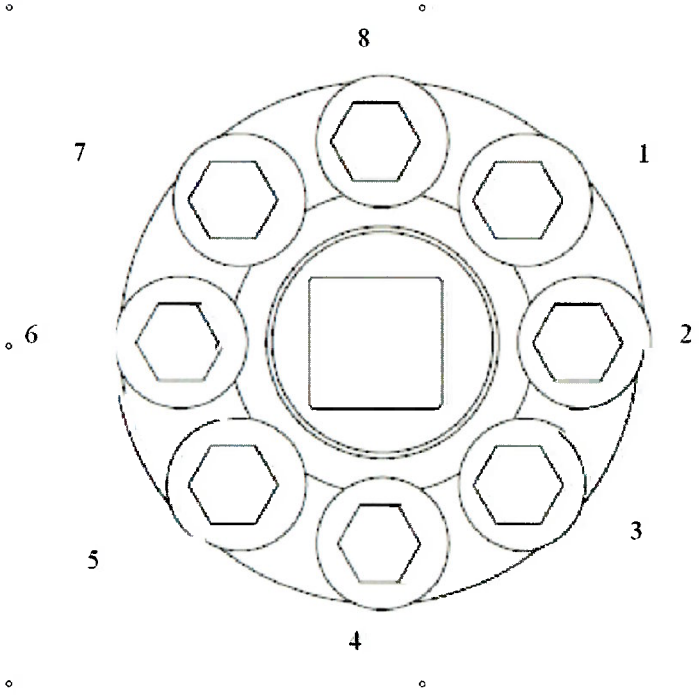
- Set the turbine in PAUSE mode and activate the <emergency stop button> to activate the disc brake.

18.2.1 Mounting the manual rotor lock

1. Turn the hub until the highest point points up and one of the blade bearings points downwards.
2. Lock the rotor with the hydraulic rotor lock or mount the three centering mandrels using 3 x 2 M20x40 from in front of the hub flange and into the locking holes of the main foundation.
3. Place 16 x M42 bolts (782139) 5 on each side and 6 in the top.
4. Insert 16 shims (782142) so the bolt is placed in the slot and the shims. Use a small hammer for mounting to ensure there is no space between the shim and the hub/main foundation.
5. Screw on the special nut, with washer underneath so it hits the hub flange.
6. Tighten the yellow M16 special bolts (782141) following this procedure:
   Tighten the 8 M16 bolts to 70Nm. Then tighten the 8 M16 bolts to 140Nm in a circular way and proceed with this operation with the first 3 bolts again, so you at the end have tightened 11 bolts to 140Nm.
   (see figure on the following page)

NOTE **Do not at any time remove the centering mandrels when the M 16 bolts are not tightened.**

Tightening force sequence. the full sequence has to be used.



Bolt nr.	Torque Nm
1	70
2	70
3	70
4	70
5	70
6	70
7	70
8	70
1	140
2	140
3	140
4	140
5	140
6	140
7	1 40
8	140
1	140
2	140
3	140

Figure 5

18.2.2 Dismantling the manual rotor lock after service work

1. Loosen all the M16 special bolts.
2. Loosen and remove all M42 special nuts.
3. Remove all the M42 special pin bolts
4. Remove the centering mandrels or pull back the hydraulic rotor lock.

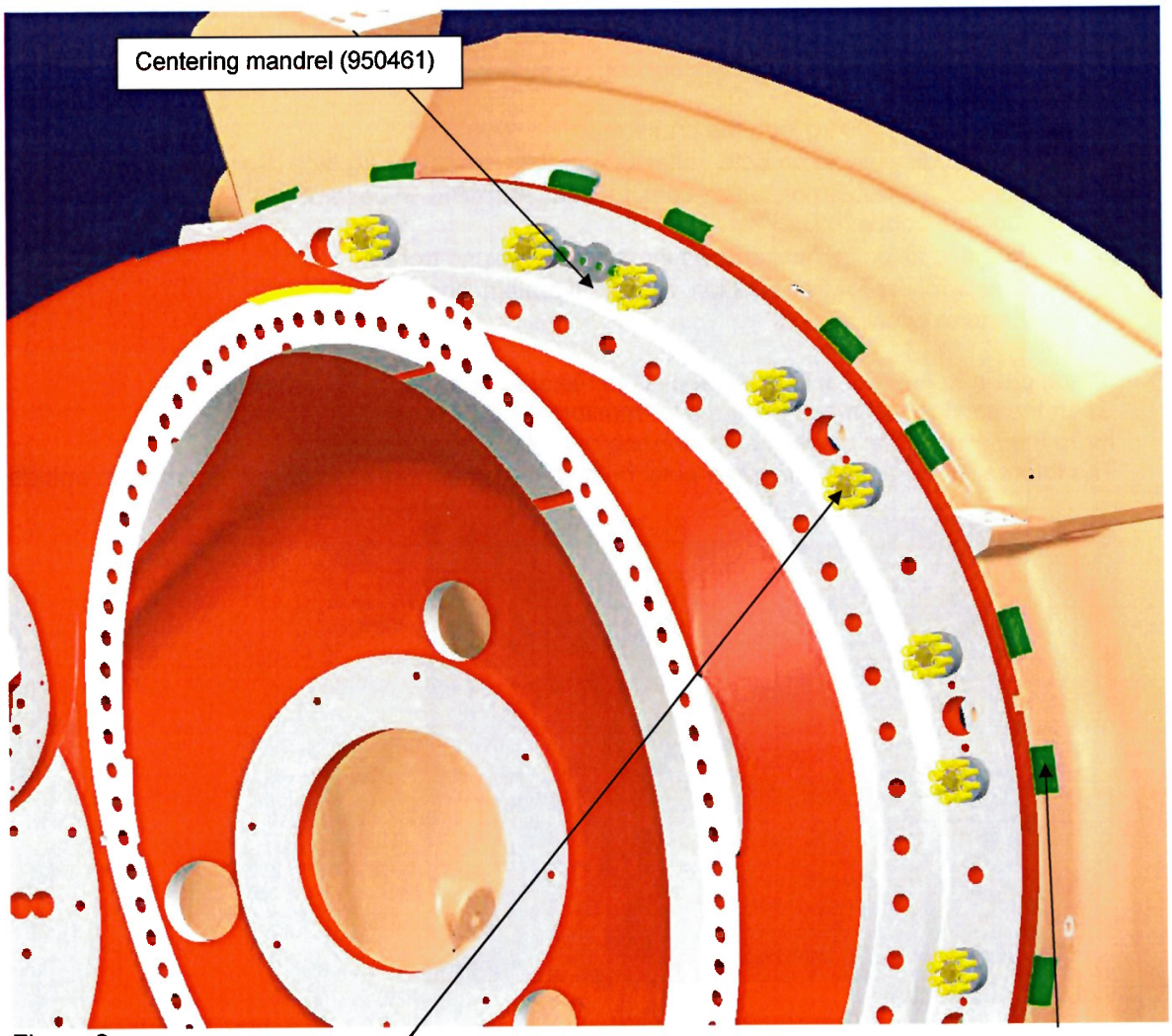


Figure 6

All these components are shown in an additional document 958627.

19. Operating the Internal Crane

Limitations on use:

- Lift or landing to floating vessels is not permitted for any crane constellation.
- Lift or lowering of personnel is not permitted for any crane constellation.
- Do not use any of the crane constellations for external operation above wind speed 15 m/sec 10 min.
- Do not operate the crane without correct authorization.

After 50 lifts with 12000 kg load the crane must be recertified:

- Inspect all welding on both trolleys for cracks. Repair or replace damaged items.
- Inspect all welding on lattice construction for cracks. In case of cracks Vestas Technology must be contacted.
- Replace all bolts, nuts and washers on bridge and trolley.
- Check rollers for free rotation, replace if malfunction.
- Perform overload test.

Attach chain to prevent accidental access to hazardous area.
Open the service hatch and secure it to transformer partition wall.
Keep the service hatch closed after hoisting operation is completed.
The internal crane and the traverse must be fastened in parked position when turbine in operation.

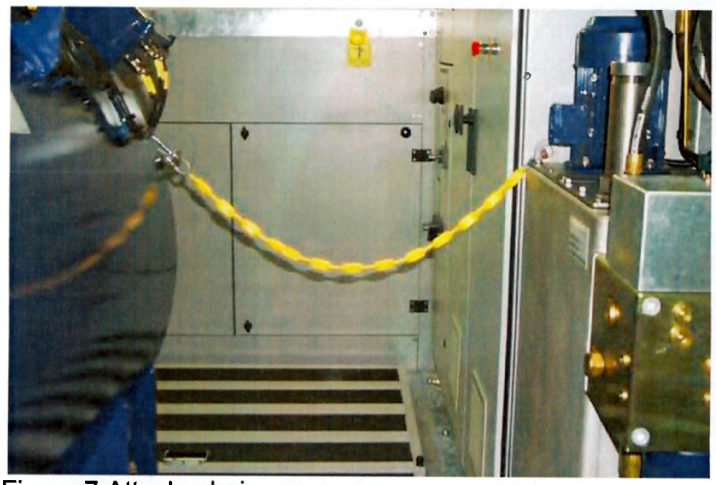


Figure 7 Attach c hain



Figure 8 Service Hatch

Release the chain from the chain box.

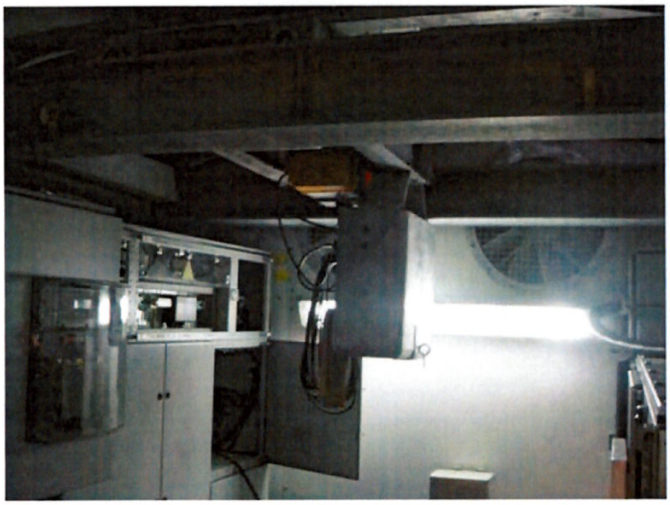


Figure 9 The chain box

The crane can be moved longitudinally by a winch mounted on the machine foundation.



Figure 10 The Crane Winch placed on foundation.

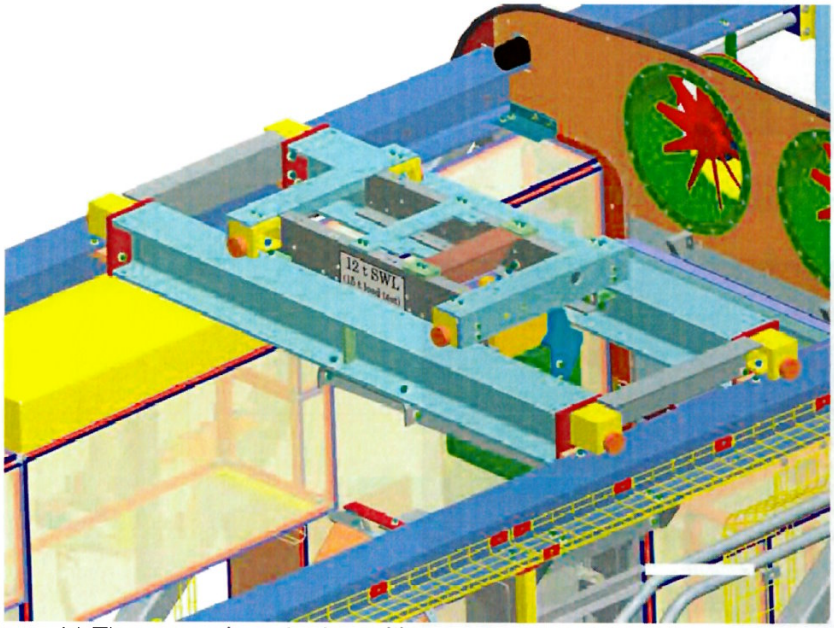


Figure 11 The crane in parked position

General crane functions:

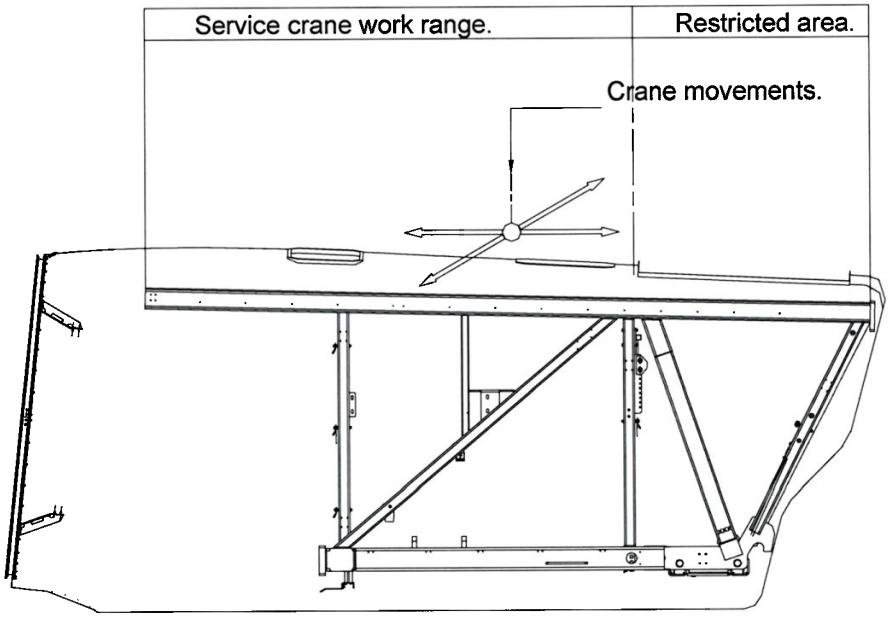
The internal nacelle overhead traverse trolley support 4 lifting functions, each with specific manual.

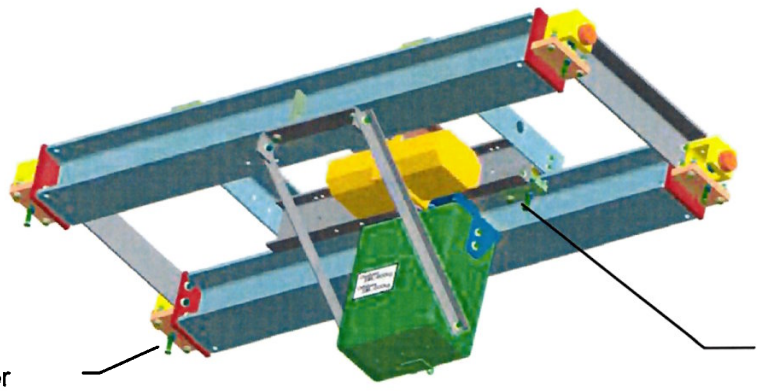
- Normal service operation. Max. Work load is 800 kg.

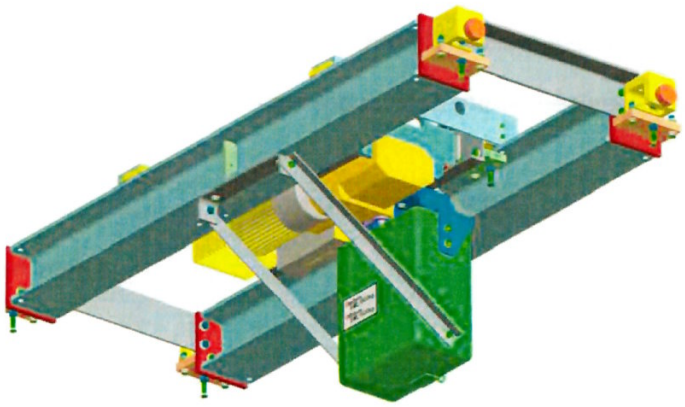
Prior to lowering the trolley must be locked in sideways direction by tightening lock screws ¼ extra turn after contact and in longitudinally direction locked by keeping the steel wire tensioned and tightening lock screw for longitudinally direction by tightening lock screws ¼ extra turn after contact .
Warning:
Visual inspect:

- The bridge and trolley for corrosion, wear, defect bolts and connections before using the crane.
- Winch for oil/grease leaks and corrosion.

The crane must not be used before defects are repaired.

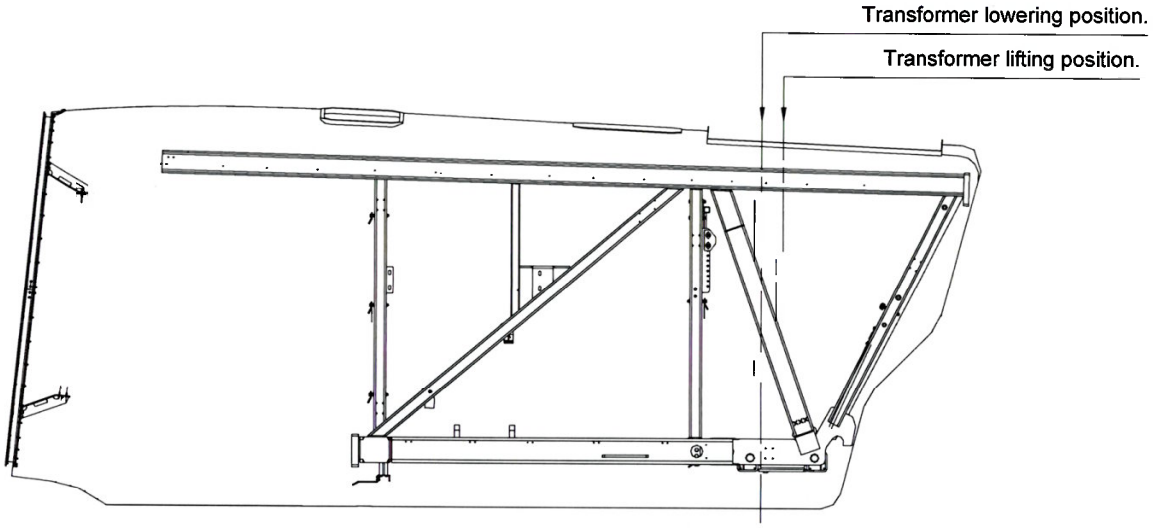






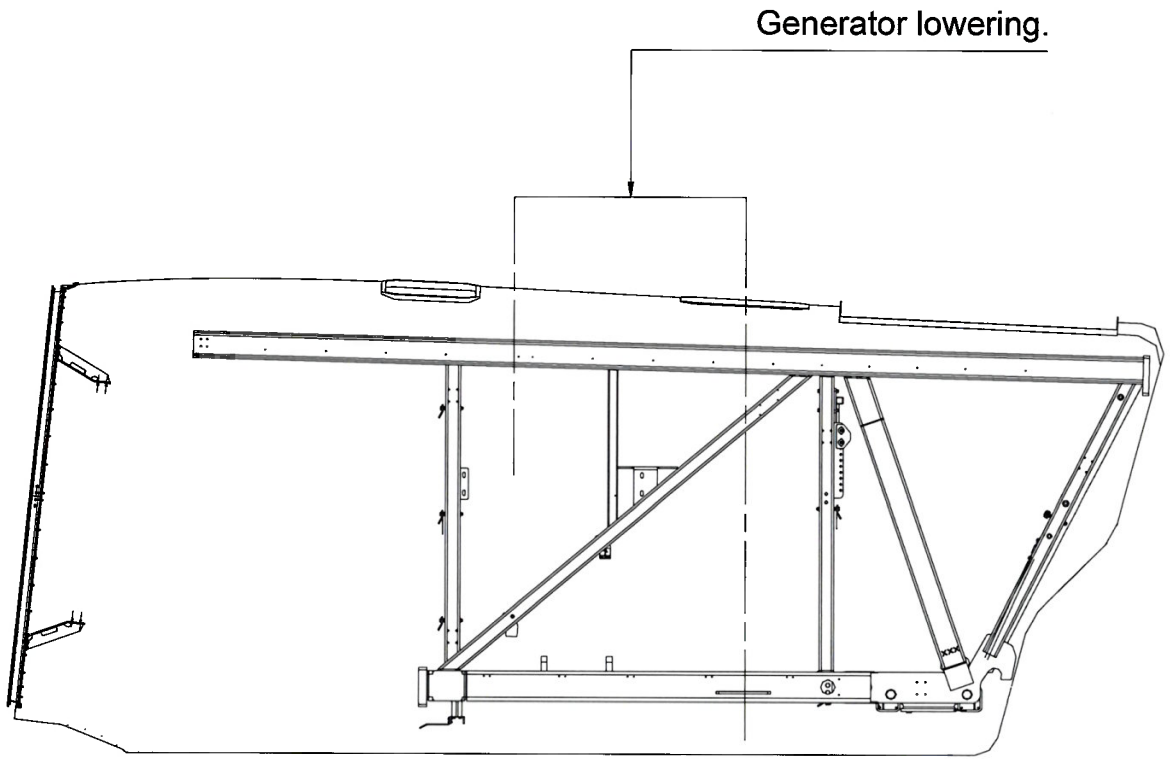
- Lifting transformer. Max. work load is 12000 kg.

This operation is only to be done by authorized personnel.



- Lifting generator. Max. Work load is 12000 kg.

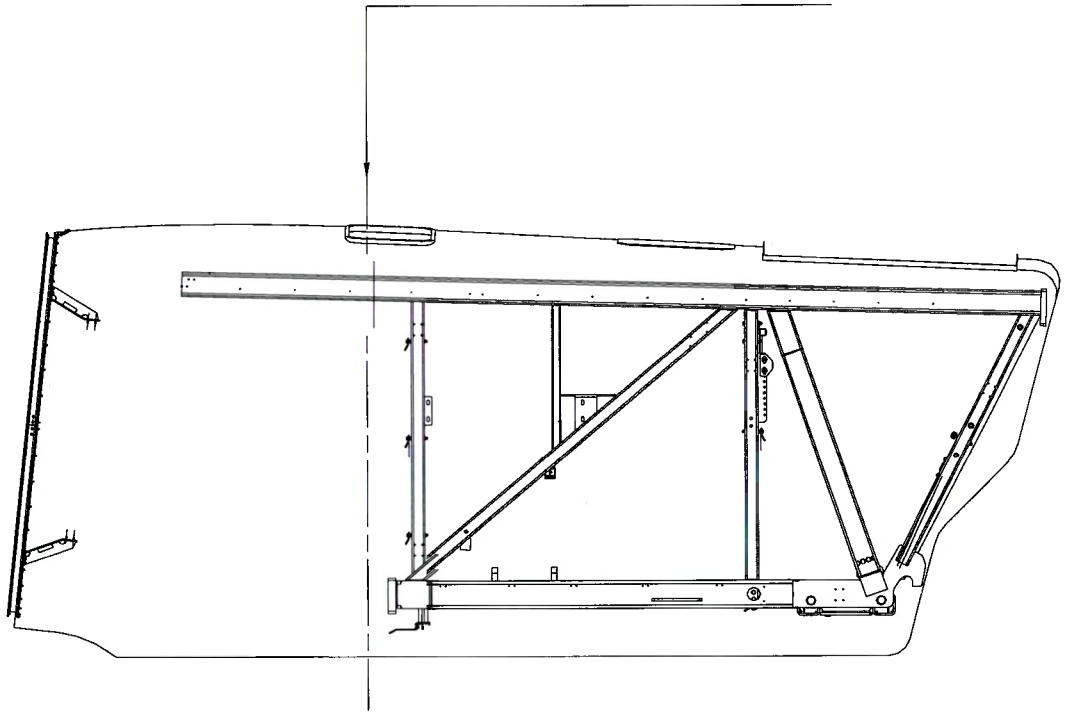
This operation is only to be done by authorized personnel.



Internal crane for lifting components in the hub:

This operation is only to be done by authorized personnel.

Hub components position.



Internal crane for lifting gear stages, Max. work load is 12000 kg:

This operation is only to be done by authorized personnel.

