A.68. In 2006, the results of a study specifically commissioned by the UK Department of Trade and industry (DTI) to look at the effects of infrasound and low frequency noise (LFN) arising from the operation of wind farms have been published in what is commonly referred to as the DTI LFN Report[34]. This Report is quite categorical in its findings: infrasound is not the perceived health threat suggested by some observers, nor should it even be considered a potential source of disturbance. Quoting from the Executive Summary to the DTI LFN Report:

> *'Infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion.*
>
> *The document "Community Noise" prepared for the World Health Organisation, states that "there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects". Other detection mechanisms of infrasound only occur at levels well above the threshold of audibility.*
>
> *It may therefore be concluded that infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour'.*

A.69. The same report noted that low frequency sound in the greater than 20 Hz frequency range may, under some circumstances, be measured to be of a comparable or higher level than the threshold of audibility. On such occasions this low frequency sound may become audible to low frequency sensitive persons who may already be awake inside nearby properties, but not to the degree that it will cause awakenings. However, such noise should still be assessed for its potential subjective effects in the conventional way environmental noise is generally assessed, on the basis of A-weighted levels. In particular, the subjective effects of this audible low frequency sound should not be confused with the claimed adverse health effect arguments concerning infrasound which, in any event, have now been shown from the results of the DTI LFN Report to be wholly unsubstantiated.

A.70. This has been subsequently confirmed by many subsequent international studies and reviews, some of which are listed below:

- A study for the National Institute for Public Health and the Environment (RIVM) in the Netherlands[35] published in 2020 concluded in this regard that: 'Although low frequency sound and infrasound might have other effects than 'normal' sound has, these effects are highly unlikely at sound levels typical for wind turbines. Brain studies show that low frequency and infrasound are processed in the same parts of the brain as 'normal' sound and there is no evidence that infrasound elicits any reaction at sub-audible levels.'
- A 2010 review by the UK Health Protection Agency[36] noted: "*The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects*."
- A study in Japan[37] determined that infrasound from wind turbines was inaudible and below relevant criteria.

34 'The measurement of low frequency noise at three UK wind farms', M. Hayes, DTI Report W/45/00656/00, 2006
35 Health effects related to wind turbine sound: an update, I. van Kamp, G.P. van den Berg, National Institute for Public Health and the Environment (RIVM), RIVM report 2020-0150, October 2020.
36 UK Health Protection Agency, Health Effects of Exposure to Ultrasound and Infrasound, Report of the independent Advisory Group on Non-ionising Radiation (2010).
37 Shimada A, Nameki M (2017), Evaluation of Wind Turbine Noise in Japan, 12th ICBEN Congress on Noise as a Public Health Problem.

- A study in Australia[38], based on a highly robust double-blind randomised controlled study, considered the effects, including on sleep, to exposing people to 72 hours of infrasound (designed to simulate a wind turbine infrasound signature). It concluded that: "*High level, but inaudible, infrasound did not appear to perturb any physiological or psychological measure tested in these study participants*."
- A large cross-sectional epidemiological study undertaken by Health Canada[39] found that assessment using metrics representing low-frequency noise was not necessary and did not identify association between noise-levels and chronic health conditions such as migraines, tinnitus or high blood pressure.
- Controlled experiments[40] from Germany, which included participants self-reported to be sensitive to wind turbine infrasound, demonstrated that exposure to infrasound at levels representative of those experienced at dwellings was not associated with physiological or psychological health effects.
- A study in Finland[41] was undertaken in assessing whether wind turbine infrasound has harmful effects on human health and found that wind turbine infrasound exposure did not cause physiological responses in any of the participant groups in the study.
- Other reviews of health effects, such as by Harrsion RV in 2014[42], Tonin et al (2016)[43], Nelson et al (2019)[44], and Maijala et al (2021)[45], showed that infrasound emission from wind turbines at ranges relevant to neighbouring dwellings were typically too low to expect any adverse effects, even for people with heightened sensitivity due to medical conditions.
- A report commissioned by the UK Government[46] published in February 2023 concludes that controlling A-weighted noise levels from wind turbines provides sufficient control of low-frequency noise, and that, based on the latest available evidence, "*exposure to infrasound at levels representative of wind turbine immissions at dwellings is not associated with physiological or psychological health effects*."

A.71. The Institute of Acoustics (IOA) also published a position statement[47] which noted that:

> *The IOA is aware that there is some information presented at planning inquiries suggesting the potential for physiological health effects from low frequency noise from wind turbines. It is current advice to members that there is no need to assess low frequency noise as part of the noise impact assessment process, as the absolute levels, whilst potentially audible at typical receptor distances,*

38 Marshall et. al., The Health Effects of 72 Hours of Simulated Wind Turbine Infrasound: A Double-Blind Randomized Crossover Study in Noise-Sensitive, Healthy Adults. Environmental Health Perspectives (EHP), 131(3) March 2023.
39 D. Michaud, Wind Turbine Noise and Health Study: Summary of Results, 6th International Meeting on Wind Turbine Noise, 2015.
40 Krahé, D, Alaimo Di Loro, A, Müller, U, Elmenhorst, E, De Gioannis, R, Schmitt, S, Belke, C, Benz, S, Großarth, S, Schreckenberg, D, Eulitz, C, Wiercinski, B & Möhler, U, 2020. Lärmwirkungen von Infraschallimmissionen (Noise Effects from Infrasound Immissions, in German, with abstract in English).
41 Infrasound Does Not Explain Symptoms Related to Wind Turbines, Maijala et al, Government's Analysis, Assessment and Research Activities, Helsinki, Finland, 2020
42 Harrison, RV, 2014. On the biological plausibility of Wind Turbine Syndrome. International Journal of Environmental Health Research.
43 Tonin, R, Brett, J & Colagiuri, B, 2016. The effect of infrasound and negative expectations to adverse pathological symptoms from wind farms. Journal of Low Frequency Noise, Vibration and Active Control.
44 Nelson, P, Bryne, A, Waggenspack, M, Lueker, M, Feist, C, Herb, B & Marr, J, 2019. Testing the human response to wind turbine emissions. Wind Turbine Noise 2019, 12-14 June, Lisbon. INCE-Europe
45 Maijala, PP, Kurki, I, Vainio, L, Pakarinen, S, Kuuramo, C, Lukander, K, Virkkala, J, Tiippana, K, Stickler, EA & Sainio, M, 2021. Annoyance, perception, and physiological effects of wind turbine infrasound. Journal of the Acoustical Society of America.
46 WSP, A Review of Noise Guidance for Onshore Wind Turbines, report for the UK Department for Business, Energy & Industrial Strategy, October 2022 (published 10 February 2023).
47 Institute of Acoustics, Statement in Respect of Wind Farm Noise Assessment, December 2024. https://www.ioa.org.uk/publications/wind-turbine-noise [accessed December 2025]

are well below those reported to trigger physiological health effects based on peer reviewed research to date.

A.72. In conclusion, whilst is known that infrasound can have an adverse effect on people (potential adverse health impacts are listed by the World Health Organisation as stress, irritation, unease, fatigue, headache, possible nausea and disturbed sleep), these effects can only come into play when the infrasound reaches a sufficiently high level. This is a level above the threshold of audibility. However, all available information from measurements on current wind turbines reveals that the level of infrasound emitted by these wind turbines lies below the threshold of human perception. Consequently, there is no reason to treat noise from wind farm development any differently to noise from any other form of development.

Blade swish (amplitude modulation)

A.73. The noise assessment methodology presented in ETSU-R-97, sets out noise limits which already account for typically encountered levels of blade swish. Notwithstanding the conclusions and advice presented in the preceding paragraphs concerning both infrasound and low frequency sound, the DTI LFN Report went on to suggest that, where complaints of noise at night had occurred, these had most likely resulted from an increased amplitude modulation of the blade passing noise, making the 'swish, swish, swish' sound (often referred to as 'blade swish') more prominent than normal. Whilst it was therefore acknowledged that this effect of enhanced amplitude modulation of blade aerodynamic noise may occur, it was also concluded that there were a number of factors that should be borne in mind when considering the importance to be placed on the issue when considering present and proposed wind farm installations:

- it appeared that the effect had only been reported as a problem at a very limited number of sites (the DTI report looked at the 3 out of 5 U.K. sites where it has been reported to be an issue out of the 126 onshore wind farms reported to be operational at the time in 2006);
- the effect occurred only under certain conditions at these sites (the DTI LFN Report was significantly delayed while those involved in taking the measurements waited for the situation to occur at each location);
- at one of the sites concerned it had been demonstrated that the effect can be reduced to an acceptable level by the introduction of a Noise Reduction Management System (NRMS) which controls the operation of the necessary turbines under the relevant wind conditions (this NRMS had to be switched off in order to gain the data necessary to inform the DTI LFN Report);
- whilst still under review, it appeared that the most likely cause of the increased amplitude modulation was related to an increase in the stability of the atmosphere during evening and night time periods, hence the increased occurrence of such an effect at these times, but this effect had been shown by measurement of wind speed profiles to be extremely site specific;
- internal noise levels were below all accepted night time criteria limits and insufficient to wake residents, it was only when woken by other sources of a higher level (such as local road traffic) that there were self-reported difficulties in returning to sleep.

A.74. The Government then commissioned an independent research project to further investigate the prevalence of the impact of enhanced levels of amplitude modulation across UK wind farms. This research work was awarded to the University of Salford who reported on their findings in July 2007[48]. The Salford study concluded that that the occurrence of increased levels of 'blade swish' was infrequent, but suggested it would be useful to undertake further work to understand and assess this feature of wind turbine noise.

48 'Research into Aerodynamic Modulation of Wind Turbine Noise', Report by University of Salford, URN 07/1235 (July 2007)

A.75. As a consequence of the findings of the report by the University of Salford, the UK Department for Business, Enterprise and Regulatory Reform (BERR formerly the DTI) issued a statement in August 2007[49] which concluded:-

> *'A comprehensive study by Salford University has concluded that the noise phenomenon known as aerodynamic modulation (AM) is not an issue for the UK's wind farm fleet.*
>
> *AM indicates aerodynamic noise from wind turbines that is greater than the normal degree of regular fluctuation of blade swoosh. It is sometimes described as sounding like a distant train or distant piling operation.*
>
> *The Government commissioned work assessed 133 operational wind projects across Britain and found that although the occurrence of AM cannot be fully predicted, the incidence of it from operational turbines is low'.*

A.76. The statement then concludes with the advice:

> *'Government continues to support the approach set out in Planning Policy Statement (PPS) 22 – Renewable Energy. This approach is for local planning authorities to "ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels", through the use of the 1997 report by ETSU to assess and rate noise from wind energy development'.*

A.77. This represents an aspect of wind turbine noise which has become the subject of considerable research in the UK and abroad in the past years and the state of knowledge on the subject is rapidly evolving. An extensive research programme entitled 'Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect' was published in 2013[50]. This research, commissioned by RenewableUK (ReUK) was specifically aimed at identifying and explaining some of the key features of wind turbine AM noise.

A.78. Claims have emerged from different researchers that wind turbines were capable of generating noise with characteristics out with that expected of them. This characteristic was an enhanced level of modulated aerodynamic noise that resulted in the blade swish becoming more impulsive in character, such that those exposed to it would describe it more as a 'whoomp' or 'thump' than a 'swish'. It could also become audible at distances from the wind turbines that were considerably greater than the distances at which blade swish could ordinarily be perceived. It has since emerged that this may be similar to the character of the noise identified in the DTI LFN study. Hence for the purposes of the ReUK project, any such AM phenomena with characteristics falling outside those expected of this "normal" AM (NAM) were therefore termed 'Other AM' (OAM).

A.79. The research identified the most likely cause of OAM noise is transient stall on the wind turbine blade (i.e. stall which occurs over a small area of each turbine blade in one part of the blade's rotation only). The occurrence of transient stall will be dependent on a combination of factors, including the air inflow conditions onto the individual blades, how these inflow conditions may vary across the rotor disc, the design of the wind turbine blades and the manner in which the wind turbine is operated. Variable inflow conditions may arise, for example, from any combination of wind shear, wind veer, yaw errors, turbine wake effects, topographic effects, large scale turbulence, etc. However, the occurrence of OAM on any particular site cannot be predicted at this stage.

A.80. As a consequence of the combined results of the ReUK research, and most notably the development of objective techniques for identifying and quantifying AM noise and the ability to relate such an

49 'Government statement regarding the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise', BERR, Ref: 2007/033 (1st August 2007)
50 Wind Turbine Amplitude Modulation: Research to Improve Understancing as to its Cause and Effect, Renewable UK, December 2013.