Noise

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Introduction

1. Inspectors make their decisions on the basis of the evidence before them. Consequently, they may, where justified by the evidence, depart from the advice given in this training material, although Planning Policy Wales (PPW) and Technical Advice Note 11: Noise 11 (1997) (TAN11) will still be relevant in all cases.

2. Noise can have significant effects on the environment and on quality of life. Exposure to noise can have effects on sleep and general annoyance and can lead to chronic health effects (e.g. heart disease and hypertension)[1]. In view of this noise is a material consideration in the determination of planning, transport and environmental casework and a key indicator of sustainable development and therefore needs to be given appropriate 'weight' in the decision-making process.

3. Noise as a form of pollution has a primarily local impact. A single noise source (point sources) rarely has an impact beyond a neighbourhood. Exceptions may include transportation sources (linear sources) such as a major road, rail or other installation such as an airport.

Fundamentals of Noise

4. Sound can be considered a form of energy conversion when any form of 'work' is carried out, where the 'work' is not converted into heat or other energy forms. Noise is a term meaning any *unwanted* sound. Noise associated with environmental sources i.e. transport or industrial plant are unwanted as they can impose a burden of annoyance, distraction, interference or intrusion on people who may receive no immediate or direct benefit from the noise-producing system.

5. The dB is the standard unit of noise measurement that you will come across in casework. See Annex A of this chapter for more information on noise concepts and terminology.

Policy, legislation and guidance

International/European:

6. **Environmental Noise Directive (END)[2]** – concerns the assessment and management of environmental noise and is the main EU instrument to identify noise pollution levels and to trigger action at both Member State and EU level.

[1] It is estimated that in Europe in 2014 road traffic noise was the most dominant source of noise with approx.125 million people affected by noise levels >55dB L_{den}; environmental noise caused at least 10,000 premature deaths per year; about 20 million adults are annoyed and a further 8 million suffer sleep disturbance due to environmental noise; with >900,000 cases of hypertension caused by noise – Noise in Europe, EEA Report No 10/2014, EEA, Dec 2014.

[2] Directive 2002/49/EC on the assessment and management of environmental noise.

The END compelled EU Member States to produce noise maps every five years, the drafting of local noise action plans and collection of noise data to inform future Community policy and to consult on and make this information publicly available – see below. The Environmental Noise (Wales) Regulations 2006[3] transposed the END into UK Law.

7. **ISO 9613-2: 1996 Attenuation of sound during propagation outdoors** - describes a method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level (as described in ISO 1996) under meteorological conditions.

8. **WHO Guidelines for Community Noise 1999 (CNG)** – gives guidance on suitable internal and external noise levels, for steady sound in and around residential properties, which recommends:

   - 39 dB L_{Aeq} in bedrooms, with <45 dB L_{Amax}, over 8 hrs at night;
   - 35 dB L_{Aeq} in living rooms over 16 hrs in the day;
   - 50 to 55 dB L_{Aeq} in gardens/outdoor living areas over 16 hrs in the day; and
   - 45 dB L_{Aeq} outside bedrooms with an open window over 8 hrs at night

   It is important to note the time periods over which these levels apply.

9. **WHO Night-time Noise Guidelines for Europe 2009 (NNG)** – provides additional guidance on night-time noise and recommends noise levels based on effects on health.

10. **Environmental Noise Guidelines for the European Region 2018**, updates and supersedes the CNG (apart from the indoor guideline values and any other values not covered by the new guidance e.g. industrial noise and shopping areas, which remain valid) and complements the NNG. The revised guidelines cover two new noise sources: wind turbines and leisure noise. The guidelines apply a 1 dB increment scheme, whereas prior guidelines (CNG and NNG) formulated or presented recommendations in 5 dB steps. The guidelines are source specific. They recommend values for outdoor exposure to road traffic, railway, aircraft and wind turbine noise, and indoor as well as outdoor exposure levels for leisure noise.

National and Planning:

The Well-being of Future Generations (Wales) Act 2015 (WFGA)

11. Noise policy in Wales now sits, not in a vacuum, but within the cross-cutting policy framework set by the WFGA. This requires public bodies such as local

[3] SI 2006/2629 (W.225), which came into force on 4/10/2006.

authorities, local health boards, NRW and the Welsh Government to carry out sustainable development. This is the process of improving the economic, social, environmental and cultural well-being of Wales by taking action, in accordance with the sustainable development principle, aimed at achieving the seven well-being goals.

12. Accordingly, noise and soundscape management through planning decisions should be carried out by:

- Pursuing long-term, enduring solutions to any existing instances of noise nuisance;
- Seeking to manage noise and soundscapes at the same time as achieving other, related outcomes;
- Keeping exposure to noise (that is, unwanted or harmful sound) as low as reasonably practicable across the whole of the population, looking out in particular for areas where noise levels might qualify as a statutory nuisance or noise action planning priority area, or where public amenity might be adversely affected by noise at some point in the future, and acting pre-emptively to prevent those things from happening.

Planning Policy Wales, Edition 12 (Feb 2024) (PPW)

13. PPW recognises the importance of appropriate soundscapes to the health and well-being of people and the environment. PPW ensures that long-term approaches are taken to prevent the creation of new, or worsening of existing, problems and seek to encourage integrated solutions. PPW recognises the positive role that soundscapes can play in creating a sense of place, rather than solely focusing on noise as a form of pollution.

14. Soundscape and noise are factors that should affect initial policy choices when preparing development plans and, similarly, they must feature as considerations in the initial choice of location of development, where appropriate, and in the early design stages of developments and projects.

15. Making this principle explicit as a matter of policy in PPW means that a developer would have to ensure that solutions to address noise from nearby pre-existing infrastructure or businesses can be found and implemented as part of ensuring that the development is acceptable. This is essentially what planning policies already amount to, but by explicitly making reference to the principle there are wider behavioural benefits to be gained in terms of improved planning practice and promoting a wider appreciation of the nature of places. Noise issues should not be relegated to being just a technical matter or an afterthought.

16. **Technical Advice Note: 11 Noise** - This TAN was published in 1997, so is somewhat out of date and references to other guidance etc should be double checked as it may have been superseded. Nevertheless, the general principles

still hold strong. The glossary is particular helpful in explanation of noise terminology. The annexes set out: noise exposure categories for dwellings; noise assessments from different sources; and noise planning conditions.

17. **CONSULTATION DRAFT - TECHNICAL ADVICE NOTE 11: AIR QUALITY, NOISE AND SOUNDSCAPE** – The consultation exercise on the proposed changes to TAN11 ended on 20 January 2023. That document sought to bring the content of the TAN in line with that of PPW, with an emphasis on air quality, noise and soundscapes. WG have confirmed that it has no current plans to publish a new TAN11, as such the consultation document should be treated with caution in planning decisions.

18. **Minerals Planning Guidance: The control of noise at surface mineral workings** – This MPG was published in 1993, so is somewhat out of date and references to other guidance etc should be double checked as it may have been superseded. Useful information on noise abatement methods.

19. **Technical Advice Note: 12 Design** – Paragraphs 5.14.6 states "*Those involved in the design and management of the public realm should be aware of the potential for* noise *generation in their proposals and the impact this may have on neighbouring amenity. Opportunities to minimise ambient noise, such as traffic, should be explored and reflected in the layout and detailed design of the public realm and by use of low-noise surfacing materials and natural or man-made barriers to noise*."

20. **Strategic Noise Maps -** The Environmental Noise Directive (2002/49/EC) states that "*Member States shall adopt the measures necessary to ensure that no later than 30 June 2012, and thereafter every five years, strategic noise maps showing the situation in the preceding calendar year have been made and, where relevant,* approved *by the competent authorities for all agglomerations and for all major roads and major railways within their territories*." The Directive also states that "*The strategic noise maps shall be reviewed, and revised if necessary, at least every five years after the date of their preparation*."

21. The Welsh Government published strategic noise maps in 2012 for major roads, major railways and agglomerations, showing the situation in 2011 and in 2017 showing the situation in 2016.

Noise and soundscape action plan 2018 to 2023

22. Following on from the Noise Mapping, the 'Noise and soundscape action plan' (NSAP) sets out the long-term vision for Government noise policy. Under the Environmental Noise Regulations, the Welsh Ministers have an obligation to draw up action plans for places near major roads and major railways, and for agglomerations. The Regulations apply to environmental noise to which humans are exposed in particular in built-up areas, in public parks or other quiet areas in an agglomeration, and near schools, hospitals and other noise-sensitive buildings and areas. They do not apply to noise that is caused by the

exposed person, noise from domestic activities, noise created by neighbours, noise in workplaces or noise inside means of transport or due to military activities in military areas.

Quiet Area Mapping

23. The NSAP has identified Quiet Area and Priority area (for roads and railways). These areas provide a framework for the local management of noise. Mapping is available for: Newport; Cardiff and Penarth; and Swansea and Neath Port Talbot.

24. Natural Resources Wales has also produced a map of Wales graded to show levels of Tranquillity. It results from combining several underlying layers of data, covering different factors that either contribute to tranquillity or detract from tranquillity. Produced to provide a strategic baseline for monitoring change in tranquillity in Wales to inform strategic planning and policy-making.

Environmental:

Noise Act 1996

25. The Noise Act 1996[4] created the 'night noise offence' which can occur between 2300 and 0700 hours, which is in addition to the Statutory Nuisance provisions already in force under the EPA 1990 – see below.

Environmental Protection Act 1990

26. Sections 79-82 in Part III of the EPA1990[5] imposes duties on local authorities to deal with 'statutory nuisances'. These include noise emitted from premises so as to be prejudicial to health or a nuisance under section 79(1)(g), and noise that is prejudicial to health or a nuisance and is emitted from or caused by a vehicle, machinery or equipment in a street [or in Scotland, road] under section 79(1)(ga). Section 79(1)(h) also imposes duties on local authorities to deal with any other matter declared by any enactment to be a statutory nuisance.

27. When assessing whether a statutory nuisance exists, local authorities will consider a number of relevant factors, including the noise level, its duration, how often it occurs, the time of day or night that it occurs and the 'character of the locality'. The factors influencing the 'character of the locality' may include long-established sources of noise in the vicinity – for example, church bells, industrial premises, music venues or public houses.

28. Local authorities have a duty to take such steps as are reasonably practicable to investigate a statutory nuisance complaint. It is a matter for them whether they take further formal action to remedy a statutory nuisance.

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[4] Noise Act 1996 (C.37)

[5] Environmental Protection Act 1990 (C.43)

The Clean Neighbourhoods and Environment Act 2005

29. The CNEA[6] Provides local authorities in Wales with powers to deal with noise from intruder alarms and extends the powers for dealing with night time noise, referred to in the Noise Act 1996, to cover licensed premises.

Control of Pollution Act 1974 (COPA)

30. The COPA[7] introduced the concept of noise abatement zones[8], where criminal sanctions are imposed if levels are exceeded. Section 60 relates to 'Control of Noise at Construction Sites'; section 61 relates to 'Prior Consent for Work on Construction Sites'. This is often used in conjunction with BS5228, Notices served under the Act can specify noise levels and hours of operation and mitigation measures. These controls are normally used for major infrastructure projects but can apply to Transport and Works Act (TWA) casework.

Industrial Emissions Directive (IED) and Environmental Permitting Regime

31. The IED[9] require that all industrial operations in sectors covered by this EU Directive carry out noise assessments and make provisions to minimise noise emissions. The IED also requires that Best Available Techniques (BAT)[10] is be used to control noise emissions, taking into account the cost, which should be reasonable for the changes to be implemented. The IED (and other related environmental EU Directives) are implemented in Wales under the Environmental Permitting Regulations 2016 (EPR). Noise impact for activities subject to EPR should be measured using the BS4142 rating levels.

British Standards/Building Regulations

32. **BS4142:2014 + A1: 2019 – Methods for rating and assessing Industrial and Commercial Sound –** describes methods for the determination of the following levels at outdoor locations:

    - rating levels for sources of an industrial and/or commercial nature; and

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[6] Clean Neighbourhoods and Environment Act 2005 (C.16)

[7] Control of Pollution Act 1974 (C.40)

[8] Under COPA s63-67. NAZs were repealed on 1/10/2015 by Schedule 13, Part 5 of the Deregulation Act 2015 as the powers were not being widely used – there were only 81 NAZs, of which only 2 were being managed.

[9] Directive 2010/75/EU, which had to be transposed by member states by 7/1/2013. The IED repealed the IPPC Directive and other sectorial Directives on 7/1/2014 and the LCP Directive on 1/1/2016.

[10] BAT – the available techniques which are best for preventing or minimising emissions and impacts on the environment. This includes both the technology used and the way in which the installation is designed, built and operated. In deciding the level of control that constitutes BAT for an installation, a number of factors should be considered: i) costs and benefits, ii) the technical characteristics of the installation, iii) geographical location and iv) local environmental conditions. BAT for each sector is set out in process or sector-specific guidance, derived from the EC BAT Reference Documents (BREF).

[19] SI 2016/1154

- ambient, background and residual sound levels,

for the purposes of:

- investigating complaints;
- assessing sound from proposed new, modified or additional source(s) of sound of an industrial and/or commercial nature; and
- assessing sound at proposed new dwellings or premises used for residential purposes.

33. **BS5228:2009+A1:2014 Code of Practice for Noise and Vibration control on Construction and Open Sites -** gives data and methods for calculating noise from construction and other open sites (e.g. quarries, landfill sites); Part 1 relates to noise, Part 2 deals with vibration.

34. **BS8233:2014 Guidance on sound insulation and noise reduction for buildings -** provides guidance for the control of noise in and around buildings based on the WHO guidelines. It applies to the design of new buildings and refurbished buildings undergoing a change of use but does not provide guidance on assessing the effect of changes in the external noise levels to occupants of an existing building.

35. **BS6472:2008 Guidance to evaluation of human exposure to vibration in buildings** – provides guidance on the application of methods measuring and evaluating vibration to assess the likelihood of complaints. Part 1 (*Vibration* sources *other than blasting*) provides guidance on prediction of human response to vibration in buildings from sources other than blasting (in the frequency range of 0.5Hz-80Hz) and describes how to determine the vibration dose value (VDV) from frequency-weighted vibration measurements. Part 2 (*Blast-induced vibration*) provides guidance on prediction of human response to vibration in buildings from blast-induced sources (in the frequency range of 4.5Hz-250Hz), primarily from mineral extraction activities, and can also be used for assessing other forms of vibration caused by blasting. However, this guidance is not suitable for one-off explosive events, e.g. bridge or building demolitions.

36. **Building Regulations (Approved Document E – Resistance to the passage of sound)**[11] **–** Regulations 20A and 12A introduced pre-completion testing for sound insulation as a means of demonstrating compliance for 'rooms for residential purposes' i.e. new houses and flats and those formed by conversion of other buildings. Alternatively, the use of robust details will be accepted i.e. use of high-performance materials separating wall and floor construction.

Transport:

[11] Approved Document E, DCLG, March 2015

37. **Calculation of Road Traffic Noise (CRTN) –** Published by the Department for Transport (DfT) in 1998, the CRTN is the standard UK procedure for calculating noise from road traffic. Divided into three sections - Section I provides a general method for calculation of predicted noise levels at a distance from a highway (taking parameters into account); Section II provides additional procedures that may need to be taken into account when applying the method in Section I. Finally, Section III sets out procedures and requirements for when traffic conditions fall outside the scope of 'standard' prediction methods. Examples are given in Annexes 118.

38. **Calculation of Railway Noise (CRN) –** Published by the Department for Transport in 1995, the CRN sets out the methods and procedures for calculating noise from moving railway vehicles[12]. Divided into three sections – Section I provides a general method for calculation of predicted noise levels at a distance from a railway (taking parameters into account); Section II provides additional procedures that may need to be taken into account when applying the method in Section I. Finally, Section III sets out procedures and requirements for when railway traffic and/or the site layout conditions fall outside the scope of 'standard' prediction methods in Section I.

39. **Design Manual for Roads and Bridges (DMRB) –** Volume 11, section 3, Part 7[13] of the DMRB provides guidance on the assessment of impacts that road projects may have on levels of noise and vibration. The DMRB uses noise levels calculated by the CRTN methodology.

40. **Transport Analysis Guidance (WebTAG) –** TAG Unit A3[25] sets out a five step methodology for environmental appraisal of transport projects – i) Scoping, ii) Quantification of noise impacts; iii) Estimation of the affected population, iv) Monetary valuation of changes in noise impact, and v) Consideration of the distributional impacts of changes in noise based on the DETR Guidance[14]. The guidance makes reference to the WHO Health and Noise report[15], Defra Guidance[16], the CRTN/CRN and the DMRB.

41. **Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996** – legislation, by virtue of the 1973 Act[17], used to determine which properties should be provided with or pay a grant for sound insulation against noise from a new or significantly altered rail scheme. To qualify properties have to fulfil criteria set out in regulation 4 and 7.

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[12] As defined in r3 of the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996, SI 1996/428 and the Transport and Works Act 1992.

[13] HD213/11 – Rev 1, Environmental Assessment Techniques, Noise and Vibration [25] TAG unit A3 - Environmental impact appraisal, [DfT, December 2015].

[14] Guidance on the Methodology for Multi-Modal Studies Volume 2 (DETR, 2000)

[15] Burden of disease from environmental noise: Quantification of healthy life years lost in Europe (WHO/EC (JRC) 2011)

[16] Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet (Defra, 2014)

[17] S20 of the Land Compensation Act 1973 (c.26)

42. **The Noise Insulation Regulations 1975** and the **Noise Insulation (Amendment) Regulations 1998** – provides by virtue of the 1973 Act[29], equivalent legislation to the 1996 Regulations, used to determine which properties should be provided with or pay a grant for sound insulation against noise from a new or significantly altered road scheme. To qualify properties have to fulfil certain criteria set out in the regulations.

43. **Aviation Policy Framework** – Published in 2013 by DfT, sets out the Government's policy on aviation and sets out the parameters within which the Airports Commission would work. Section 3.1 deals with noise predominantly. Paragraph 3.12 states the Government's overall policy on aviation noise – to limit and where possible, reduce the number of people in the UK significantly affected by aircraft noise.

Other Guidance

44. **Professional Practice Guidance on Planning and Noise – New Residential Development (ProPG) -** The Professional Practice Guidance on Planning and Noise (ProPG)[18] has been produced by the Institute of Acoustics (IoA), Chartered Institute of Environmental Health (CIEH) and the Association of Noise Consultants (ANC). The ProPG, aimed at new residential developments, was published in June 2017, following consultation in 2016. It is published in 3 parts - the Main Guidance and 2 supplementary documents. Supplementary Document 1: Planning and noise policy and guidance gives an overview of noise policy related to planning. Supplementary Document 2: Good Acoustic Design relates to the use of good acoustic design in dwellings.

45. The ProPG has been produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England. It seeks to assist in the delivery of sustainable development by promoting good health and well-being. The guide promotes the use of a good acoustic design process in and around proposed new residential development. The ProPG follows a two-stage, risk-based approach:

    - Stage 1 – initial assessment where external noise is rated against four Noise Risk Categories (NRCs)[19][20];
    - Stage 2 – a systematic consideration of four key elements[34]

46. Having followed the approach to its conclusion, noise practitioners will have a choice of four possible recommendations for the decision-maker to – grant without conditions; grant with conditions; avoid (refuse unless…) and prevent (refuse regardless).

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[18] Professional Practice Guidance on Planning & Noise – New Residential Development (May 2017).

[19] Can be considered as an updated replacement for the Noise Exposure Categories (NECs) set out in PPG24, cancelled in March 2012.

[20] – demonstrate a 'Good Acoustic Design Process'; 2 – observe 'Internal Noise Level Guidelines'; 3 – undertake an 'External Amenity Area Noise Assessment'; and 4 – consider 'Other Relevant Issues'.

47. It should be noted that the ProPG does not constitute government guidance and neither replaces nor provides an authoritative interpretation of the law or government policy, so should be given the appropriate weight by the decision-maker.

Case Law

General Noise Issues

a) *Coventry and others v Lawrence and another*

Date: 26 February 2014; Ref: [2014] UKSC 13

48. There have been very few rulings on private nuisance at Supreme Court level. Conflicting Court of Appeal judgments over recent years have created uncertainty for land owners, developers and planners. A particular issue has been how the grant of statutory authority, for example a planning permission or environmental permit, to undertake the activity complained of affects the decision as to whether a nuisance exists.

49. This is therefore highly significant. In the Judgment the Supreme Court examines a number of key issues. These include whether a right to commit a noise nuisance can arise by way of prescription, the extent to which the grant of planning permission can affect whether a nuisance exists and is relevant to the determination of the character of the locality, and also the approach to be followed by the lower courts in deciding whether to grant damages instead of an injunction.

b) *Pauline Forster v Secretary of State for Communities and Local Government & Tower Hamlets London Borough Council, Swan Housing Association Limited*

Date: 29 June 2016; Ref: [2016] EWCA Civ 609

50. This Court of Appeal judgment about allowing dwellings near to a live music venue raises issues about developing near to an existing noise source, nuisance/licensing and closing windows to achieve reasonable noise levels. It is a useful reminder that the effects of the appeal proposal on an existing use that is a source of noise can be a material consideration that will need to be adequately addressed in the decision. It is no defence under nuisance proceedings that the complainant came to the nuisance. The third bullet of NPPF paragraph 123 states that planning policies and decisions should aim to recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established.

51. The Court of Appeal found the High Court judge to have erred in holding that if residents of the flats were not going to be subjected to unreasonable noise levels it would follow that those residents would not be likely to complain about the noise. It was held that humanity being what it is, people are liable to complain about anything, and the question is whether there is any objective possibility of quantifying the likely prospects of success of such complaints [it is relevant to note that LPAs should not presume that licence conditions will provide for noise management in all instances].

52. Lord McFarlane LJ raised the possible significance of the fact that the Inspector's conclusion on noise proceeded on the implicit basis that the windows of the flats would be closed. He commented that residents would be likely to open their windows in fine weather (or would wish to do so), and if they did, increased levels of noise from the music venue might fuel complaints. The Court of Appeal found that any point about noise and open windows was a matter to be taken into account in deciding whether noise levels would be acceptable.

c) *Stoke Poges Parish Council v SSCLG and Secretary of State for Education, South Buckinghamshire DC and Slough Sikh Education Trust Limited*

Date: 15 July 2016; Ref: [2016] EWHC 1772 (Admin)

53. This High Court judgment offers a reminder that British Standards and WHO Guidelines were not drafted with the same objectives as planning policy nor intended to have the same formal role and effect as development plan policies. In the context of national policy they do not set any specific standards and are clearly a matter of judgement for the decision maker, but they need to be understood sufficiently to enable them to be taken into account correctly.

54. It is also a reminder that a condition which secured noise levels at the boundary of the appeal site to 40 dBA between 0700 and 2200 and 30 dBA between 2200 and 0700 is unenforceable because it does not specify whether it applies to $L_{max,}$ $L_{90,}$ L_{eq} or something else!

Environmental Noise Control

55. Once noise levels have been measured or predicted and found to be a problem or potential problem, there are three strategies that need to be considered to enable the noise to be controlled in order to meet any required limits. These are control at source; between the source and receiver and at the receiver. These are considered in turn below:

Control at source

56. Noise reduction at source may be achieved by various methods including – control of noise by design or choice of process, e.g. choice of quieter machines or processes in industrial premises. Specific noise control measures can be

applied after machine installation e.g. vibration isolation or enclosures (full or partial). It should be noted that in a situation where there are multiple noise sources, each source needs to be identified and the most dominant located in order to ascertain priorities for noise reduction. However, it may not be the loudest noise source that should be the priority – see cumulative effects section. It may be that reducing levels of other sources will have the same effect as reducing the level of the single dominant noise source.

Between the Source and Receiver

57. Control of noise between the source and receiver can be split into two groups – active noise control and passive noise control. Active noise control is where the noise can in effect be cancelled out when another noise source is placed nearby, which is 'out of phase' with the offending noise. This interference between two sound waves is technically complex and can only be used in certain situations e.g. enclosed spaces such ventilation ducts, or in the cab of a tractor. Passive noise control techniques involve interfering with the path of the sound by use of indirect sound paths (airborne flanking paths to direct sound away); sound absorbing materials; sound barriers, e.g. walls, earth mound, acoustic fence or building to deflect or diffract the sound.

Control of Noise at the Receiver

58. This is most commonly achieved by sound insulation of buildings as windows, air bricks and doors are 'weak links' in the sound insulation of the façade of a building. Sound insulation of buildings can be achieved by various means including – use of non-porous materials, ensuring there are no flanking paths directing the sound to the receiver; use of acoustic double glazing, ventilators with sound attenuating inlet ducts, and use of secondary doors.

Noise prediction and correction factors

59. Although noise prediction is useful, it should be noted that a predicted noise level can never be as accurate as a measured one. Correction factors may need to be applied in certain situations, but care should be taken to apply the most appropriate correction factors to the noise source involved. Using the BS4142 methodology:

- background noise levels (BNL) L_{A90} are measured at noise sensitive receptors;
- noise levels from the new source(s) are predicted for the receptor location as L_{Aeq};
- noise levels are corrected (if appropriate) for duration and character[21]. The corrected noise levels are termed the rating levels and expressed in L_{Aeq};
- The rating levels are then compared with the BNLs for the area.

[21] Methodology for determination of corrections for tonal, impulsive or any other distinctive character is set out in BS4142:2014.

60. Other correction factors may need to be considered, such as those for weather and ground effects as sound levels are affected by wind, temperature gradients, the nature of the ground surface, by turbulence and air absorption (depending on temperature, frequency and humidity). These may be taken into account in the method used for the propagation of sound from the source to the receiver.

61. Other factors may be needed to be considered when assessing whether noise disturbance is likely:

- **Nature of noise** - Is the noise bland and easy to ignore? or is the noise tonal and/or information rich drawing attention to itself? e.g.
- traffic noise is easier to ignore than a crying baby;
- **Time of day or night it occurs** - One hour of disturbance is easier to tolerate at 3 pm than at 3 am;
- **Day of the week on which it occurs** - Generally people are more tolerant of noise generated during the working week, than at weekends;
- **How long it occurs for** - one minute of noise causes less disturbance than one day or one week of noise;
- **How often it occurs -** Once per year is less disturbing than once per week;
- **The character of the area in which it occurs -** city centre residents are more likely to be tolerant of 'entertainment' noise than rural residents;
- **The attitude of the observer to the noise -** People are less tolerant of noise generated by sources which they consider as undesirable in other ways.

Noise character

62. The overall character of noise can be presented in terms of sound pressure level and frequency. This can be further divided in terms of the '**spectral character of noise**' into three different types:

i) Discrete frequency noise (pure tones – generated mainly from rotating machinery);
ii) Broadband noise (random – *rumble*, *roar* or *hiss* from e.g. high-velocity nozzles from industrial sources); and

iii) Impulsive noise (impact – transient acoustical event of short duration

iv) [usually >0.5 seconds] e.g. gunshot, hand clap, stamping machine.

63. Most noise sources will take on one or more of these sub-characteristics and will therefore possess a unique acoustical signature. **Loudness** is another characteristic of sound, but is highly subjective, from person to person. Assessments and decisions should refer to noise levels not loudness.

Casework Types where Noise arises

Planning Appeals (including Minerals):

64. Wind turbines/Windfarms – onshore: noise sources in rural areas with low background levels, the characteristics of machinery and aerodynamic noise – see Annex C; offshore: noise from piling of turbine foundations, underwater noise.

65. Superstores and other retail developments - traffic noise; servicing yards; ventilation plant; hours of opening. Particular problems such as hot food takeaways and amusement centres where the effects on amenity are those of disturbance from infrequent noise events or noise in public places.

66. Warehousing/industry - noise from industrial processes; goods & material handling and transport operations. Noise levels, hours of working, layout of development, intervening uses, subsequent changes of use or intensification. Note that the emission of noise may be a factor in enforcement or lawful development cases where the effect is to cross the boundary between B1 and B2 uses.

67. Catering and leisure/entertainment - public houses, restaurants, wine bars and clubs - control over hours of operation, duplication with licensing control, car parks and the behaviour of patrons.

68. Noisy sports – e.g. motorsports, model aircraft. Some guidance from The Sports Council. Issues include - control over duration and frequency of events, traffic and parking.

69. Petrol filling stations - hours of operation, ancillary developments such as shops and car washes - siting considerations.

70. Dogs and cats - location of catteries and kennels, character of surroundings, limited scope of planning conditions - other means of control through the law of nuisance.

71. Flat conversions - overlap with Building Regulations but residential amenity a legitimate planning concern - look at internal room arrangements critically; the location of parking provision in relation to living and bedrooms. Problem of insulation between homes created from conversion into flats may arise. Conversions could therefore exacerbate noise problems in urban areas.

72. Residential development in noisy areas but where land supply is limited - Good practice in housing layouts and mitigating measures. New residential development as an inhibition on other land uses because of prospective complaints/action over noise. Given the promotion of mixed developments as a desirable form of urban development how are resulting noise problems to be addressed?

73. Minerals - guidance in PPW and Minerals Planning Guidance on assessment and control of noise at mineral workings but there are off-site impacts such as lorry traffic. Coal stocking areas at mines and dockyards - noise from handling and transport operations.

Transport:

74. Airport/aviation development – note the limitations of planning control in dealing with aircraft noise; siting of facilities; routing of landings/departures; problems of assessment of effects from small scale developments such as flying and gliding clubs, helicopter landing pads.

75. Highways – new or substantially altered roads resulting in increase in traffic; problems associated with additional traffic noise. Assessment via CRTN.

76. Railways - new or substantially altered rail schemes[22] resulting in increase in rail traffic; problems associated with additional traffic noise and vibration. Assessment via CRN.

Environmental (IPPC/IED):

77. Industrial facilities – manufacturing, energy, chemicals/refining operations. May feature noise emitting activities within and beyond the site boundary e.g. machinery, heavy plant movements and site traffic entering/leaving facility. May require the use of acoustic barriers and activities within enclosed buildings.

78. Waste management operations – Amenity sites, Waste Transfer Stations, waste treatment and landfill operations may all feature noise emitting activities within and beyond the site boundary e.g. machinery, heavy plant movements and site traffic entering/leaving facility. May require use of acoustic barriers and activities within enclosed buildings.

79. Assessment for industrial sites under the Environmental Permitting Regime (EPR) is usually via BS4142. Guidance on Best Available Techniques (BAT), suitable noise conditions and noise assessment via BS4142 can be found in the IPPC Horizontal Guidance for Noise: part 2 – Noise Assessment and Control[23].

Casework Considerations

80. What factors influence whether noise could be a concern? The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation.

[22] Including casework involving Trolley Buses and Trams under TWA 1992.
[23] IPPC H3 (Part2) [EA, June 2004].

81. These factors include:

- the source and absolute level of the noise together with the time of day it occurs. Some types and level of noise will cause a greater adverse effect at night than if they occurred during the day – this is because people tend to be more sensitive to noise at night as they are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night;
- for a new noise making source, how the noise from it relates to the existing sound environment;
- for non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise;
- the spectral content of the noise (i.e. whether or not the noise contains particular high or low frequency content) and the general character of the noise (i.e. whether or not the noise contains particular tonal characteristics or other particular features), and;
- the local arrangement of buildings, surfaces and green infrastructure, and the extent to which it reflects or absorbs noise.

82. More specific factors to consider when relevant include:

- The cumulative impacts of more than one source of noise;
- Whether any adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time (and the effect this may have on living conditions). In both cases a suitable alternative means of ventilation is likely to be necessary;
- In cases where existing noise sensitive locations already experience high noise levels, a development that is expected to cause even a small increase in the overall noise level may result in a significant adverse effect occurring even though little to no change in behaviour would be likely to occur;
- Noise Action Plans (where these exist), and, in particular the Important Areas identified through the process associated with the Environmental Noise Directive and corresponding regulations should be taken into account. Local authority environmental health departments will also be able to provide information about Important Areas;
- The effect of noise on wildlife. Noise can adversely affect wildlife and ecosystems. Particular consideration should be given to noisy development affecting designated sites;
- Where external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended; and
- Some commercial developments including fast food restaurants, night clubs and public houses can have particular impacts, not least because activities are often at their peak in the evening and late at night. Local planning authorities will wish to bear in mind not only the noise that is

generated within the premises but also the noise that may be made by customers in the vicinity.

- When proposed developments could include activities that would be covered by the licensing regime, local planning authorities should consider whether the potential for adverse noise impacts will be addressed through licensing controls. Local planning authorities should not however presume that licence conditions will provide for noise management in all instances and should liaise with the licensing authority.

83. **Health & quality of life** – The World Health Organisation (WHO) defines health as a 'as state of complete physical, mental and social well-being and not merely the absence of disease or infirmity', and recognises that the enjoyment of the highest attainable standard of health as one of the fundamental rights of every human being. In the NPSE, there is a distinction between 'quality of life' defined as 'the subjective measure that refers to people's emotional, social and physical well-being' and 'health', which refers to physical and mental well-being. It is important to note this distinction in the NPSE.

84. Exposure to noise can cause annoyance and sleep disturbance, which affects quality of life and can cause impacts on health. The distinction made between 'quality of life' and 'health' recognises that evidence suggests that long term exposure to some types of transport noise may cause an increased risk of direct health effects. Research on the long-term health effects of noise exposure is ongoing.

85. **NPSE Effects Levels** – Two established toxicology concepts applied to noise impacts are:

- **No observed effect level (NOEL)**: this is the level of noise exposure below which no effect at all on health or quality of life can be detected.
- **Lowest observed adverse effect level (LOEL)**: this is the level of noise exposure above which adverse effects on health and quality of life can be detected.

86. These concepts have been extended in the NPSE to:

- **Significant observed adverse effect level (SOAEL)**: This is the level of noise exposure above which significant adverse effects on health and quality of life occur.

87. SOAEL is likely to be different for different noise sources, for different receptors and at differing times. Further research will be required to increase understanding of what may constitute significant impact on health and quality of life from noise.

88. **Noise effects on wildlife/habitats/countryside** – the effect of noise on wildlife and ecosystems is a factor that may need to be taken into account in certain proposals, particularly when potentially noisy development may affect

'designated sites'. A Defra commissioned report[24] concluded that a strong evidence base does not exist regarding the potential impact of anthropogenic noise on non-marine UK protected species (PS) and species of principal importance (SPI). However, the study showed that it is likely that birds, bats and amphibian behaviour are affected by road traffic noise, but there is more work to be done in this area to confirm these effects.

89. Consideration must be given where potentially noisy development is proposed in or near SSSIs or any other 'protected areas' – National Parks, AONBs and Heritage Coasts, where noise would affect the quiet and tranquil enjoyment of these areas. Noisy development may also have a serious effect on the welfare of livestock on nearby farms. When considering proposals which could affect livestock, Inspectors should be satisfied that appropriate consultation with Defra has been carried out.

90. **Road Traffic** – road traffic noise predictions usually depend on the accuracy/precision of the underlying transport assessment. The use of suitable topographic data is also important. Planning techniques can be employed to mitigate road traffic noise (assessed using the CRTN methodology incorporated into modelling software, which can also assist in mitigation design), such as separation, traffic management, the use of barriers and design/insulation of buildings. The effectiveness of noise barriers or earth bunds depends on many factors including the precise geometry such as barrier height, source and receiver height, distance between the source and receiver, the distance between the source and the barrier and between the receiver and the barrier[25]. Reductions of up to 1215 dB(A) can be achieved if the barriers are sufficiently high and in the optimum position. Resurfacing the road with low noise surfaces can also achieve reductions. Other techniques include separation of vehicles from noise receptors by the use of ring roads, pedestrian only streets, limiting HGVs to designated routes; establishing minimum distances from new residential development to traffic flows of prescribed volumes. Speed and volume restrictions, encouragement of traffic restraint and the use of public transport can also bring about improvements in the urban noise environment. Some of these techniques could be implemented by the use of conditions.

91. **Air Conditioning Units & Kitchen Exhausts** – control of noise from A/C[26] and exhaust[27] equipment will be needed in particular for densely populated areas where there are large numbers of business, commercial and entertainment premises and assessed by using the methodology in BS4142:2014 + A1: 2019. Air conditioners should ideally not be located adjacent to residential windows, bedrooms or living areas and should not be located near multiple reflective

[24] The effects on noise on biodiversity (NO0235) – final report for Defra, 2012.

[25] Mitigation techniques are covered in HD/213/11 in Part 7, Section 3 Volume 11 of the DMRB. Design for Environmental Barriers is covered in HA/65/94 in Part 1, Section 5 of Volume 10 of the DMRB.

[26] Originating from the hum of the fan, rattling/vibration of the case or internal parts, shaking/rattling of the glass/frame where the unit is installed.

[27] Originating from high air velocities through the extraction hood/grille/supply ductwork, fan motor noise and high extract/intake air velocities from the extraction/supply discharge point.

surfaces (e.g. walls and eaves) as noise will be reflected onto nearby properties. Acoustic barriers and enclosures can be used to mitigate noise from A/C units. With regard to kitchen exhausts, noise mitigation can be achieved by use of good design practice, e.g. have low turbulence ducts and fittings or locate high velocity ducts in non-critical areas; use quieter fans; use of sound absorbing lagging around ducts, duct silencers or sound plenums in supply and return air ducts; location of equipment rooms in non-critical areas[28]. Additionally, opening times of commercial and business premises could be restricted so that that it is not operational late at night. Some of these techniques can be implemented by the use of conditions.

92. **Entertainment/Leisure venues** – could include premises such as public houses, night clubs, leisure centres, town or village halls, club pavilions, outdoor festival sites, outdoor concert arenas. Noise problems may result from use of amplified music, crowd noise (both inside and outside the venue), A/C units or other mechanical equipment and traffic noise. Noise may be mitigated by use of restricted opening hours, altering the orientation of the building and therefore the relationship with receptors, use of good design e.g. internal layout:

- buffering of hall with ancillary rooms,
- sound insulation of premises including roof structure,
- acoustic lobbies – internal or external,
- use of windows and doors,
- ventilation/air conditioning,
- positioning and mounting of amplification equipment,
- partial containment of external areas (in particular smoking areas),
- use of noise limits/noise limiter (this may not be practical).

93. 6.14 The Good Practice Guide on the Control of Noise from Pubs and Clubs[29] contains useful advice in the absence of robust noise limits for entertainment, often referred to by practitioners:

- The $L_{Aeq\ 5minute}$ level measured 1m outside a window to a habitable room, with entertainment taking place, shall show no increase when compared with the representative $L_{Aeq\ 5minute}$ measured from the same position, under the same conditions and during a comparable period with no entertainment taking place and;
- The $L_{Aeq\ 5minute}$ level in the 63Hz and 125Hz octave bands measured 1m outside a window to a habitable room, with entertainment taking place, shall show no increase when compared with the representative $L_{Aeq\ 5minute}$ level in the 63Hz and 125Hz octave bands measured from the same position…

[28] Further information can be found in the Guidance on the Control of Odour and Noise from Kitchen Exhaust Systems, Defra, Jan 2005.

[29] Good Practice Guide on the Control of Noise from Pubs and Clubs, IoA, March 2003. The Noise Council produced a Code of Practice on Environmental Noise Control at Concerts in 1995, which sets out suggested limits and restrictions for events.

94. It should be noted that some noise controls may be imposed by the Local Council post planning permission via the licensing regime under the Licensing Act 2003.

95. **Motor sports/Model Aircraft** – includes any vehicular racing (cars, motorbikes, trucks), which can cause high noise levels and disturbance to nearby residents not only from the activity itself, but from crowd noise and traffic. Also included is model aircraft, which creates noise and can often be located near to residential areas. Statutory nuisance controls under the Environmental Protection Act 1990 and Control of Pollution Act 1974 can be applied to these activities. Noise from these events can be controlled by the use of the following mitigation techniques – siting of the venue away from noise sensitive areas, use of noise barriers around the site, use of existing topographical features between site and noise sensitive receptors when choosing site, restriction of hours when activity is allowed, use of mufflers on engines to reduce noise emission from vehicles. Additionally, for model aircraft[30] a restriction in amount of aircraft flown simultaneously can help reduce noise emissions. Some of these measures can be implemented by the use of conditions.

96. **Human Rights/PSED** – Under the ECHR, certain protocols can be applied in relation to noise disturbance. Article 8 – the right to respect for private and family life in *Hatton vs. UK (2003); 37 EHHR 28*, paragraph 96 of the judgment stated "There is no explicit right in the convention to a … quiet environment, but where an individual is directly and seriously affected by noise … an issue may arise under Article 8…". Article 1 of Protocol 1 – the protection of property has also been the subject of a judgment in *Thomas & Ors v Bridgend County BC [2011] EWCA Civ 862*, where the claimant argued that noise from a road was a breach of Article 1 by interfering with the peaceful enjoyment of possessions (i.e. the claimant's house) and they should be entitled to compensation, the Judge concluded that as there was no compensation offered, that was a breach of Article 1.

97. With regard to the general requirement under the Public Service Equality Duty, decision makers need to take into account the potential effect of noise from a proposed development or activity and if any discrimination may arise from the effect on noise receptors. Further guidance on Human Rights and PSED can be found in the corresponding ITM Chapter.

98. **Underwater noise** – From piling (for construction of offshore wind turbines/windfarm[31], other offshore development); harbour works/operations, other coastal works where noise may be an issue. The National Physical

[30] Further guidance can be found in the Code of Practice on Noise from Model Aircraft, DoE 1982.

[31] The Offshore Renewables Joint Industry Programme (ORJIP) have commissioned a project to investigate acoustic disturbance of the marine environment from underwater noise and mitigation technologies for piled foundations. Vattenfall (a Swedish Energy Company) is taking forward the research project on underwater noise effects. The EC published the final report MaRVEN – Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewables in Sept 2015, which concluded that there are likely to be some effects on marine wildlife, in particular those that use sound as primary mode of communication, but there are many questions that remain.

Laboratory published a guide[32] for underwater noise measurement, which provides guidance on in-situ measurement of underwater sound, processing the data and for reporting the measurements using the appropriate metrics.

99. **Underground noise** – from underground road/rail development, e.g. Crossrail, mining and drilling operations, basement conversions and additions (in London particularly). Methodology outlined in BS5228 should be used for noise prediction and the assessment of effects applied using that set out in the NPSE. This should be set out in more detail in the Local Authorities 'Construction and Demolition Code of Practice'. Where rail is concerned methodology set out in the appropriate WebTAG and where road proposals arise the DMRB guidance should be used.

Example decisions

Planning casework:

100. **APP/A3010/W/15/3131556** – S78 Appeal against refusal to grant planning consent for proposed new dog kennels and associated COU to operate dog boarding kennels. The main issue in this case was effect on living conditions of neighbouring occupiers with regard to noise and odour, in particular noise form dogs barking, vehicles and pedestrians visiting the site, which is within a rural village. The appellant submitted a noise assessment, to take account of background noise (but only for 2hrs) in the daytime on one day only, not in the evenings or weekend, when disturbance is more likely. Noise emission levels were based on the Councils SPD (which had not been adopted by the Council and is not part of any national guidance); there was no assessment under BS 4142:2014, enabling effects on people to be fully assessed. The appellant intended to erect acoustic fencing and insulation, but without adequate noise assessment, their effectiveness could not be assessed. Inspector concluded that the evidence fails to demonstrate that the proposal would not cause harm to living conditions of the neighbours; the appeal was dismissed.

Enforcement casework:

101. **APP/H5390/C/15/3124727** – S174 Appeal against breach of planning control [non-compliance with conditions on previous permission – in accordance with approved drawings (cond. 2) and audibility of amplified sound emitted from commercial part of the building (cond. 6)] – development was COU to fitness studio with ancillary retail use. One of the main issues related to noise and vibration disturbance on the neighbouring occupiers, following complaints made to the Council. Remedial measures were undertaken by the appellant, including additional insulation, noise management plan and use of a sound limiter during certain classes, set to 81 dB(A) which appeared to resolve the issues. As the Council refused to withdraw the Notice in case of future problems, it was agreed that condition 2 be withdrawn and condition 6 be altered to include maintenance

[32] NPL Good Practice Guide No. 133 – Underwater Noise Measurement, NPL, 2014

of the remedial measures on the proviso that if these were not adhered to the use of the premises as fitness studio (for certain activities) should stop. The appeal was allowed, the notice quashed, and planning permission to include new condition 6.

Transport casework:

102. **DPI/H5960/13/21 – TWA Application for Line Extension Order by London Underground**, (LPA - LB Wandsworth). Application for the construction and operation of 3.2km extension to Charing Cross Branch of the Northern Line (NLE) from Kennington to a new station at the site of the disused Battersea Power Station. Noise and vibration impacts of the NLE during construction and operation were a major issue in this case. The Inspector recommended and the SoS agreed that the noise levels experienced from the operation of trains on the NLE would be below the NOEL and therefore acceptable; there should be no effect in terms of vibration (IR 8.79, 9.15). During construction the effects would be intrusive (even with BPM), but taking into account the controls that would be in place e.g. Code of Construction Practice (CoCP) and proposed planning conditions, the residual impacts would be acceptable (IR 8.94, 9.13-14).

103. **DPI/W2275/10/05** – **Multiple Trunk Road Orders & Detrunking Order, Side Road Order, Slip Road Order and Compulsory Purchase Order** for A21 Improvements Scheme (Tonbridge to Pembury) under the Highways Act 1980 and Acquisition of Land Act 1981. Various objections were raised in relation to increase in noise levels – Inspector concluded that most objections were unfounded. The scheme includes various acoustic barriers and use of low noise road surfacing to mitigate noise at sensitive receptors.

104. **DPI/U3100/10/12** – **TWA Rail Improvement Order and Exchange Land Certificate**, Chiltern Railways (Bicester – Oxford Improvements). Application under TWA 1992 for Chiltern Railways (Bicester to Oxford Improvements) Order made under s1 & 5 of the Act; a direction for deemed planning permission for development in the Order issued under s90(2A) of the 1990 Act. Issues concerning noise and vibration were raised – Inspector concluded (SoS agreed) that the scheme would have acceptable effect on local residents, providing the Code of Construction Practice was followed and appropriate Noise and Vibration mitigation used – this was secured by condition.

Minerals casework:

105. **APP/H090/A/13/2201261 & 2201262** – s78 appeals by Tarmac Ltd against **refusal of planning permission for extraction of sand and gravel without complying with condition on previous permission; additional soil storage bund without complying with previous condition**. Noise and vibration from filling of trucks, revving of vehicles and use of heavy plant (for screening/crushing) affecting residents was a major issue. An ES noted that the topography and vegetation in the area provides acoustic screening and noise

mitigation. The Minerals PPG seeks to ensure that noise from minerals sites at sensitive sites does not exceed 55dB(A) or +10dB(A) more than background during 07.00-19.00hrs, but allows up to 70dB(A) for eight weeks a year (for particularly noisy short-term activities such as soil stripping or removal of soil storage mounds). The Inspector imposed noise conditions and restricted hours of operation as agreed at the inquiry.

DNS / National Infrastructure casework:

106. **TR010002** – **DCO application under s37 of the Planning Act 2008** for proposed A556 (Knutsford to Bowden Improvement) DCO. Order granting construction of 7.5km improvement of the A556 trunk road between M6 Junction 19 nr Knutsford and the M56 Junction 7 nr Bowden, Greater Manchester. The examining Inspector recommended the order be grated, SoS for Transport agreed – Development Consent Order granted. Main issues – Noise and vibration impacts, air quality and emissions, alternative schemes, biodiversity impacts, flood risk, water quality and resources, dust, pollutants and lighting and other impacts. Noise impacts were assessed as in the short and longer term there will be a perceptible increase in noise for a number of nearby dwellings, but with the substantial mitigation measures proposed the project would see a net benefit in terms of operational noise.

Annex A: Noise Concepts/Terminology

A.1 This part of the chapter builds on the concepts outlined in the introduction and refers to terminology that Inspectors are most likely to encounter in casework where noise is an issue.

Basic Concepts:

Sound Pressure Level (SPL)

A.2 Sound pressure level (SPL), sometimes referred to as acoustic pressure level, is a logarithmic measure of the effective pressure of a sound relative to a reference value. The commonly used reference for sound pressure in air is the threshold of human hearing.

Sound Power Level (SWL)

A.3 Sound power level (SWL), sometimes referred to as acoustic power level, is a logarithmic measure of the power of a sound relative to a reference value. Again, the commonly used reference for sound power is the threshold of human hearing.

Sound energy

A.4 Sound energy is a form of energy associated with the vibration of matter. The standard unit of sound energy is the joule (J).

Noise units (decibels/dB)

A.5 The decibel (dB), i.e. a tenth of a Bel is a unit of measurement of the magnitude of sound, changes in sound level, and a measure of sound insulation, which is an expression of the ratio between two quantities expressed (more conveniently) in logarithmic (log) form. One of these values is often a standard reference value, in which case the decibel is used to express the level of the other value relative to this reference.

A.6 The unit is most readily recognised as a unit of sound pressure level (dB_{SPL}) in the realm of acoustics. In this context, dB_{SPL} reference sound pressure as a field quantity, using the reference pressure in air (at standard atmospheric pressure) at the typical threshold of perception of an average human. The *number* of dB is ten times the logarithm to base 10 of the ratio of the squares of two field amplitude quantities. The lower limit of audibility is defined as SPL of 0 dB, the guide for the upper limit often used is 140 dB for threshold of pain – see table below. A 1 dB change in level is very small and would not be noticed; a 3 dB change would generally just be noticeable and a 10 dB increase would be large and would be a doubling in loudness.

A.7 Decibel Range (SPL):

0 dB	Threshold of hearing
10 dB	Leaves rustling
20 dB	Night-time quiet bedroom
40 dB	Daytime living room / refrigerator humming
60 dB	Speech level
70 dB	Toilet flushing
80 dB	Levels near busy road / vacuum cleaner
85 dB	City traffic inside car
90 dB	Noisy office
100 dB	Nightclub
110 dB	Chain saw / baby crying
120 dB	Threshold of feeling
115 db	Rock concert
120 dB	Pneumatic drill / ambulance siren / thunder
140 dB	Threshold of pain / Fireworks
180 dB	Aircraft at take off

Period

A.8 In the context of acoustics, a signal that repeats the same pattern over time is called periodic, and the period is defined as the length of time encompassed by one cycle, or repetition.

Frequency/Frequency Band

A.9 A frequency represents the number of times that a periodic function or vibration occurs or repeats itself in a specified time, often 1 second - cycles per second. It is usually measured in Hertz (Hz). A frequency band is a continuous range of frequencies between two limiting frequencies. Low frequency sound is considered in the range 10-150Hz[33], propagated by travelling through materials, even low levels can travel large distances and at the lower end of the frequency range are felt as low resonances akin to vibration. Sources of low frequency sound are typically industrial, e.g. pumps, boilers, amplified music, transport or can be natural, e.g. wind, thunder, ground movements. High Frequency sound is considered in the range 5kHz–20kHz[34], propagated by travelling through air, heard as high pitched sounds, from which exposure to high levels for prolonged periods can cause tinnitus or even hearing loss. Sources of high frequency sound can be industrial e.g. pneumatic tools, grinders, drills, machines or other sources such as alarms, aircraft engines and increasingly at the higher end of the frequency range electronic equipment.

[33] Frequencies below 20Hz are also referred to as infrasound.

[34] Frequencies above 20kHz are also referred to as ultrasound.

Octave bands

A.10 The whole frequency range is divided into a set of frequencies called bands. Each band covers a specific range of frequencies. A frequency is said to be an octave in width when the upper band frequency is twice the lower band frequency.

A.11 Sound Pressure Level is often measured in octave bands. A one-third octave band is defined as a frequency band whose upper band-edge frequency (f2) is the lower band frequency (f1) times the cube root of two, is employed by arithmetically adding a table of values, listed by octave or third-octave bands, to the measured sound pressure levels in decibels (dB).

Wavelength

A.12 Wavelength is defined as the distance between repeating units of a sound wave.

Noise Rating Curves

A.13 Noise rating curves (NR) were developed by the International Standards Organization (ISO) to determine acceptable levels for the indoor environment. The NR Curves range from 0 to 130 – the NR level for different uses should not exceed the recommended Noise Ratings e.g. NR30 for private dwellings, hospitals, theatres, cinemas, conference rooms, through to NR70 for heavy engineering works or foundries. These are often used in the measurement of noise from mechanical sources such as air conditioning units in hotels, schools of other buildings. The SPL readings (in dB) taken at various frequencies (in Hz) can be plotted on to an NR curve – the overall NR value is the highest of the individual NR values over all the frequency bands, which corresponds to the value of that particular space/room.

A.14 Noise rating (NR) curves ensure that the sound is within a known level for each frequency band. Each curve is named after its respective value at 1kHz. As NR curves define limits at different frequencies, this enables the noise character to be defined or controlled. For example, a SPL of 30 dB L_{AEQ} may have the majority of its sound energy at 63Hz, or 125Hz or any other frequency. NR curves are usually applied to 1/3 octave band levels but can be applied to other parameters such as L_{eq}, L_{90}, L_{10} & L_{max}. It should be noted that there is no direct relationship between dB(A) and NR curves. However, Annex B to BS8233:2014 states that there is an approximate relationship (in the absence of strong low frequency noise) of NR = dB(A) -6.

A.15 To determine the NR level, the sound level in each frequency band is compared to the values in the NR tables[35] for the corresponding frequency. The NR curve number which applies to each frequency band is the highest numerical value not exceeded in that band. The NR provides a weighted indication of measured noise which can then be used to determine acceptable

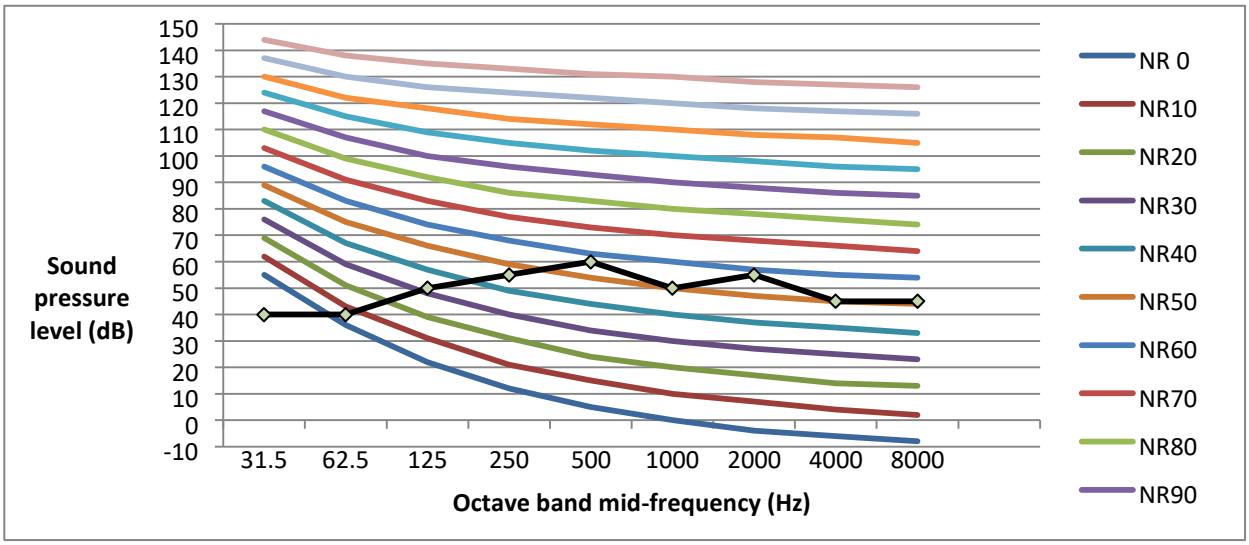
[35] See pp71-73 of The Little Red Book of Acoustics – A Practical Guide, [R Watson/O Downey, 3rd Edition 2013, Blue Tree Acoustics].

noise levels in various environments e.g. NR 30-35 is a target level for dwellings.

A.16 In the chart below, a noise source is represented by a number of sample sound pressure level (SPL) for each frequency band. These are then plotted are plotted against a series of noise rating curves (the sample measurements are illustrated with a black line and diamond points):

Octave mid-band frequency (Hz)	SPL = Sound pressure level (dB)
31.5	40
62.5	40
125	50
250	55
500	60
1000	50
2000	55
4000	45
8000	45

A.17 When plotted against the noise rating curves, these give a NR value of approximately 58[36]. The NR value is the highest of the individual SPL measurements in relation to the values of the NR curves:



Octave band Mid Frequency (Hz)

[36] Derived from the 7th plotted point as the highest individual NR value corresponding to the NR in the table below (from ISO/R 1996:1971, replaced by ISO 1996-2:2017).

NR	63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	8000.0
NR70	90.80	82.90	77.10	73.00	70.00	67.50	65.70	64.10
NR69	90.00	82.00	76.20	72.00	69.00	66.50	64.70	63.10
NR68	89.20	81.10	75.20	71.00	68.00	65.50	63.60	62.00
NR67	88.40	80.30	74.30	70.10	67.00	64.50	62.60	61.00
NR66	87.60	79.40	73.30	69.10	66.00	63.50	61.50	59.90
NR65	86.80	78.50	72.40	68.10	65.00	62.50	60.50	58.90
NR64	86.00	77.60	71.50	67.10	64.00	61.50	59.50	57.90
NR63	85.20	76.80	70.60	66.10	63.00	60.50	58.50	56.90
NR62	84.50	75.90	69.60	65.20	62.00	59.40	57.40	55.80
NR61	83.70	75.10	68.70	64.20	61.00	58.40	56.40	54.80
NR60	82.90	74.20	67.80	63.20	60.00	57.40	55.40	53.80
NR59	82.10	73.30	66.90	62.20	59.00	56.40	54.40	52.80
NR58	81.30	72.40	65.90	61.30	58.00	55.40	53.40	51.70
NR57	80.50	71.60	65.00	60.30	57.00	54.30	52.30	50.70
NR56	79.70	70.70	64.00	59.40	56.00	53.30	51.30	49.60
NR55	78.90	69.80	63.10	58.40	55.00	52.30	50.30	48.60
NR54	78.10	68.90	62.20	57.40	54.00	51.30	49.30	47.60
NR53	77.30	68.10	61.30	56.40	53.00	50.30	48.30	46.60
NR52	76.60	67.20	60.30	55.50	52.00	49.20	47.20	45.50
NR51	75.80	66.40	59.40	54.50	51.00	48.20	46.20	44.50
NR50	75.00	65.50	58.50	53.50	50.00	47.20	45.20	43.50

Background Noise/Sound Level

A.18 Defined as any sound other than the sound being monitored (primary sound). Also known as ambient noise level; residual noise or reference sound level. The background sound level is the underlying level of sound over a given period, T, and may be used as an indication of relative quietness at a given location. These sound levels are characterized by continuous or semi-continuous sounds, e.g. waves, traffic, mechanical noise from power supplies, A/C units, white goods; talking and other bio-acoustic noise from animals and birds.

A.19 The background noise level is the threshold below which, the time varying community noise level seldom drops. Studies have shown that the background noise level in areas not directly exposed to a major noise source seems to be proportional to the population density and linked to distribution of road traffic[37].

[37] Background noise levels in Europe, SINTEF Report No A6631, June 2008.

Rural areas have a relatively low level of background noise, and therefore may be subject to more disturbance from intrusive noise. Methodology for the determination of background sound level, $L_{A90,\ T}$ can be found in Chapter 8 of BS4142:2014+A1:2019, where it is defined as the '*A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of the given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels'*. In general, background sound levels **exceeded by more than 5dB** may cause disturbance at noise sensitive receptors.

Vibration

A.20 Defined as the oscillation of an object about a reference point, the number of these oscillations per second gives the frequency of vibration in Hertz (Hz). Sound can be detected by hearing, whereas vibration can be felt as it is transmitted through solid structures directly to the human body. Similar to sound, vibration is usually characterized by a number of different frequencies occurring simultaneously, e.g. different parts of a machine will vibrate at different frequencies[38]. Vibration may be continuous or intermittent. Sources of vibration include steel presses or other machinery, road and rail traffic and blasting (for mineral extraction or demolition).

A.21 An object can vibrate in two ways: free vibration and forced vibration. Free vibration occurs when an object or structure is displaced or impacted and then allowed to oscillate naturally. For example, when you strike a tuning fork, it rings and eventually dies down. Forced vibration occurs when a structure vibrates because an altering force (or power) is applied. Rotating or alternating motion can force an object to vibrate at unnatural frequencies. Forced vibration at or near an object's natural frequency causes energy inside the structure to build, i.e. the structure will start to 'resonate'. Over time the vibration can become quite large even though the input forced vibration is very small.

A.22 A particle may vibrate along one of three axes (vertical, longitudinal and transverse), but will often vibrate in all three axes simultaneously. When measuring peak vibration levels, the highest level in any of the axes may be used and sometimes the resultant is used. But the resultant level can be difficult to measure as the three axes may not vibrate in phase with each other.

A.23 Vibration can be expressed in metric units (m/s^2) or units of gravitational constant "g," where 1 g = 9.81 m/s^2. The vibration in each axis can be quantified using three parameters:

- Acceleration – the rate change of velocity over time (in ms^{-2} or mms^{-2});
- Velocity – the rate at which displacement varies with time (in ms^{-1} or mms^{-1}); and

[38] The human perception range for vibration (1-80Hz) is far less than for sound (20-20,00Hz).

- Displacement (or amplitude) – the distance (in m or mm) moved from the fixed reference point.

A.24 Vibration is often caused by airborne sound waves in both audible and subsonic ranges. For example, complaints from blasting at quarries are often not related to ground-borne vibration, but are from shaking windows or ornaments, induced by the air pressure wave from the blast. For blasting in quarries maximum peak particle velocity is often set as a limit in planning conditions. For example, a maximum peak particle velocity of 6 mms^{-1} for inhabited buildings and 18 mms^{-1} for uninhabited buildings. Humans can feel blast that result in vibrations down to 1.5 mms^{-1}.

A.25 Part 2 of BS5228: 2009+A1:2014 gives recommendations for basic methods of vibration control in relation to construction and open sites. The Standard also describes the legislative background to control of vibration and provides guidance on methods for measuring vibration and assessment of its environmental effects.

Vibration dose value (VDV)

A.26 Vibration dose value (VDV) is a cumulative measurement of the vibration level received (as in the measured magnitude of vibration and the length of time for which it occurs) over an 8-hour or 16-hour period. VDV can be considered to be the magnitude of a one-second duration of vibration which will be equally severe to the measured vibration. Calculation of VDV includes duration weighting, giving greater weight to occasional peaks in the level. After a vibration has been weighted for frequency, direction, duration, and magnitude, a value for the overall VDV is obtained. Vibration may vary and in many cases be intermittent. If the vibration level is 'steady' then shorter measurements of the acceleration may be used in the calculating formulae.

A.27 VDV is the standard methodology for determination of vibration levels, and will usually be encountered in the context of measurements from buildings adjacent to proposed developments. VDV limits are derived from BS 6472 (see paragraph 2.49 above) which sets out detailed guidance on human response to vibration in buildings.

Acoustic parameters and descriptors:

A-weighting

A.28 A-weighting is the most commonly used of a family of curves defined in the international standard sound level meter performance IEC 61672:2003 and various national standards relating to the measurement of Sound Pressure Level. A-weighted values are obtained by arithmetically adding a table of values, listed by octave or third-octave bands, to the measured Sound Pressure Levels in decibels (dB).

A.29 A-weighting is applied to instrument-measured sound levels in an effort to account for the relative loudness perceived by the human ear, as the ear is less sensitive to low audio frequencies. However, although A-weighting was

originally intended for the measurement of such low-level sounds, it is now commonly used for the measurement of environmental noise and industrial noise.

Acoustic Indicators

A.30 Many units and indicators have been developed for the purposes of characterising one or more attributes of environmental sound. Some indicators in common use include:

$L_{Amax,F}$ / $L_{Amax,S}$	The A weighted maximum sound pressure level during the event or measurement period. F for fast and S for slow, which varies the length of time the sound meter captures the noise energy.
$L_{A10,T}$	The A weighted sound pressure level exceeded for 10% of the measurement period, T. This indicator provides a measure of the higher sound pressure levels that occur during the measurement period. In particular, it is used when assessing certain aspects of road traffic noise. In describing this level, it is good practice to include the measurement period e.g. $L_{10\ 24\ hour}$.
$L_{Aeq,T}$	The equivalent continuous A weighted sound pressure level which contains the same sound energy in the period, T, as the actual (usually varying) sound over the same time period. L_{eq} is the Sound Pressure Level in decibels (dB), equivalent to the total Sound Energy over a given period of time. This indicator describes the average sound energy but with a bias towards the noisier events that occur during the measurement period. For sources that comprise identical specific events, the $L_{Aeq,T}$ will increase by 3 dB(A) if: • the source level increases by 3 dB(A); or • the number of events double; or • if the duration of each event doubles in length. $L_{Aeq,T}$ is often used in many areas of environmental noise assessment.
$L_{A90,T}$	The A weighted sound pressure level exceeded for 90% of the measurement period, T. This indicator provides a measure of the lower sound pressure levels that occur during the measurement period. It is sometimes defined as the background noise level. It is again good practice to include the measurement period when describing this level. This descriptor excludes noise events of short duration such as a passing vehicle.

L_{An}	L_{An} is the noise level exceeded for n% of the measurement period, A-weighted, and calculated by statistical analysis - where n is between 0.01% and 99.99%.

Sound Exposure Level (SEL)

A.31 SEL is the logarithmic measure of the A-weighted, Sound Pressure Level squared and integrated over a stated period of time or event, relative to a reference sound pressure value. The measurement units are decibels (dB).

Sound Behaviour:

Diffraction

A.32 Diffraction occurs when a sound wave encounters interference, in the form of an obstacle or an opening comparable in size to its wavelength. Depending on the size of the object and the wavelength of the sound, the sound wave bends or diffuses around the object and the diffraction or interference is significant. Similarly when sound waves pass through a gap it spreads out depending on the gap size and the wavelength. Low frequency noise is diffracted more than high frequency noise.

Reflection

A.33 Reflection represents the change in direction of a sound wave upon contact with a surface or medium so that the sound wave returns into the medium from which it originated. An echo is a reflection of sound returning with sufficient magnitude and delay so as to be perceived by its originator.

Diffusion

A.34 Sound diffusion occurs where a sound wave reflects or scatters from a surface. Diffusion may change the sound so that perception of its location or source becomes more difficult, or make it appear to originate from a number of directions simultaneously.

Absorption

A.35 Sound absorption occurs where a sound wave affects the boundary of a material which has the propensity to convert sound energy to another medium (generally heat).

Refraction

A.36 Refraction represents the bending of a sound wave from its original path, either because it is passing from one medium to another with different velocities or by

changes in the physical properties of the medium, for example, a rise in temperature or a change in wind speed in the air.

Annex B: Noise Conditions

Introduction

B.1 As with any other conditions, noise conditions need to adhere to the tests referred to in WGC 016/2014. In particular noise conditions need to be **precise** and **enforceable**. Considerations when drafting or assessing suggested noise conditions include:

i) General Considerations:

- If a noise limit is proposed is it achievable?
- Does a single measured exceedance of a limit constitute a breach?
- What happens in the event of non-compliance?
- If works are required, are they proportionate to the development?
- If restrictions to operations are necessitated would the operation become unprofitable?
- If conditions necessary to protect amenity are such as to warrant the continued operation untenable, should permission for the proposal have been granted?

ii) Particular Considerations:

- Is a noise limit condition essential or can practical measures avoid this need?
- Who is responsible for assessment – can they access the compliance point(s)?
- Can the measurement be made – is the required level too low? what are the potential interferences?
- Does treatment of interferences need to be included e.g. weather, birdsong? Or does the methodology incorporate standard procedures to deal with such matter as in BS 4142?
- How onerous are the monitoring requirements – will they be prohibitive?
- Is the methodology clear? Uncertain interpretation may effect expedience.
- Is the methodology contained in a BS, ISO or other standard? If so, specify the year and do not allow inclusion of 'successors'.

B.2 WG Circular 016/2014 'The use of planning conditions for development management' contains various conditions related to noise issues and can be used as a starting point to consider and amend, if appropriate, to the particular circumstances of the case. Conditions should not of course come as a surprise to the parties. Special care is necessary to ensure that the appropriate noise indices/descriptors are properly used. The suggested noise planning conditions are reproduced below for convenience:

Noise – music restriction (20) –

Amplified or other music may only be played in the premises between the following hours: [1100 - Midnight] Mondays – Fridays; [1100] Saturdays - [0100] Sunday mornings.

Noise – location restriction (89) –

[**] shall not take place anywhere on the site except within building(s).

- The condition should describe precisely the activities to be controlled as well as the particular building(s) in which they are to take place.

Noise – insulation of building (90) –

The building shall be [constructed/adapted] so as to provide sound insulation against internally generated noise of not less than [**] dB(A), with windows shut and other means of ventilation provided. The sound insulation works shall be completed before the use of the building begins and retained thereafter.

Noise – level of noise on the boundary (91) –

The level of noise emitted from the site shall not exceed [A] dB LAeq [X], between [1100 and 2300 Monday to Friday] and [A] dB LAeq [X], at any other time, as measured on the [specified boundary/boundaries] of the site at [location(s) of monitoring point(s)].

- Specify: A = noise level expressed as LAeq, T over a time period X (e.g. 1 hour). T = time of day.

Noise – hours of operation (92) –

No [specified machinery] shall be operated on the premises before [time in the morning] on Mondays to Fridays and [time in the morning] on Saturdays nor after [time in the evening] on Mondays to Fridays and [time in the evening] on Saturdays, or at any time on Sundays or on Bank or Public Holidays

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Noise – insulation of plant/machinery (93) –

Before [any] [specified plant and/or machinery] is used on the premises, it shall be [enclosed with sound-insulating material] [and] [mounted in a way which will minimise transmission of structure-borne sound] in accordance with a scheme that shall first have been submitted to and approved in writing by the local planning authority. The measures implemented as approved shall be retained thereafter.

- Advice should be included in the reasoning to justify the sound insulation required, or the maximum permitted noise level at a specified monitoring point

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Noise – submission of scheme & implementation (94) –

Construction work shall not take place until a scheme for protecting the proposed [noise-sensitive development] from noise from the [**] shall have been submitted to and approved in writing by the local planning authority. All works which form part of the scheme shall be completed before [any part of] the [noise sensitive development(s)] is occupied and retained thereafter.

- Reasoning should justify any guidance on the maximum noise levels to be permitted within or around the noise-sensitive development so as to provide precise guidelines for the scheme to be permitted.

Noise – hours of operation (95) –

[specified machinery] shall be operated on the premises only between the following hours: [** - **] Mondays - Fridays [** - **] Saturdays and shall not be operated at any time on Sundays or on Bank or Public Holidays.

Noise – protection of individual dwellings (96) –

The building envelope of plot no[s]. [**] shall be constructed so as to provide sound attenuation against external noise, not less than [**]dB(A), with windows shut and other means of ventilation provided. The sound attenuation works shall be completed before the dwelling[s] are occupied and be retained thereafter.

Annex C: Noise Considerations for Wind Turbines

Introduction

C.1 With the number of onshore wind turbines and the increase in size of each turbine, an increasingly common issue arising in wind turbine proposals is noise, the main types being from either the 'swish' of the blades through the air (Amplitude Modulation) or low frequency hum/vibration from the drive train or the generator in the nacelle, which is located behind the rotor hub. These two types of noise can be categorised as aerodynamic and mechanical respectively and can have potentially detrimental effects on nearby properties if poorly located, by e.g. sleep disturbance and are therefore a material consideration in the decision-making process regarding applications and appeals.

C.2 Noise emissions from turbines are generally low i.e. between 35-45 dB(A) at about 300-400m from the turbine[39], so generally not significantly above background noise levels. This Annex aims to describe the types of noise that can occur from wind turbines where complaints may arise, how assessment of noise is presented using ETSU-R-97; circumstances that can affect noise issues, together with mitigation techniques and use of appropriate planning conditions.

Types of Wind Turbine Noise

Aerodynamic Noise

C.3 A study from 2005[40], which looked into localising and quantifying noise sources from wind turbines concluded that: *These results clearly show that, besides a minor source at the rotor hub, practically all noise (radiated to the ground) is produced during the downward movement of the blades. The noise is produced by the outer part of the blades (but not by the very tip)….* Aerodynamic noise, generally the major noise source from modern wind turbines originates from the flow of air around the turbine blades. The 3 main mechanisms of aerodynamic noise production are outlined a Defra commissioned report from April 2011[41] and are listed as Low Frequency Noise; Inflow Turbulence Noise and Airfoil Self Noise. The frequency of the noise generated depends on the size of the turbulent eddies – large producing low frequency noise; small eddies producing higher frequencies, which do not contain a distinguishable tone and is of a random character as in e.g. white noise. The dominant character is the 'swish' as the sound level fluctuates in a

[39] Dependant on the size of blades (can range from 1 – 80 metres), wind speed/direction, atmospheric factors & model of turbine. Most modern proposals are three-bladed, horizontal-axis turbines.

[40] Localisation and quantification of noise sources on a wind turbine, Wind Turbine Noise: Perspectives for Control, Oerlemans S, Lopez BM, Oct 2015.

[41] Wind Farm Noise Statutory Nuisance Complaint Methodology, prepared for Defra by AECOM, April 2011.

cycle of increased and reduced sound level, occurring at a rate of 1-2 times every second. This blade 'swish' is known as Amplitude Modulation of aerodynamic noise or AM and potentially could alter the noise level by up to 3-5 dB(A) in each blade rotation. AM noise generation is affected by primarily the rotor tip speed, but also the wind speed and wind shear.

C.4 In the past few years research into AM has shown that there other types of AM, so blade swish is now also known as Normal AM (NAM). AM that exhibits behaviours outside of NAM is known as Other AM (OAM), some of this research has shown that the cause of OAM is most likely from partial blade stall, where 'thumping' or 'whoomphing' is heard. There is also Enhanced AM (EAM), where periods of increased swish or thumping have been reported, which may increase the noise level by up to 10 dB(A). There is currently ongoing research into all forms of AM by e.g. Institute of Acoustics (IoA), Defra and Renewable UK, therefore any evidence presented will need to be treated with caution. It seems that OAM is heard at nearer the turbine(s) and OAM/EAM is heard at large distances from turbine(s).

Mechanical Noise

C.5 Arising from the movement of mechanical parts in the nacelle; sources of mechanical noise are: the gearbox; generator; yaw drives; cooling fans and auxiliary equipment, e.g. hydraulics. Noise generated is similar to that from other rotating machinery and occurs through the transmission of vibration into the structure of the turbine, which radiates out as airborne noise. It should be noted that in modern turbines mechanical noise has been dramatically reduced to the extent that it has been more or less eliminated as a problem. However, increases in mechanical noise can occur through faults and wear & tear of e.g. bearings within the gear box/generator, worn gear teeth or misalignment of the generator drive shaft.

Noise Assessment

Introduction

C.6 The rise of wind turbine proposals, primarily in order to help meet the Renewable Energy targets, together with the reported complaints regarding noise emissions from turbines led to the formation of a standardised methodology for the assessment of noise from wind turbines/wind farms in order to provide indicative noise levels which would offer reasonable protection to residences near wind turbines and encourage best practice in turbine design and layout.

ETSU-R-97

C.7 A working group[42], facilitated by DTI produced a report in September 1996, which described a framework for measurement of noise from primarily wind farms and gave indicative noise levels, which would offer a level of protection to nearby residents without placing unreasonable restrictions on development. Although the report[43] is not a Government report, but the common views of noise experts, it was and still is the view of Government that this methodology should be used when assessing and rating noise from wind turbine proposals[73].

C.8 The method of assessment is broadly based on principles in the then existing standards and guidance for noise emissions; in particular BS4142 and in relation to night-time noise limits the WHO Environmental Health Criteria 12: Noise (i.e. between 2300–0700hrs) from 1980, where a level of 35 dB(A) is recommended to preserve the restorative process of sleep – it should be noted that these have been revised and updated since 1996. In summary the ETSU noise assessment procedure is as follows:

- Predict noise levels from all turbines (existing and proposed) at the nearest receptors;
- Determine a study area;
- Identify potentially affected properties;
- (If required) Undertake a measurement survey consisting of simultaneous measurement of background noise levels at representative properties with wind speed and direction at the proposed turbine site;
- Analyse the data to remove rain affected and atypical data, and derive the noise limits for the scheme;
- Update noise predictions & assess compliance with the noise limits for a candidate turbine and provide design advice if compliance with the limits is considered unlikely.

C.9 The purpose of the procedure above is to set out the noise data required and the analysis needed to allow a decision-maker to assess the proposals compliance with the guidance for noise limits set out in ETSU-R-97. Limits are based on background noise, measured as L_{A90}, which can be very low in rural areas. However, but both background and turbine noise varies with wind speed, so limits need to reflect this. Noise limits apply to the *total* wind turbine noise as a receptor and are specified as follows:

Daytime amenity hours:

- Evenings (1800-2300);

[42] Energy Technical Support Unit (ETSU)

[43] The Assessment & Rating of Noise from Wind Farms [ETSU-R-97], DTI, 1997 [73] Paragraph 015 - Renewable and Low Carbon Energy PPG, DCLG, March 2014

- Saturday afternoons (1300-1800);
- Sundays (0700-1800)

  - 5 dB(A) above background
  - Lower cut off of 35-40 dB(A)

Night-time (2300-0700)

  - 5 dB(A) above background
  - Lower cut off of 43 dB(A)

In addition the guidance recommends that where the occupier of a property has some **financial involvement** in the proposed wind turbine/farm the limits shall be:

Financial involvement:

  - 5 dB(A) above background
  - Lower cut off of 45 dB(A)

but there is no guidance about what would constitute such involvement or how it should be specified in a planning condition with the necessary precision

For **single turbines and wind farms with very large separation distances** between the turbines and nearest residences the limits shall be subject to a simplified assessment[44]:

Simplified assessment:

  - Flat 35 dB(A) limit
  - No need for monitoring

The Actual value chosen within the 35-40 dB range depends upon three factors which require judgment:

- The number of dwellings in the neighbourhood of the wind farm;
- The effect of noise limits on the number of kWh generated; and The level of exposure

C.10 For wind farms the Appellant will usually have carried out an assessment based on predicted noise levels for a candidate turbine and the recording of background noise levels at the nearest dwellings at different wind speeds to ensure that ETSU limits can be complied with.

[44] Where wind speed is up to 10 m/s at 10m height or above 10 m/s in sheltered areas.

C.11 Paragraph 2.7.58 of EN-3 provides that where the correct methodology has been followed and a wind farm shown to comply with ETSU-R-97 recommended noise limits, the decision maker may conclude that it will give little or no weight to adverse noise impacts from the operation of the wind turbines.

C.12 Notwithstanding the advice in ETSU-R-97, there may be a case in some circumstances for imposing the same lower fixed limit at night as in the day. Such a restriction might accord with the second bullet point in paragraph 123 of the Framework and the NPSE, which aims to minimise adverse impacts on the quality of life arising from noise. This could also accord with the PPG in relation to the impact of noise on those affected, which includes as a relevant factor, that some types of noise will cause a greater adverse effect at night than if they occurred during the day because people tend to be more sensitive to noise at night as they are trying to sleep.

Supplementary Guidance

C.13 The Government commissioned the Institute of Acoustics (IoA) to take forward the recommendations of the Hayes McKenzie report[45], which set out potential problems in how LPAs dealt with noise assessments from wind turbine proposals. Problems highlighted included – the structure and presentation of noise assessment reports; the variations in ways some factors are taken into account in noise assessment and interpretation of ETSU-R-97 e.g. from differing approaches to background noise measurement to suggesting that background noise measurement is not required until planning consent is granted. Some variation was also found in the prediction methodology[46]. Wind shear and modulation correction/penalties were also not included in many cases, however it should be noted that ETSU-R-97 does not address these issues[47]. There is currently no agreed methodology to address modulation issues, although Renewable UK have published advice and suggested condition for AM[48] – further research is being carried out by the IoA and others to formulate an appropriate threshold for AM.

C.14 The IoA Good Practice Guide[49] was published in May 2013, following extensive consultation. The aim of the guide is to set out what is currently considered good practice in the application of ETSU-R-97 assessment methodology for all wind turbine developments above 50kW. The guide

[45] Analysis of how noise impacts are considered in the determination of wind farm planning applications (HM: 2293/R1), Hayes McKenzie, April 2011.
[46] A method for noise prediction at the nearest properties is not described in ETSU-R-97. This is covered in chapter 4 of the IoA Good Practice Guide.
[47] Wind shear factors were addressed in the IoA Acoustics Bulletin article and the Good Practice Guide SGN 4.
[48] Template Planning Condition on Amplitude Modulation: Noise Guidance Notes, Renewable UK, December 2013.
[49] A Good Practice Guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise, IoA, May 2013.

covers technical matters of acoustics which the IoA believe represent current good practice in the assessment of noise from wind turbines, to enable a decision maker to make an informed decision when assessing compliance with ETSU-R-97 guidelines. The guide does not endorse the noise limits set as this is a matter of Government policy. The good practice guide and the six accompanying supplementary guidance notes (SGNs), which provide additional issue specific information e.g. data collection; wind shear and sound power level data, for undertaking wind turbine noise assessments will be referred to in wind turbine appeal submissions and at events and as mentioned above should be considered a material consideration. Throughout the guide there are useful Summary Boxes, which highlight the main points in the text, there is also a glossary of terms used and an example planning condition aimed at large-scale onshore wind farm proposals – see below.

C.15 The IoA has also published its preferred methodology for measuring and rating amplitude modification in wind turbine noise in the final report from their Amplitude Modification Working Group (AMWG). Their Reference Method involves the following stages:

- Noise is measured in short1term, 1001millisecond LAeq values in 1/3octave bands. Three frequency ranges or bands are evaluated: 50 - 200 Hz; 100 - 400 Hz and 200 - 800 Hz, and the results which exhibit the highest resulting levels of AM are used;

- The fundamental length of input sample to be assessed (the minor time interval) is 10 seconds;

- The hybrid reconstruction method is used to determine the AM value for each 10 second value;

- The values of AM measured by the metric in each 101second interval are aggregated over a 101minute period (the major time interval) to provide a single value which is the AM rating for the 10 minute period.

C.16 **Cumulative issues** – ETSU-R-97 and the good practice guide deals with cumulative issues. Page 58 of ETSU-R-97 states *'that absolute noise limits …above background should relate to the cumulative effect of all turbines in the area that contribute to the noise received at the affected properties'*. A HMP report stated that '*if an existing wind farm has permission to generate noise up to the ETSU-R-97 limits, noise limits set at any future nearby wind farm would have to be at least 10dB lower than that set for the existing wind farm to prevent breaching the ETSU-R-97 limits'*. The IoA guide suggests a more detailed analysis on a case by case basis and recommends a cumulative noise impact assessment be carried out if a proposed wind farm is likely to produce noise levels within 10dB of any existing wind farm in the locality at a given receptor location. If it is predicted to be greater than 10 dB (but compliant with ETSU-R-97 in its own right) then an impact assessment is not necessary. The guide suggests additional means of resolving cumulative

noise issues, such as strategic approach to planning to allow for 'headroom' i.e. using lower limits than ETSU-R-97 or apportioned limits for each wind farm; negotiation between wind farm developers on reviewing original limits and apply to alter relevant conditions. Cumulative conditions could be applied, whereby if noise limits increase from an existing wind farm, any noise levels from a second nearby wind farm will have to reduce.

C.17 **Buffer Zones and Separation Distances** – Noise varies with local topography, size and make of turbine. An acceptable separation distance for noise purposes is addressed in ETSU-R-97 at page 46, where it states that separation distances of 350-400 metres cannot be relied upon to give adequate protection to properties near wind farms.

C.18 **Mitigation Measures** – for modern turbines as mentioned above the predominant noise source is from the trailing edge of the blades. This can be reduced by adopting various design options e.g. blade add-ons to improve blade performance e.g. vortex generators or trailing edge serrations, which also reduce noise, 'smart' blade control strategies and alterations to blade shape – planform, airfoils etc. Another option is to run the turbine in Low Noise Mode (i.e. running at reduced rotational speed, resulting in lower power output and consequently lower noise output – this will obviously affect the economic performance of the site.).

Planning Conditions

C.19 As always conditions need to be justified and adapted to particular circumstances. Noise conditions for wind farms are complex and much will depend on the evidence adduced and form of suggested conditions, which should be informed by the approach set out in ETSU-R-97. Suggesting model conditions is problematic as the Hayes McKenzie report highlighted a number of different interpretations of ETSU and variations in prediction methodology. It suggested that guidance on best practice could usefully be more prescriptive on the approach to background noise measurements and interpretation of data, since this not only forms the basis of any assessment but is likely to determine the noise limits used in any eventual planning conditions.

C.20 **The use of ETSU-R-97 'simplified' approach** - The ETSU 'simplified approach' provides that if the developer can demonstrate that noise conditions [presumably the lower absolute limits suggested in ETSU which are $L_{A90,10min}$ 35-40 dB day-time and 43 dB night-time] would be met even if there was no increase in background noise until quite high wind speeds, then a simplified approach can be adopted that if the noise is limited to an $L_{A90,10min}$ of 35 dB(A) up to wind speeds of 10 m/s at 10 m high then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary. This might be suitable for small wind turbines where full noise assessments are not submitted. The following condition could be used:

The level of noise emissions from the turbine(s) hereby permitted when measured in free field conditions at the boundary of the nearest noise sensitive receptor which lawfully exists or has planning permission for construction at the date of this planning permission, or measured closer to the turbine(s) and calculated out to the receptor in accordance with a methodology previously approved in writing by the local planning authority, shall not exceed 35 dB $L_{A90,10min}$ up to wind speeds of 10 m/s measured at a height of 10 m above ground level at a location near to the turbine(s). All instrumentation and methodology, along with specified positions, for all measurements of noise and wind speed, shall have been previously approved in writing by the local planning authority.

C.21 **IoA Good Practice Guide condition for larger-scale wind development** – Annex B of the IoA Guidance on ETSU-R-97 sets out an example condition with attached guidance notes, the form of which has been the basis for noise control at several larger-scale UK wind farm developments at recent planning appeals. Conditions which are more concise may be acceptable, for smaller proposals in particular.

C.22 **Renewable UK Template Planning Condition on Amplitude Modulation** – published in December 2013, this alternative template condition is intended to be read in conjunction with the 'Example Planning condition' set out in Annex B of the IoA Good Practice Guide, contains some alterations, with specific reference to application of penalty components for Amplitude Modulation.

Example Wind Turbine decisions involving noise

C.23 **APP/F2605/A/12/2185306 – s78 T&CPA 1990 recovered appeal by Ecotricity (Next Generation) Ltd** for two wind turbines [max. height of 100m] at Wood Farm, Church Lane, Shipdham. Inspector recommended dismissal, SoS agreed – appeal dismissed. Main issues – acoustic effects: findings of the noise assessment (tranquillity, amenity and noise, effects on health and elderly people, weight given to noise impacts); visual amenity, effect on listed buildings.

C.24 **DPI/A0655/11/13 – S36 Electricity Act 1989 application by Peel Wind Farm (Frodsham)** to SoS for nineteen wind turbines [max. height 125m] at Frodsham Canal Deposit Grounds, Cheshire, Inspector recommended consent be granted, SoS DECC agreed – application approved. Main issues – impact of the noise from the development on local amenity, govt's policy on energy mix; impact on the Green Belt, visual impact, impact on wildlife, impact on scheduled ancient monument,
COMAH regulated sites, impact on radar. Conditions attached contain requirements similar to model conditions in Annex b of the IoA Good Practice Guidance.

Case Law involving wind turbine noise

a) Greaves v Boston Borough Council;

Date: 25 November 2014; Ref: [2014] EWHC 3590 (Admin)

In dismissing a claim by the owners of a property in Lincolnshire that Boston Borough Council had imposed an unenforceable condition which sought to limit noise emissions from a wind turbine, the High Court also held that they no longer had any legal standing to bring the challenge.

The condition stated that noise arising from the turbine should not exceed a specified level above background noise. However, the claimant asserted that it was not enforceable because in practice it was impossible to accurately measure individual noise levels over a specified five-minute period as required by the condition. In response the council stated that by the time of the court hearing the claimant had sold their house and had no legal standing to bring the challenge.

Mr Justice Dove stated that the approach to interpreting planning conditions should be benevolent and not overly narrow and strict. The fact that the condition was technical in nature was not fatal to its interpretation and enforceability since it was common for experts in the field of noise to be involved. Although the condition did not stipulate at what height noise measurements should be taken, their absence left the matter to good sense and professional judgement. It did not mean that the condition was hopelessly vague as to be incapable of being interpreted. In any event the judge also concluded that after the sale of the house the claimant had no legal basis for pursuing the challenge because he had no vested interest in the operation of the turbine.

b) Joicey v Northumberland County Council

Date: 7 November 2014; Ref: [2014] EWHC 3657 (Admin)

The High Court has considered a claim for judicial review of a planning permission for a wind turbine. A farmer applied for planning permission for a wind turbine on his farm. He commissioned a noise assessment to support his application. The council only uploaded the noise assessment to their website the day before the planning committee meeting, which was in breach of their statutory duties under the "right to know" legislation.

The noise assessment assumed that the farmer's tenants had a financial involvement in the wind turbine, as the properties they occupied were owned and controlled by the farmer. As a result of this perceived financial involvement, the noise assessment based its calculations on higher permitted noise levels. This was an incorrect interpretation of "financial involvement".

This judgment has ramifications for the application of ETSU-R-97's guidance on financial involvement of 'wind-farm neighbours' and the application of noise limits at the 'nearest noise-sensitive properties'. In particular, the judge made a distinction between 'occupiers' and 'residents' at the nearest noise-sensitive properties, finding 'occupiers' to be the crucial term here and, further, that 'owners and tenants would be occupiers. Ordinarily, someone in a holiday let would be the occupier of premises, even if only for a few days'.

The judge found that a modest sum reducing rent or electricity costs did not make an occupier financially involved, particularly if the sum was compensatory rather than profitable for the occupier. However, the judge found that as a matter of planning judgment, the developer, and in turn the Council, had been entitled to conclude that the ETSU-R-97 financial involvement limits were applicable to a property owned and occupied by a party/parties with a clear financial return from the wind farm, and to other properties owned by that party/those parties for letting out for short periods as holiday lets.

However, a further property owned by the applicant for the scheme had been incorrectly assessed for these purposes. Stressing that ETSU-R-97 referred to occupiers having the financial involvement, the judge noted that the applicant's tenants would not have a financial involvement by virtue of the applicant's own financial involvement.

c) Hulme v SoS for Communities and Local Government

Date: 26 May 2011; Ref: [2011] EWCA Civ 638

The Court of Appeal considered the meaning of two planning conditions relating to the levels of turbine noise from a proposed wind farm. The planning conditions set out what noise levels would be regarded as greater than expected and required the developer to submit a scheme designed to measure the levels. However, there was no express prohibition against the noise exceeding these levels.

The court held that it was plainly the intention that the noise levels could be enforced in some way and that the conditions should be construed as imposing an obligation on the developer to comply with them. The Court of Appeal saw this as a matter of construction, rather than an implied condition.

This case demonstrates the need for planning conditions to be unambiguous and clear on the face of the permission to avoid the uncertainty and possible challenges that arose in this case.

Annex D: Environmental Impact Assessment (EIA)

D.1 EIA provides a process where the interaction of environmental effects resulting from a proposed development can be predicted where there is likely to be significant effects (positive or negative) on the environment. These effects can then be reduced or avoided, where appropriate, through mitigation measures. The main purpose of an EIA is to provide the decision maker and the public with a clear description of what the likely significant effect of a project would be and how the effects have been assessed, provided through the Environmental Statement (ES). EIA is applied through the EIA Directive[50] transposed into English law through the EIA Regulations 2017[51] and Infrastructure Planning EIA Regulations 2017[52]. Schedule 4 of the regulations establishes the minimum information necessary for inclusion within an ES in order for it to be considered as such.

D.2 The effects of noise on humans are usually the main consideration when assessing noise impacts. However, noise can also have significant direct or indirect effects on the environment, for example:

- Disturbance of wildlife – the effects on sensitive bird species or populations;

Table - Generic Scale of Noise Impacts on Fauna[53]

Effect	**Description of magnitude of Impact**	**Significance of Effect (if required, particularly if the noise impact assessment is part of a formal EIA)**
No reaction	No Impact	Not significant
Noise causes a reaction, either physiological or behavioural, but fauna returns to pre-exposure conditions relatively quickly and without continuing effects	Slight	Not Significant
Noise causes a reaction, either physiological or behavioural but cause more permanent changes that do not readily allow individuals or communities to return to pre-exposure conditions. Can include temporary nest abandonment.	Moderate	Significant
Noise causes demonstrable harm, either injury or death or causes situations such as permanent nest abandonment.	Severe	Significant

- The level and type of noise can have an effect on the character of a landscape or the setting of historic buildings/monuments; and

[50] Directive 2011/92/EU

[51] The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, SI 2011/571.

[52] The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, SI 2017/572.

[53] Guidelines for noise environmental impact assessment Version 1.2, IEMA, November 2014

- Air overpressure from blasting activities can cause structural damage

D.3 The EIA process requires the following steps to be taken:

1) Scoping of issues to be addressed in the noise impact assessment;

Scoping is the process of identifying the content and extent of the Environmental Information to be submitted to the Competent Authority under the EIA process. Before undertaking a noise impact assessment, it is important that the assessor has a thorough understanding of the project and its context. This would involve:

- understanding the nature of the development and identifying the potential sources of noise;
- understanding the nature and character of the prevailing noise environment;
- identifying all the potential new noise sources that will arise from the proposals, during the construction, operation and, if appropriate, de-commissioning;
- understanding the nature of the new noise sources that will arise from the proposal, including such features as tonal characteristics, intermittency, duration and timing (diurnally and seasonally);
- identifying potential noise sensitive receptors; and
- understanding the policy context of the proposal, including central and local government policy, relevant international and national guidelines, British Standards etc.

Having considered these issues in the scoping process together with the outcome of consultation with relevant stakeholders, the noise assessor is then able to define the detailed scope of the assessment, or even, determine whether a noise study is necessary.

2) Understanding and description of the existing noise environment, including identification of sensitive receptors (baseline condition);

Baseline noise refers to the noise environment in an area prior to the construction and/or operation of a proposed (or new) development that may affect it.

Baseline noise levels may be required for different years. In many cases the year in which the study is carried out will be relevant and these baseline noise levels may be referred to as existing (or current). However, there may be occasions when baseline data are required for other years.

Baseline noise levels can serve several purposes in the assessment process:

- They provide a context for the noise levels predicted to arise from the proposed development.

- They may be required as a formal part of the noise assessment process.
- They may demonstrate that the noise environment is already unsatisfactory.

In order for baseline noise levels to fulfil any of these functions, they must be the values expected at the relevant time for the phase of the proposed development being considered. This may be at some future date either because the development will not be operational for several years or because its noise emissions will not be constant throughout its operating life.

For example, an industrial development may take several years to be planned, a year or more to be constructed and may be designed to have further production lines coming on stream in the years after it is first operating. In such circumstances different baseline years may be relevant for the construction and operating phases and neither of them will be the same as the situation at the time the assessment is conducted. Although it is possible to measure noise levels at the time an assessment is conducted, this may not be the relevant time for which the baseline noise levels are required. Baseline noise levels may therefore be determined by direct measurement, by prediction, or by a combination of these methods.

Sensitive receptors may include uses other than dwellings, and animals other than human beings. Normally, the objective is to identify those locations most sensitive to or likely to be adversely affected by the proposed development. (It should be noted that not all of these receptors would necessarily have the same degree of sensitivity. This variation would need to be taken into account during the assessment process. Possible receptors that may need to be considered when determining the baseline noise levels include:

- Dwellings;
- Schools / Colleges;
- Hospitals;
- Especially sensitive commercial / industrial installations;
- Commercial premises;
- Community facilities (including libraries, surgeries, health centres);
- Places of Worship;
- Retail premises;
- Open Air Amenities;
- Cemeteries;
- Light Industrial sites;
- Farms, kennels;
- Wildlife sites; and

- Vacant Land (Classify according to potential future use where possible. Consult planning consents, relevant planning strategies and similar local development documents, etc.)

"Open air amenities" covers a wide range of receptors and sensitivities. Sites such as those of special historic interest, nationally recognised footpaths and areas of landscape value should be considered as particularly sensitive[54].

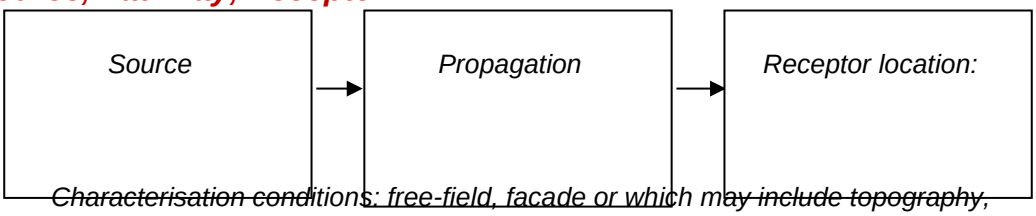
3) Prediction of the noise expected to be generated by the proposed development;

Prediction is a very important part of noise impact assessment. When a development is in the planning stage, it is the only way of quantifying the likely noise impact.
The prediction of noise for impact assessment requires consideration of both the way sound travels from source to receptor and analysis of the changing character of the noise during the various phases of the scheme to be assessed. Different predictions and prediction methods may be necessary during site preparation, construction, operation and decommissioning. For example, when planning for surface mineral working or waste disposal sites, consideration needs to be given to site preparation, fixed plant noise, mobile plant noise, site restoration and vehicle movements (both within the site and on the local road network).

Prediction Procedure

The basic prediction procedure involves consideration of the nature and noise level of the sources, the propagation along the paths between sources and receptors and the location of the receptors, as shown in the Figure below.

Figure - Source, Pathway, Receptor



Any noise prediction requires information about the sound power of the source or the sound pressure due to the source at a reference distance. The level of noise received from any source depends not only on the sound power frequency spectrum of the source but on the type and size

[54] This category includes both nationally and locally designated sites but might also include locations that are valued locally even though they have no formal designation.

of the source, the distance between source and receptor, the intervening topography and the climatic conditions, and on the location of the receptor. Consideration should also be given to whether the predictions are intended to give internal or external levels. If external levels are to be predicted, it should be decided whether they are to be the levels at a building facade or those free from the influence of vertical reflecting surfaces near to the receptor (free-field). This will often be determined by the requirements of any formal modelling methods which may apply to the situation being assessed, relevant British Standards, other codes of practice and planning guidance which may exist. Reference should be made also to the discussion of receptors in, Baseline, for suggestions about the locations that should be included.

4) Assessment of the significance of the expected noise impact at the sensitive receptors that may be affected;

The ultimate aim of any noise assessment is to determine the effect of the expected change in the acoustic environment arising from the proposed development. Previous sections of this manual have described how information regarding the expected noise change can be acquired. The baseline and future noise levels at residential properties, schools, hospitals or in amenity areas will have been found, and it is from this and any other relevant information, that an overall conclusion regarding the significance or otherwise of the change in the acoustic environment must be drawn.

Table - Assessment Factors[55]

Factor	**Issue**
Averaging Period	Is the averaging time so long that it might mask a greater impact at certain times, or does the noise change occur for such a small proportion of the time that it can therefore be considered of little consequence?
Time of Day / Night / Week	Is the change occurring at a time that might increase or reduce its impact from that implied by the basic noise change?
Nature of the Noise Source	Is there a change in the nature of the noise source which might alter the impact?
Frequency of Occurrence	How does the frequency of the occurrence of the noise source affect the impact?
Spectral Characteristics	Is there a change in the spectral characteristics which might affect the impact?

[55] Guidelines for noise environmental impact assessment Version 1.2, IEMA, November 2014

Noise Indicator	Has the change which would be heard been correctly identified? (i.e. Does the change in level as described by the indicator used adequately detect the change that would be experienced by those exposed to it?)
Absolute Level (Benchmark)	How does the change relate to any applicable published guidance?

Table - Sensitivity of Receptor to Noise Level Exposure

	Large	**Medium**	**Small**	**Negligible**
Relative change	Greater than 10 dB(A) change in sound level	5 to 9.9 dB(A) change in sound level	3 to 4.9 dB(A) change in sound level	2.9 dB(A) or less change in sound level

To determine the overall noise impact the magnitude and sensitivity criteria are combined into a Degree of Effect matrix as shown in the Table below, with the corresponding effect descriptors in the Additional Table below.

Table - Degree of Effect Matrix

		Importance/sensitivity of receptor			
		High	**Medium**	**Low**	**Negligible**
Magnitude/scale of change	**Large**	Very Substantial	Substantial	Moderate	None
	Medium	Substantial	Substantial	Moderate	None
	Small	Moderate	Moderate	Slight	None
	Negligible	None	None	None	None

Table - Effect Descriptors

Very Substantial	Greater than 10 dB L_{Aeq} change in sound level perceived at a receptor of great sensitivity to noise

Substantial	Greater than 5 dB L_{Aeq} change in sound level at a noise sensitive receptor, or a 5 to 9.9 dB L_{Aeq} change in sound level at a receptor of great sensitivity to noise
Moderate	A 3 to 4.9 dB L_{Aeq} change in sound level at a sensitive or highly sensitive noise receptor, or a greater than 5 dB L_{Aeq} change in sound level at a receptor of some sensitivity
Slight	A 3 to 4.9 dB L_{Aeq} change in sound level at a receptor of some sensitivity
None/Not Significant	Less than 2.9 dB L_{Aeq} change in sound level and/or all receptors are of negligible sensitivity to noise or marginal to the zone of influence of the proposals

Cumulative and In-Combination Effects: Cumulative effects can be defined as: "*those that result from additive impacts caused by other past, present or reasonably foreseeable actions together with the plan, programme or project itself and synergistic effects (in- combination) which arise from the reaction between impacts of a development plan, programme or project on different aspects of the environment* ". [56]

There can be situations when separate, independent proposals are put forward at about the same time and which are going to impact on the same receptors. The various proposals need to be assessed independently, but, at some point, there should be liaison between the projects to consider the cumulative impact on the sensitive receptors of all the proposals. The cumulative impact is likely to be of concern for the local planning authority and, of course, those affected by the proposals are unlikely to differentiate between the noise from the different developments. They are simply going to perceive the total change to their noise environment should all the developments be implemented.

5) Identification of noise mitigation measures to reduce the noise impact;

The outcome of this step may mean that steps 3) and 4) will need repeating. The types of mitigation which might be employed may be classified, in order of importance and preference, as:

- Avoidance;
- Reduction; and
- Compensation.

For an industrial development, the first category includes the initial choice of plant or technology, which should be consistent with BAT[57] principles (Best Available Techniques). The site layout, building design and the

[56] Guiding Principles for Cumulative Impact Assessment in Offshore Wind Farms, RenewableUK, June 2013.
[57] Directive 96/61/EC on Integrated Pollution Prevention and Control.

operational management can also significantly affect potential noise impacts. Consequently, the initial avoidance of potential noise impacts and effects by plant selection, mode of operation and layout should be sought wherever possible.

Similar avoidance principles can be applied to transport developments, by careful selection of road or rail alignments to minimise the sensitive areas affected, or by careful location and route design for aviation developments. In addition for railways and airports, constraints could be placed on the noise generated by individual train units or aircraft either through the use of specific criteria or by making use of national or international noise emission standards.

Avoidance can also be achieved by:

- controlling the hours of operation
- limiting the duration of operation,
- limiting the number of events, or
- limiting the number of different sources operating concurrently.

Reduction for industrial developments means adopting noise reducing methods such as enclosures, screening or fitting silencers to noisy plant. Such detailed acoustic/engineering design would normally be undertaken by a noise consultant or specialist engineer to achieve a given noise criterion or to minimise the noise impact.

The same principles can be applied to transport developments, with the use of landscaping or noise barriers for road and rail links or along airport taxi-ways, and the use of noise reducing surfaces on roads or resiliently mounted rails, rail dampers etc.

Compensation may include measures applied outside of the development area such as the fitting of double/secondary glazing to affected premises. In certain cases, legislation provides for financial compensation for the loss of value of properties affected by noise. It may also be possible to offer compensation in the form of the provision of alternative or additional community facilities. Liaison with the relevant local authority or affected community groups might assist in identifying a suitable form of alternative compensation.

Residual Impact - This term effectively describes the resulting noise impact of the proposal that would remain once any mitigation has been implemented. The term ‘residual impact’ tends to focus on the adverse impacts that remain (rather than any beneficial effects) and its function is to ensure that the remaining adverse effects are not overlooked even if the overall conclusion is that the proposal produces a net noise benefit, or the scheme is permitted because of other economic or social benefits.

6) Monitoring of noise effects after development has been granted consent.

The need for on-going monitoring in addition to inspection both during and after project commissioning should be considered. The nature and extent of such monitoring will be dependent on the project scale, and the economic and practical limitations. However, such on-going monitoring is important to enable the detection of any degradation of the mitigation schemes occurring over time.

Noise prediction and assessment should be carried out using the established principles and guidance set out in Guidelines for noise environmental impact assessment Version 1.2, IEMA, November 2014.

D.4 **Noise Assessment/Report -** The manner in which the noise impact assessment of a proposed development is reported is likely to depend on the nature of the project. For smaller projects the assessment is likely to be reported in a self-contained document. If, however, the assessment is part of a larger scheme that requires a formal EIA, the results are likely to form part of both the non-technical summary and the Environmental Statement (ES). It may also be necessary to present the results of the noise assessment in a form suitable for public consultation, possibly by way of displays or other easily accessible information.

D.5 The noise assessment report needs to provide a sufficient quantity and detail of information to satisfy the needs of those who will be making a decision regarding the overall merits and disbenefits of the proposal. For a small proposal it may be appropriate to include all relevant information in one document. However, for a large project or where noise is considered as part of an ES, a Technical Appendix may also be required. This would contain all the technical information that would not necessarily be required by the decision maker or stakeholders/members of the public but would assist people with a technical background to evaluate the noise assessment in more detail.

D.6 The information that should be contained in the noise assessment report is set out below, together with a brief description of the scope of each topic:

Description of Project - This should consist of a description of the project but recognising that it is likely to have been described in detail elsewhere or by others. When that is the case, the project description in the noise report or Chapter should refer to those other documents for the general description and focus on the potential sources of noise.

Scope of the Noise Assessment - This should cover the potential noise impacts associated with the proposed development. It should include all potential noise sources, including those from any construction or de-commissioning element of the proposed development, on and off-site activities, and the area over which a possible impact could be experienced.

Standards and Other Guidance - This should describe the relevant standard(s) and other guidance document(s) that have been used in considering the noise impact of the proposed development. Full technical

references to the documents should be included (e.g., title, author, publisher, and date).

Assessment Procedure - The method of assessment, and relevance to the standard(s) or other guidance covered above, should be clearly stated, together with the noise indicators used. Where a criterion has been specially developed for a particular impact assessment then this should be described as required.

Description of Baseline - Qualitative descriptions of the existing area including noise sources should be included together with information about any relevant features that may affect the noise aspects of the potential development.

Noise Levels from Proposed Development - The results of the noise predictions will need to be presented in a form appropriate to the particular development. Predicted noise levels at specific locations where assessment is to be carried out will need to be included. Separate predictions will normally be required for different phases of any construction or de-commissioning elements of the proposed development.

Impact Assessment - The noise impact should be described by considering the baseline noise levels, the predicted noise levels and the method of assessment and criteria that were described in the preceding Chapters, including any mitigation that has been incorporated in the proposals. A summary of the severity of impact should be included here for all receptor locations defined within the Scope Chapter. When the scale or complexity of the proposals merit it, noise impacts should also be shown on a plan, and would probably take the form of coloured bands showing the impact descriptor, or noise contours, depending on the assessment methodology adopted.

Mitigation - This Chapter should describe the mitigation measures that will be incorporated in the development together with their likely effectiveness. An indication should be given of the scope for further mitigation which could have been included to reduce further the potential impact, and why it has been rejected. The practical, economic and other implications associated with such mitigation should be described.

Conclusions - The conclusions should summarise the results of the impact assessment, their relevance to existing standards, criteria or other guidance, together with proposed measures to ensure that the described impacts are not exceeded. The conclusion should include commentary about the overall severity or otherwise of the noise impacts once all these factors have been taken into account.

Technical Appendix - if it is appropriate to produce a Technical Appendix, it should contain any relevant additional information that would aid a more

detailed evaluation of the noise assessment report by a technically competent person.

Public Consultation - Although the noise impact assessment report or environmental statement would usually be made available to interested members of the public, it may also be necessary to provide information for a public meeting or to be displayed at council offices or other public buildings. The results of the noise assessment should be presented in this case in an easily accessible form.