MANCHESTER
CITY COUNCIL

Planning and Noise

Technical Guidance

October 2022

Environmental Protection
Environmental Health
The Neighbourhoods Service
Manchester City Council

Contents

Service Aim

The Our Manchester Strategy 2016-2025 sets out the future Manchester our whole city is building together. We aim to be in the top-flight of world class cities with a dynamic economy and highly skilled people; well-connected, addressing climate change, feeling sage and living well.

The Council has recently reset its priorities up to 2025, refocusing on the challenges – pitting equality, inclusion and sustainability centre stage, with a renewed focus on young people, out economy, health, housing, our environment and infrastructure.

Through each priority runs Manchester's commitment to build a fairer city for everyone who lives, works, volunteers, studies or plays here:

- Thriving and sustainable – vibrant with a cutting-edge economy
- Highly Skilled – work ready, well educated people
- Progressive and equitable – so people can thrive, with better joined up support and services
- Liveable and zero carbon – safe, enjoyable neighbourhoods with affordable housing, zero carbon by 2038 using green growth and design, energy and more climate resilience
- Connected – more walking, cycling and green transport, and accessible digital technology used by and working for everyone.

The guidance aims to provide help and advice in relation to noise in a planning context to encourage good acoustic design. It outlines what is expected in relation to current guidance and policy with the aspiration that new developments achieve the highest possible standards without compromising the health and well being of people that live and work within the City of Manchester.

Applicants, developers and acoustic consultants are advised to read this document prior to submitting a planning application.

1.0 Introduction

Noise is often an important factor in assessing the environmental acceptability of a development proposal and it should be one of the factors addressed in a planning application submission. The planning process is the primary mechanism for local authorities to prevent serious conflicts between different land uses.

Many developments can generate significant amounts of noise or are sensitive to the impact of noise. It is the responsibility of Manchester City Council (the Council) as Local Planning Authority to ensure that developments are appropriately designed so that they do not have an unacceptable impact on local communities and that noise sensitive developments are also appropriately designed and are not subjected to unacceptably high levels of noise.

Although undertaking a noise survey and assessment as part of the planning application process will incur a financial cost for a developer, the costs of remedying any noise problems after a development has been completed are likely to be much higher.

This document provides guidance to applicants and consultants concerning the assessment and prediction of environmental noise associated with a particular development. It does not provide guidance concerning Part E of the Building Regulations. The Building Control Department deal with all issues associated with the Building Regulations including Part E and F. If you have any questions or queries concerning compliance with the Building Regulations please contact the Building Control Department.

This document provides guidance that is not exhaustive. If you have any questions or wish to discuss the requirements of a specific noise assessment please contact Environmental Health by registering your enquiry at www.manchester.gov.uk

Building Regulations Approved Document E is the main reference document which relates to the insulation of buildings against airborne and structure borne noise. These regulations do not cover environmental noise, meaning that reference to other technical documents is required if environmental noise is a significant consideration.

Approved Document E covers general building situations and common issues, which could arise if appropriate attention is not paid to the construction elements of a building. It identifies minimum standards for airborne and impact noise within a building. It reviews both new build and conversion of existing buildings (i.e. a change of use). It identifies common structural designs and comments upon the level of acoustic protection that these may offer, allowing review of these factors against guideline values, which should *generally* protect residential amenity.

The document also covers impact noise arising from 'foot fall' on floors and details construction techniques designed to mitigate against such noise. The document either requires testing to be carried out to demonstrate compliance with the required standards or alternatively, construction to a 'robust detail' standard.

2.0 Noise

Noise is defined as unwanted sound (whether that is music, industrial machinery or road traffic) and is an unavoidable part of everyday life. It can be a source of stress and irritation and can have a detrimental impact on people's health and quality of life.

2.1 Noise & Planning

Typically, any developments involving residential dwellings are the most noise-sensitive, whilst industrial developments such as general industry are one of the least noise-sensitive.

However, industrial and commercial uses are amongst the most likely to cause a noise impact. Thus, many developments require noise control or protection measures to mitigate against the effects of noise from outside sources, which include the effects of noise from road or rail, industry or commercial premises.

The express inclusion of noise in the National Planning Policy Framework (NPPF) means that it is a material planning consideration for local planning decisions.

2.2 The role of Environmental Health

Environmental Health (EH) are consulted by the Planning Department on all planning applications within Manchester.

EH consider a number of environmental issues including noise and vibration, before making a recommendation to the Planning Department. Typically, this recommendation is that the application be approved, be approved subject to appropriate conditions, or be refused.

The recommendations made by EH are not binding on the Planning Authority who will consider all relevant issues concerning a planning application.

3.0 Planning Policy & Guidance

Noise management is a devolved issue. This means that, although there are many similarities, different policies and regulations apply in England, Wales, Scotland and Northern Ireland. In England, the overarching policy on noise management is set out in the Noise Policy Statement for England (NPSE). The NPSE contains the vision of promoting good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

3.1 Noise Policy Statement for England

The Noise Policy Statement for England (NPSE) launched in March 2010 states the long-term vision of Government noise policy is to "promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development".

The long-term vision is supported by the following aims; through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- Avoid significant adverse impacts on health and quality of life;
- Mitigate and minimise adverse impacts on health and quality of life;
- Where possible, contribute to the improvement of health and quality of life.

The intention is that the NPSE should apply to all types of noise apart from noise in the workplace (occupational noise).

3.2 Noise Planning Policy Framework

NPPF was published in March 2012 and sets out the Government's planning policies for England and how these are expected to be applied.

The framework states (among other commitments) that the planning system should **contribute to and enhance** the natural and local environment by:

"preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or **noise pollution** or land instability".

The express inclusion of noise in the NPPF means that it is a material planning consideration for local planning decisions.

Paragraph 123 of the NPPF document states that planning policies and decisions should aim to:

A. Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;

B. Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;

C. 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; and

D. Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

3.3 National Planning Practice Guidance

The National Planning Practice Guidance (PPG) is a web-based resource, launched by the Department for Communities and Local Government (DCLG) in March 2014 to support the NPPF and make it more accessible.

It advises on how planning can manage potential noise impacts in new development. The guidance is regularly reviewed and updated and noise is listed as a specific category. The guidance is for ad hoc developments, as major infrastructure is covered by overarching National Policy Statements.

Listed overleaf are the paragraph headings contained within the PPG and it is strongly recommended that the information presented in this document is read in conjunction with the web-based resource.

- When is noise relevant to planning?
- Can noise override other planning concerns?
- How to determine the noise impact?
- Observed Effect Levels
- How to recognise when noise could be a concern?
- What factors influence whether noise could be a concern?
- Enforcement action against a statutory nuisance
- How can the adverse effects of noise be mitigated?
- Are there further considerations relating to mitigating the impact of noise on residential developments?
- Can Local Plans include noise standards?
- Are noise concerns relevant to neighbourhood planning?
- What factors are relevant to identifying areas of tranquillity?

A summary of the effects of noise exposure (in terms of health and quality of life) associated with both noise generating developments and noise sensitive developments is presented within the PPG and reproduced in Table 1 on the next page.

Table 1: Noise Exposure Hierarchy

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect (NOAEL)	No specific measures required
Lowest Observed Adverse Effect Level (LOAEL)			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level (SOAEL)			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very intrusive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

PPG does not provide numerical values for the different effect levels, instead recognising that 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.

It therefore remains for local authorities to consider the PPG noise exposure hierarchy and seek to align it with significance criteria, having regard to British Standards, World Health Organisation guidance and other relevant sources of information.

3.4 ProPG Guidance

The Professional Practice Guidance on Planning and Noise (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 promotes the use of 'Good Acoustic Design' as a primary noise management measure to optimise the acoustic environment that would be experienced by the residents.

The guidance recognises that whilst current Government planning and noise policy and guidance sets clear objectives it does not prescribe specific numerical acoustics standards and it allows a range of different approaches to be used. It states that 'following the guidance will result in a more consistent approach which should help enable the speedier delivery of new homes'.

The scope of ProPG is restricted to the consideration of new residential development that will be exposed predominantly to airborne noise from transport sources (noting that good professional practice should have regard to any reasonably foreseeable changes in existing and/or new sources of noise). It encourages improvements in the consistency and quality of plan making and decision taking in relation to acoustic matters. The context is primarily development control, although some of the content is relevant to strategic planning.

The recommended approach detailed in the guidance includes a framework to enable situations where noise is not an issue to be clearly determined, and to help identify the extent of risk at noisier sites. It states that higher development costs should invariably be anticipated in those areas exposed to high levels of noise that may be harmful or otherwise unacceptable.

The recommended approach provides opportunities to incorporate effective design interventions that will enable residential development to proceed in areas that might otherwise have been considered unsuitable. Inevitably, there may be some situations where it is not appropriate to build new dwellings. Even in those situations, this guide will assist as it encourages early identification of the risk of refusal and supports early decision making thereby avoiding unnecessary development and design costs.

3.5 Local Policy

The Core Strategy Development Plan Document 2012 -2027 (the Core Strategy) was adopted by the City Council in July 2012. It is the key document in Manchester's Local Development Framework. The Core Strategy replaces significant elements of the Unitary Development Plan (UDP) as the document that sets out the long-term strategic planning policies for Manchester's future development.

Policy DM 1 - Development Management
All development should have regard to the following specific issues for which more detailed guidance may be given within a supplementary planning document:

- Appropriate siting, layout, scale, form, massing, materials and detail;
- Impact on the surrounding areas in terms of the design, scale and appearance of the proposed development. Development should have regard to the character of the surrounding area;
- Effects on amenity, including privacy, light, noise, vibration, air quality, odours, litter, vermin, birds, road safety and traffic generation. This could also include proposals which would be sensitive to existing environmental conditions, such as noise;
- Accessibility: buildings and neighbourhoods fully accessible to disabled people, access to new development by sustainable transport mode;
- Community safety and crime prevention;
- Design for health;
- Adequacy of internal accommodation and external amenity space;
- Refuse storage and collection. Vehicular access and car parking;
- Effects relating to biodiversity, landscape, archaeological or built heritage;
- Green Infrastructure including open space, both public and private;
- The use of alternatives to peat-based products in landscaping/gardens within development schemes;
- Flood risk and drainage; and
- Existing or proposed hazardous installations;

Subject to scheme viability, developers will be required to demonstrate that new development incorporates sustainable construction techniques as follows (in terms of energy targets this policy should be read alongside policy EN6 and the higher target will apply):

a) For new residential development meet as a minimum the following Code for Sustainable Homes standards. This will apply until a higher national standard is required:

   Year 2010 - Code Level 3;
   Year 2013 - Code Level 4;
   Year 2016 - Code Level 6; and

b) For new commercial developments to demonstrate best practice which will include the application of the BREEAM (Building Research Establishment Environmental Assessment Method) standards. By 2019 provisions similar to the Code for Sustainable Homes will also apply to all new non-domestic buildings.

Policy SP 1 - Spatial Principles

The key spatial principles which will guide the strategic development of Manchester to 2027 are:

- The Regional Centre will be the focus for economic and commercial development, retail, leisure and cultural activity, alongside high-quality city living;

- The growth of Manchester Airport will act as a catalyst for the regional economy, and will also provide the impetus for a second hub of economic activity in this part of the City;

- Beyond these areas, the emphasis is on the creation of neighbourhoods of choice, providing high quality and diverse housing around district centres which meet local needs, all in a distinct environment. Most of the new residential development in these neighbourhoods will be in the Inner Areas, defined by the North Manchester, East Manchester and Central Manchester Regeneration Areas. The City is covered by regeneration areas including the City Centre. All development should have regard to the character, issues and strategy for each regeneration area as described in the North, East, Central and South Manchester and Wythenshawe Strategic Regeneration Frameworks and the Manchester City Centre Strategic Plan;

- The City's network of open spaces will provide all residents with good access to recreation opportunities. The River Valleys (the Irk, Medlock and Mersey) and City Parks are particularly important, and access to these resources will be improved; and

- New development will maximise the potential of the City's transport infrastructure, in particular promoting walking, cycling and use of the public transport. The extension to the Metrolink network through the Oldham and Ashton lines will create key corridors for new development.

Core Development Principles

Development in all parts of the City should make a positive contribution to neighbourhoods of choice including:

- creating well designed places that enhance or create character;
- making a positive contribution to the health, safety and wellbeing of residents considering the needs of all members of the community regardless of age, gender, disability, sexuality, religion, culture, ethnicity or income;
- protect and enhance the built and natural environment;
- minimise emissions, ensure efficient use of natural resources and reuse previously developed land wherever possible;
- improve access to jobs, services, education and open space by being located to reduce the need to travel and provide good access to sustainable transport provision.

Saved UDP Policies

Whilst the Core Strategy has now been adopted, some UDP policies have been saved:

Citywide Development Control Policies -26 Development and Noise

DC26.1 The Council intends to use the development control process to reduce the impact of noise on people living and working in, or visiting, the City. In giving effect to this intention, the Council will consider both:

a) the effect of new development proposals which are likely to be generators of noise; and
b) the implications of new development being exposed to existing noise sources which are effectively outside planning control.

DC26.2 New noise-sensitive developments (including large-scale changes of use of existing land or buildings), such as housing, schools, hospitals or similar activities, will be permitted subject to their not being in locations which would expose them to high noise levels from existing uses or operations, unless the effects of the noise can realistically be reduced. In giving effect to this policy, the Council will take account both of noise exposure at the time of receiving a planning application and of any increase that may reasonably be expected in the foreseeable future.

DC26.3 Developments likely to result in unacceptably high levels of noises will not be permitted:

a) in residential areas;
b) near schools, hospitals, nursing homes and similar institutions; and
c) near open land used frequently for recreational purposes.

DC26.4 Where the Council believes that an existing noise source might result in an adverse impact upon a proposed new development, or where a new proposal might generate potentially unacceptable levels of noise, it will in either case require the applicant to provide an assessment of the likely impact and of the measures he proposes to deal satisfactorily with it. Such measures might include the following:

a) engineering solutions, including reduction of noise at source, improving sound insulation of sensitive buildings or screening by purpose-built barriers;
b) layout solutions, including consideration of the distance between the source of the noise and the buildings or land affected by it and screening by natural barriers or other buildings or noncritical rooms within a building; and
c) administrative steps, including limiting the operating times of the noise source, restricting activities allowed on the site or specifying an acceptable noise limit. Any or all of these factors will be considered appropriate for inclusion in conditions on any planning permission.

DC26.5 The Council will control noise levels by requiring, where necessary, high levels of noise insulation in new development as well as noise barriers where this is appropriate.

DC26.6 Exceptions to the general policy will be considered on their merits. The Council accept, as an example, that the occasional use of outdoor facilities such as sports stadia for concerts can be acceptable in certain circumstances. Any such proposal will be considered in the light of consultation with local residents and others, and the practicability of appropriate conditions on any approval.

Reasons:

It has become increasingly accepted that noise is a major source of environmental pollution, affecting peoples' physical and mental health. The Council considers that the planning process has a role to play in reducing noise levels generally and, through the development control system, to consider carefully the relationship between different land uses from the point of view of noise generation and impact. Reaching judgments on what is or is not an acceptable amount or type of noise is a complex matter, consideration of which will depend on the particular circumstances on the ground. (NOTE: The Council will issue more detailed advice on the subject as supplementary guidance, and this will have regard to current Government policy. The UDP policies therefore are limited to broad principles.) Two key areas are:

a) a presumption against allowing highly 'noise sensitive' uses (such as housing and schools) so close to existing noise sources that problems would be likely to result. An existing noisy factory, for example, is entitled to some protection from objection about its activities from future residential neighbours, who would themselves feel entitled to a reasonable degree of residential amenity; and

b) the reverse situation, where there would be an equal presumption against allowing noisy, or potentially noisy, activities into an area with low ambient noise levels, and where people would have a reasonable expectation that no significant increase in those background levels would be allowed. Where the relationship is difficult to predict, the Council will place the onus for assessing the noise impact of, or upon, a proposed new development on the developer, and will consult (in particular) with the Director of Environmental Health. The policy sets out the range of measures which are available to help to reduce the noise effect to acceptable levels. As well as conditions on any planning permission, a 'planning obligation' (for example, an Agreement under Section 106 of the Town and Country Planning Act 1990) may be appropriate to ensure key measures are taken effectively.

3.6 National & International Standards

The following reference documents and guidance constitute some of the more important sources of information relating to noise and the planning process:

World Health Organisation (WHO) Guidelines for Community Noise 1999

The guidelines were prepared as a practical response to the need for action on community noise at a local level, as well as the need for improved legislation, management and guidance at the national and regional levels.

The health-based guidelines serve as the basis for deriving noise standards within the framework of noise management. Key issues for noise management include models for forecasting and assessing noise.

WHO says that the health effects of noise exposure are considered to be a public health problem of growing importance, where specific effects include sleep disturbance, annoyance responses, cardiovascular/psychological effects, performance reduction effects and effects on social behaviour. The guideline values have been derived from scientific studies over many years.
Table 4.1 of the WHO document provides guideline values for community noise in specific environments which are repeated in the table below:

Table 2: WHO community noise guideline values

Specific environment	Critical health effect(s)	LAeq (dB)	Time base (hours)	LAmax, fast (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

Environmental Noise Guidelines for the European Region 2018

The WHO Regional Office for Europe, which remain relevant following Brexit, have provided guidance based on the growing understanding of health impacts of exposure to environmental noise. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources such as transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise with the aim of protecting communities from the adverse effects of noise.

British Standard BS 8233: 2014 Guidance on Sound Insulation and Noise Reduction for Buildings

British Standard BS 8233 provides design guidelines for appropriate internal acoustic environments within buildings according to their function. It deals with control of noise from outside the building, noise from plant and services within it, and room acoustics for non-critical situations.

Table 4 in section 7.7.2 of the Standard provides indoor ambient noise levels for residential dwellings which are shown below:

Table 3: BS 8233 noise levels for residential dwellings

Activity	Location	07.00 to 23.00	23.00 to 07.00
Resting	Living room	35 dB $L_{Aeq, 16hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq, 16hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq, 16hour}$	30 dB $L_{Aeq, 8hour}$

These are the sum total of structure borne and airborne noise sources. Ground borne noise should be assessed separately.

The levels are based on WHO guidelines and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow this typical pattern, i.e. a nightclub operating between 23.00hrs to 03.00hrs, a more focused assessment should be carried out e.g. 1 hour may be used.

Regular individual noise events (aircraft or trains) can cause sleep disturbance and therefore a guideline may be set in relation to the SEL or $L_{Amax,F.}$

If closed windows are to be relied upon to meet the values, there needs to be an appropriate alternative means of ventilation that does not compromise the façade insulation or the resulting noise level.

The Standard states that where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5dB. However, consultants should not base their assessment on the 5dB relaxation.

Annex G contains a calculation method for noise levels inside a room, which is expected to be used for residential uses.

British Standard BS 4142: 2014 +A1 2019 - Methods for rating and assessing industrial and commercial sound

British Standard BS 4142 looks at the assessment of noise of a commercial / industrial nature. It describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The assessment method is based on the difference between the measured 'background sound level' without the influence of any industrial noise source, and the 'rating level' of the industrial source, at the receiver location.

The background sound level ($L_{A90,T}$) is the sound level existing in the absence of the 'specific sound level' at the receiver location. The specific sound level ($L_{Aeq,Tr}$) from the industrial source can be subject to a certain weighting (penalty) where it displays an identifiable character (such as tonality, impulsivity, intermittency or otherwise distinctive features) to provide a 'rating level' ($L_{Ar,Tr}$).

The background sound level is subtracted from the rating level and the difference used to inform the assessment of the effects. BS 4142 advises: 'The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level *and* the context in which the sound occurs'.

In the absence of any instruction in the Standard, Appendix A shows an example of how to calculate a 'typical' background sound level from a set of noise measurement data.

BS 4142 advises that an initial estimate of the impact of the specific sound be conducted by subtracting the measured background sound level from the rating level and consider the following:

- Typically, the greater this difference, the greater the magnitude of the impact.

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

The standard is not designed to assess noise which is not of an industrial nature such as noise from sports facilities or noise from bars, pubs or clubs, public address systems or construction and demolition.

British Standard BS 5228: 2009 +A1 2014 Code of practice for noise and vibration control on construction and open sites

This British Standard is divided into two parts:

Part 1 provides basic information on the prediction and measurement of noise from construction sites and operations. Methods of assessment are included as well as review of relevant legislation. A database of noise levels for a wide range of equipment is also provided.

Annex E provides example guidance on the assessment of construction noise, which includes a method of assessment of noise during daytime, evening and night-time periods (ABC method).

Part 2 deals with vibration from construction and open sites. The legislative background is provided, together with information on vibration control. A review of relevant vibration criteria is provided together with guidance on measuring vibration.

Annex B provides guidance on the effects of vibration levels on human receptors, as well as guide values for cosmetic damage to building structures. Vibration values have been presented as Peak Particle Velocity (PPV) parameters, measured in millimetres per second (mm/s).

BS 5228-2 indicates that construction activities (particularly piling) generally only generate vibration impacts when they are located less than 20 metres from sensitive locations. The effect depends on the type of piling, ground conditions and receptor distance.

‘Best Practicable Means’ (BPM) should be adopted as a minimum in order to mitigate against construction phase noise effects.

British Standard BS 6472: 2008 Guide to the evaluation of human exposure to vibration in buildings

This British Standard provides guidance on the likely human response to differing levels of vibration. This standard should be used to assess the likely adverse impact of developments which are likely to cause significant levels of vibration. Where there is a concern that

vibration caused by a development may damage or otherwise effect the structure of another building, BS 7385: 1990 Evaluation and measurement of vibration in buildings, can be used to determine the likelihood of this occurring.

3.7 MCC assessment criteria

In the context of government policy, the Council require that developments aim for:

1. A noise level between the **No Observed Effect Level** (this is the level of noise exposure below which no effect at all on health or quality of life can be detected) and the **Lowest Observed Adverse Effect Level** (this is the level of noise exposure above which adverse effects on health and quality of life can be detected). Conditions may be attached.

If point 1 cannot be achieved, then:

2. If the assessment results in a level between the **Lowest Observed Adverse Effect Level** and the **Significant Observed Adverse Effect Level** (this is the level of noise exposure above which significant adverse effects on health and quality of life occur), mitigation will be necessary to reduce the level and thus conditions will be attached.

If points 1 & 2 cannot be achieved, then:

3. If the assessment results in a **Significant Observed Adverse Effect Level** after mitigation, the application will be recommended for refusal.

3.7.1 MCC guidance

The NPPF, NSPE and NPPG do not present absolute noise level criteria which define SOAEL, LOAEL and NOAEL which is applicable to all sources of noise in all situations in a planning context.

One of the aims of this document, therefore, is to address this ambiguity and provide a suite of noise level design targets for typical developments (which are in accordance with current policies and standards).

Where certain developments are not specifically covered, the applicant/consultant is encouraged to contact us with a view of discussing the best that can be achieved for the given situation (in the context of the scenarios listed in section 3.6).

3.7.1.1 Residential Developments

The Council has adopted the following noise limits for residential properties:

- **Bedrooms (night time - 23.00 - 07.00) 30 dB L_{Aeq} (individual noise events should not normally exceed 45 dB $L_{Amax,F}$ by more than 10 times)**
- **Living Rooms (daytime - 07.00 - 23.00) 35 dB L_{Aeq}**

- **Gardens and terraces (daytime) 55 dB L_{Aeq}**

These criteria have been adopted for the following reasons:

- BS 8233: 2014 recognises these levels as a good standard for resting/sleeping conditions.
- The WHO document 'Guidelines for Community Noise' recommends an internal L_{Aeq} of 30dB for optimal sleep conditions (and no more than 35dB for internal rooms during daytime).
- The performance of acoustic insulation schemes can often be below that specified, according to the quality of installation, materials, noise spectrum and deterioration / wear and tear of building elements. A high design specification introduces a 'safety margin' should building elements not perform as well as expected ('on-site' performance).
- Performance specification for glazing does not usually take into account the detrimental effect of vents on the sound insulation. Even 'acoustic' vents will reduce the performance of the facade insulation, as they will inherently contain a free open area for air exchange.
- There is a general increase in urban noise levels, which can in the future be reasonably accommodated by these standards.
- The standards support the Local Authority corporate objective to prevent ill-health and improve local peoples' health and well being.

3.7.1.2 Entertainment Venues

Noise from entertainment venues, e.g. noise from recorded music, live bands, or karaoke, can be particularly annoying for local residents and businesses if not adequately contained within the venue.

When considering the potential impact of a proposal for an entertainment venue, consultants should consider the overall noise level (L_{Aeq}) and the 63 Hz and 125 Hz octave band noise levels (L_{eq}). Music noise in the 63 Hz and 125 Hz octave bands, often described as 'bass noise', is particularly difficult to contain and the impulsive and non-steady character of low frequency music noise is particularly disturbing for local residents exposed to it.

Applicants and consultants should note that, although a particular business model may require a 'chilled out' or 'acoustic' venue, planning approval for an entertainment venue will remain in place as long as the development exists. Subsequent owners or tenants may wish to provide louder entertainment in the future. For this reason, applicants and consultants should predict the noise impact of a proposed entertainment venue using noise levels representative of those found in 'typical' venues of the kind being applied for. Consultants should provide their rationale for using particular noise levels and reference the source of the noise levels used during their predictions.

A lively city centre bar can operate around 95dB L_{Aeq} and nightclubs can be even higher at 105dB L_{Aeq}. The range of levels at 63Hz and 125Hz octave bands is wider than the A-weighted levels and can be up to 115dB L_{eq} and 110dB L_{eq} respectively (Davies *et al* 2005).

There is a lack of consensus on an assessment method for noise levels within habitable rooms with regard to entertainment noise. The design aim, however, should be to design to

'inaudible'*. The building structure is therefore key and will usually involve a high performing solution in loud music venues.

Existing noise standards/criteria are not appropriate for evaluating low frequency noise; in almost all other situations the established noise descriptors are based on the A-weighted sound level (dBA), which effectively filters out low frequency sounds (Moorhouse *et al* 2011).

When dealing with noise control, especially at the lower frequencies, it is usual to look at the octave band data as a Z-weighting (linear) and not the A-weighting, due in main to the amount you have to 'take off', resulting in meaningless data (-26.2dB at 63Hz), and also with respect to the sound insulation performance of various constructions materials.

Rather than just A-weighted levels being assessed, e.g. internal noise levels as per BS 8233: 2014, a low frequency band analysis should be carried out (McCullough *et al* 2004).

*Noise is considered to be inaudible when it is at a sufficiently low level such that it is not recognisable as emanating from the source in question and it does not alter the perception of the ambient noise environment that would prevail in the absence of the source in question.

The DEFRA report 'Noise from Pubs and Clubs – Phase 1' on page 17 reproduces the Institute of Acoustics (IOA) working group guidance to achieve music noise levels which are 'virtually inaudible' inside a residential property.

In the 'Procedure for the assessment of low frequency noise complaints (NANR45) – Revision 1', Moorhouse *et al* (2011) use limits for low frequency noise levels in 1/3 octave bands between 10Hz and 160Hz.

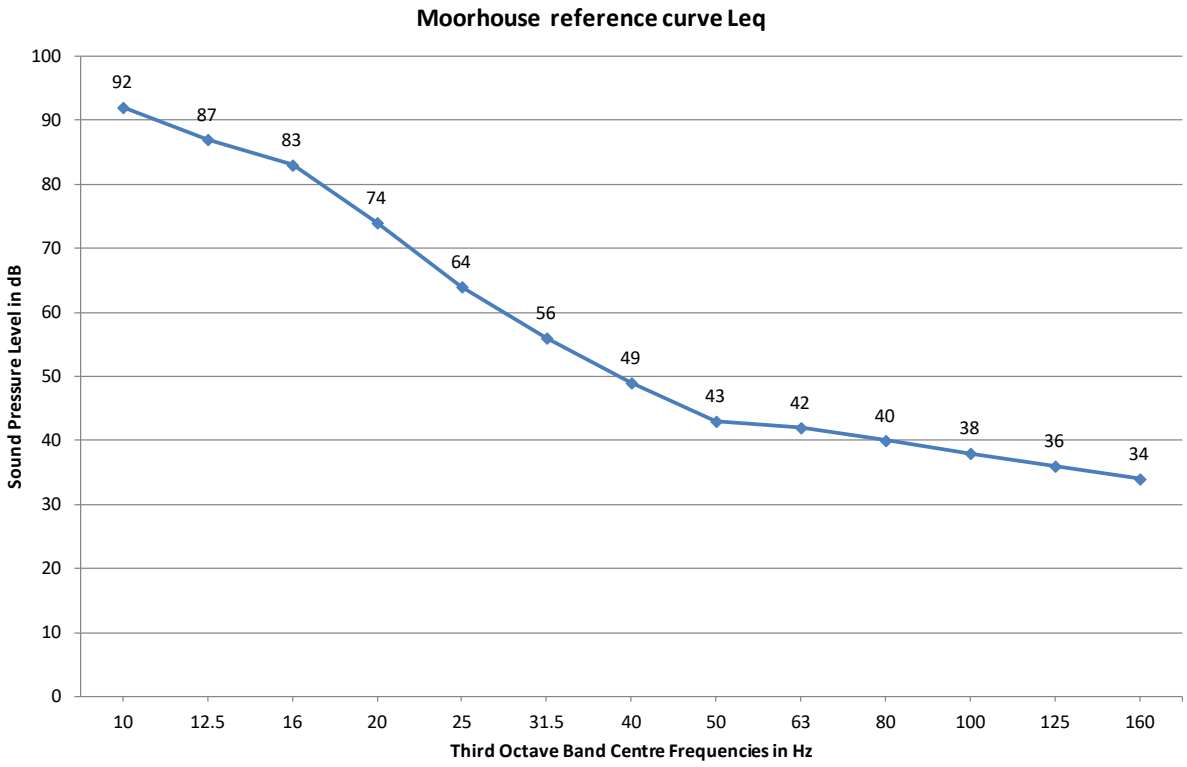

Figure 1

For the assessment of low frequency music noise, it is more practical to consider the 63 Hz and 125 Hz octave bands. The Noise Council's Code of Practice (1995) on 'Environmental Noise Control at Concerts' suggests limits on both these octave bands.

The DEFRA report 'Noise from Pubs and Clubs – Phase 1' suggests limits on 1/3 octave bands. However the problem with this particular suggestion, and one of the reasons it is not widely used, is due to the difficulty in obtaining 1/3 octave band sound insulation performance data for various construction materials.

With regards to assessing music noise, the 63 Hz and 125 Hz octave band levels as shown in Figure 1 have been plotted against the NR 15 curve as shown in Figure 2, and a good correlation at low frequencies is evident (the octave bands were calculated from the 'Moorhouse curve' by logarithmically adding the adjacent 1/3 octave bands).

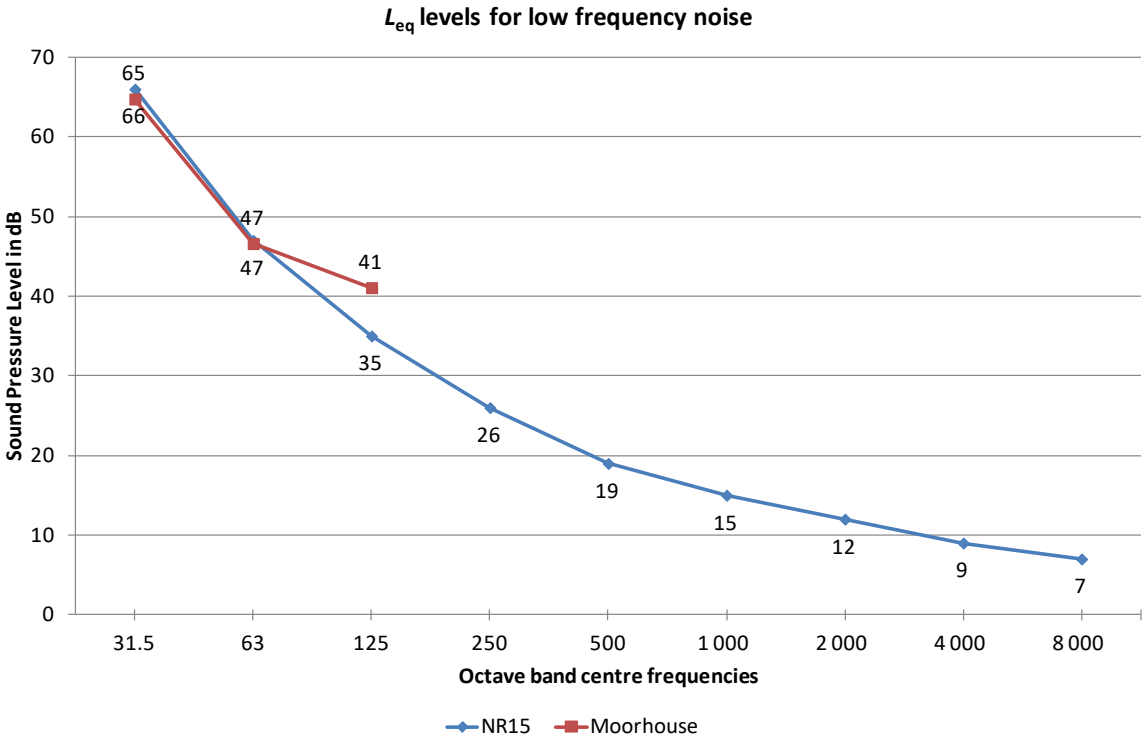

Figure 2

However, the NR curve may be too stringent at mid and higher frequencies and may be lower than background noise levels in habitable spaces. Furthermore, the NR curve is most commonly used to set limits for mechanical services noise in buildings, i.e. steady, continuous noise sources. Music noise has different characteristics and as such can be described as unsteady and non-continuous in comparison.

Even though the Moorhouse curve does not specifically relate to entertainment noise (as per the caveat in the revised edition) these levels provide a good practical basis to assess low frequency music noise. They also provide a workable prediction for planning applications and a measurement method and assessment for in-situ low frequency issues in existing habitable spaces.

Therefore, a criterion that would achieve a condition of 'inaudible' / 'virtually inaudible' which is applicable for new residential developments that are structurally connected to entertainment venues (or vice versa) would be:

'Music noise levels in the 63Hz and 125Hz octave centre frequency bands (L_{eq}) should be controlled so as not to exceed (in habitable rooms) 47dB and 41dB ($L_{eq,5min}$), respectively'.

This criterion may also be applicable for new residential developments that are structurally separate from an existing entertainment venue.

A planning application for a new entertainment venue that is structurally detached from other building uses should demonstrate that music noise from the proposal will not be 'audible' in nearby residential properties, assuming that the residential properties in question have their windows open. The criterion here is:

'Entertainment noise ($L_{Aeq,5min}$) should be controlled to 5dB below the typical background noise level (L_{A90}) in each octave band at the nearest noise sensitive location'.

Depending on the circumstances it could be that both the above criteria are applicable for the same development (new entertainment venue). In order to control music noise levels so as not to exceed any agreed maximum permissible operating levels, as a last resort, a suitable noise limiting device may be necessary to install, in addition to structural acoustic treatments such as uprated lobby systems and size, location and fixing of loudspeakers.

3.7.1.3 Mixed Use Developments

Where a planning application includes a proposal to contain a potentially noisy development within the same building as a noise sensitive use or vice versa the noise survey should consider the transfer of noise between the noisy and noise sensitive uses. An example of where this should be considered would be a proposal for a bar or club within the same building as residential properties (see section 3.6.1.2).

Consultants should demonstrate that the structure of the development will be sufficient to adequately contain the noise generated within the development. In doing so consultants should consider:

- flanking noise;
- structure borne noise;
- the overall level of noise (L_{Aeq}) generated by the use in question and any tonal or impulsive characteristics that the noise may contain; and
- the acoustic properties of the development (including the construction of party floors and/or walls, windows and doors, ventilation systems, and structural columns.)

3.7.1.4 Construction / demolition phases

Noise from construction or demolition works as part of a development can be intrusive or disruptive to local businesses and/or noise sensitive land uses. For this reason, construction or demolition activities should be restricted to daytime periods and have finite start and finish times.

All noisy works (i.e. those that are audible beyond the site boundary) should be restricted to the following hours to minimise disruption:

- **Monday - Friday: 7.30am - 6pm**
- **Saturday: 8.30am - 2pm**
- **Sunday / Bank holidays: No work**

These restrictions apply to deliveries/collections to the site.

By utilising set working hours for activities on site as well as deliveries to the site, respite is provided for local residents and businesses near to the development. Noise and disruption to local residents will occur during development works, so it is important to remember that local residents may not necessarily be in favour of the development or all aspects of it. By keeping an open dialogue and attempting to placate any complaints or grievances, the development is likely to progress more efficiently.

For larger developments or developments that are likely to progress over a long period of time, it may be worth considering a 'Considerate Contractors Scheme'. These schemes suggest guidelines to minimise disruption to local residents and businesses and provide a code of conduct for employees on site so that their work does not unduly upset local residents and/or businesses. These schemes include noise as well as many other elements such as dust suppression, deliveries, working hours, behaviour on site, approved delivery routes, etc.

A Construction Management Plan (CMP) shall be submitted to and approved by the Council for large schemes. This should contain a Noise & Vibration section that bases the assessment on BS 5228 (see section 3.5), with reference to other relevant standards. It should also contain a community consultation strategy which includes how and when local businesses and residents will be consulted on matters such out of hours works.

3.7.1.5 Industrial / commercial developments

BS 4142 should be used to assess the likely impact of noise from industrial and commercial sources at noise sensitive premises (section 3.5). One of the indications of the impact of a BS 4142 assessment is the lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

The Council consider that new developments should contribute and enhance the area in which they are located and where possible i.e. prevent ‘noise creep’, contribute to the improvement of people’s health and quality of life as per the NPSE. With this in mind, the design objective should be:

‘The development should be designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.’

Where this criterion cannot be achieved, the various noise control measures considered as part of the assessment should be fully explained (i.e. relocation of noise sources, use of quieter equipment, enclosures, screening, restriction of the hours of operation) and the achievable noise level should be identified. This information will allow a judgement to be made concerning the application and its likely impact on the surrounding area.

In addition to the above, maximum noise levels should also be adequately controlled. Where particular uses generate high noise levels of a short duration (e.g. loud bangs) on a regular basis, these should aim to be controlled so as not to exceed 60 dB (L_{Amax}) at the façade of noise sensitive premises nearby in accordance with the recommendations of the WHO (section 3.6).

Deliveries and collections are usually controlled by restricting operational hours but depending on the extent of these activities, a Noise Management Plan (NMP) may be requested, which would include an assessment of noise. This would usually involve assessing the noise upon arrival, loading/unloading period and then departure.

The NMP may also need to include controls such as acoustically sealed delivery bays, and restrictions on vehicle mounted refrigeration units and audible alarm systems. Where applicable, the noise assessment will take account of multiple noise sources operating simultaneously and report the cumulative impact.

Noise and vibration from fixed plant / equipment

Noise from fixed plant, equipment or machinery can be very annoying and disruptive to people living nearby particularly where that item involved emits a noise with impulsive or tonal characteristics.

Many of the complaints Environmental Health receive about noise from plant, equipment and machinery specifically concern the character of the noise emitted. Any noise assessment needs to consider not only the overall level of noise emitted, but also its particular characteristics. The noise assessment should be based on BS 4142, and any application for fixed plant, equipment or machinery must demonstrate that:

'Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location'.

By designing the sound pressure level of any plant items to generate a noise impact of at least 5dB below the existing background level, any plant noise impact should be of a negligible level which should not give rise to complaints from users or occupiers of existing noise-sensitive usages. See Appendix A with regards to the expectation of how to calculate a 'typical' background level.

Past experience has shown that this criterion can be readily achieved. Where available, product specification data for new items should be submitted with the acoustic report. Consultants should be using these to compare with data from the noise survey and propose mitigation where the levels are above those specified in the criterion. Where this information is not available a consultant may choose to measure the noise, levels generated by the equipment in question where the equipment has already been installed elsewhere (and in accordance with BS 4142).

Where fixed plant, equipment or machinery is attached to a building the vibration caused by it can pass through the building structure and cause structure borne noise elsewhere in the building. Where it is to be installed in or on a building containing a noise sensitive use structure borne noise should be considered in the noise assessment and adequate control measures should be proposed. An example of where this would be required is where there is a proposal to install ventilation equipment on the roof of a residential apartment block or it could be an air source heat pump attached to the side of a building.

3.7.1.6 Other potentially noisy activities

The following types of development proposals or applications may have additional specific guidance published to review noise impacts or may otherwise be a potential source of noise.

It is recommended that pre-application discussions are held with the Environmental Protection Team at www.manchester.gov.uk if any of the following application types are to be submitted:

- Motor car/bike tracks/speedways
- BMX, skateboard, scooter, mountain bike tracks
- MUGAs
- Sport stadia
- B2 Use Class developments
- Wind Turbines
- Gymnasia

The above list is far from exhaustive, however it highlights some of the applications that have been considered with particular attention to noise in the past.

4.0 Determining planning applications

Consideration of noise will depend upon the development proposal. If a particular development is for a noise-sensitive end use then consideration of the locality of the proposal is an important aspect of any application.

The review will also consider the operational times of local businesses as well as any noise that they may emit. Transport noise sources may also affect recommendations made, especially if the development proposal is near to a busy road or rail/tram line.

Noise conditions may include recommendations for upgraded sound insulation, which can be a vital means of protecting future occupants from transport noise or industrial/commercial noise sources.

However, upgraded glazing, for example may only protect or mitigate against noise if windows are kept shut. As such, some developments may also need to provide acoustic trickle vents and/or acoustically treated forced ventilation, to help reduce the need to open windows in the first place (see section 5.3).

Consideration for new businesses will typically involve a review of the noise likely to be emitted from the business. This can include plant or equipment associated with that business and its operation but may also consider transport noise from deliveries or dispatched merchandise as well as possible increased traffic flows from visitors or staff arriving or leaving the site.

Certain types of business may also be expected to have similar patterns of operation; for example, bars and hot food takeaways tend to concentrate on afternoon and evening trade, whereas storage and distribution centres are likely to include overnight operations.

All development proposals should consider the ambient noise levels already present in a given area. For developments that are likely to have an impact as per what has been stated in section 3.6, consideration of appropriate acoustic mitigation measures will be necessary to reduce the impact from the development site to an acceptable level.

4.1 Planning Use Classes

The Town and Country Planning Order 2020 puts uses of land and buildings into various categories known as 'use classes'. Sufficient knowledge of where development proposals fit into the use class system may provide an indication of the key considerations with respect to noise.

It is important to note that noise impact from transport networks can only be dealt with at the planning stage, as current legislation prevents action being taken either to increase insulation at affected properties or to take action against road users for noise. As such, on a legislative basis, noise which is likely to affect development from traffic must be addressed at the planning stage if it is to be addressed at all.

Potentially noisy development may cover a large range of different activities and planning use classes. Typically, the following use classes would be considered to have a greater impact on noise sensitive land uses at or around the proposal site:

- A3/A4/A5 Retail Food and Drink activities
- B2/B8 General Industry and Warehouse activities
- D1/D2 Non Residential Institutions and Assembly and Leisure activities
- Sui Generis uses are inherently more varied therefore specific consideration of any proposal within this category is required to ensure that any noise impacts are minimised.

4.2 Planning conditions

NPPF, Para 206, states that conditions should only be imposed where they are:

- Necessary
- Relevant to planning and the development
- Enforceable
- Precise
- Reasonable in all other aspects

Noise conditions often require an assessment of noise and the submission of a scheme of works to achieve target or previously agreed noise levels. Conditions may also relate to operating hours, opening hours or delivery hours where these are considered to be a key element for controlling noise levels.

Any application for the discharge of a condition must be supported by all information requested in the condition. If any element of the condition has not been addressed either in part or fully, then it is likely that the condition discharge application will be recommended for refusal.

Due to the often complex nature of noise and noise control engineering, it will be necessary to engage an acoustic consultant to address the requirements of any noise conditions attached to a consent. The acoustic consultant may need to carry out noise surveys and recommend appropriate noise mitigation measures either in order to respond to pre-determination requests or in support of applications to discharge conditions.

5.0 Acoustic design

To achieve good acoustic design a hierarchal or sequential approach should be encouraged starting early in the development process, with control at source being the most preferable form of mitigation and façade or off-site treatment representing methods of last resort.

5.1 Stages

The recommended sequence of stages in the planning and early design stages of a development should be to:

1. assess the site; identify significant existing and potential sources of noise, and any nearby noise sensitive locations.
2. determine design noise levels based on the Council's requirements.
3. determine appropriate sound insulation and/or noise control measures.
4. establish quality control and ensure good quality workmanship.

5.1.1 Development considerations

When planning permission is sought for a new building, change of use to an existing building or any other type of development, the Council may:

a) refuse permission if the site is too noisy for the proposed use and local or national policies will not be met; or
b) refuse permission if the proposed use is likely to cause noise disturbance to the occupants of existing buildings such that local or national noise policies will not be met; or
c) grant permission, with or without conditions regarding noise levels, so that local or national policies are met.

Where the actual use of a development is unknown then the worst-case scenario should be assumed, and corresponding noise levels should be used to predict the noise impact of the development.

Some noise sources (e.g. airports) might not always be active or might change their mode of operation under different weather conditions and/or at certain times of day or night. Furthermore, buildings might not necessarily be occupied when the outside environment is noisy. It is therefore essential to make a full assessment of the site before considering the need for, and extent of noise control.

5.1.2 Noise generated within the development

The existing and expected noise source/s should first be identified and the following procedures should be applied:

1. select metrics to use for measuring or predicting noise levels (e.g. $L_{Aeq,T}$)
2. assess effects of topography and other features, such as noise screens or reflecting surfaces.

3. measure or predict noise levels at strategic points. In some complex situations it might be beneficial to produce a contour map of external noise levels.
4. if appropriate, assess noise levels due to user activities around the development.

The levels of existing noise and noise expected in the foreseeable future should be based on measurement where practicable or may be predicted if there is reliable information.

5.1.3 Noise generated outside the development

For noise sources outside the building, the initial appraisal should take into account of the options for:

1. location of the site in relation to the noise source/s.
2. reduction of noise at source.
3. positioning of buildings on site.
4. orientation of buildings on site.
5. provision of barriers.
6. increasing the sound insulation of the building envelope.
7. re-planning the interior layout of the building.

These options might also be applicable to protecting neighbouring buildings that are likely to be disturbed by noise generated within the building.

5.2 Assessing noise

In essence the applicant/developer should:

1. compare existing noise levels with the recommended design and/or Council criteria with the noise being produced by the proposal.
2. calculate the noise reduction required.
3. identify which noise control measures would be appropriate to deliver the noise reduction.

The main reasons for requiring a noise assessment would be if:

- there is a planning application for a noise sensitive development, such as a residential development, next to or near an existing noise source, such as busy transport route, or an industrial, commercial or recreational land use.
- there is a planning application for a development that has the potential to cause noise disturbance to existing residential or other noise sensitive properties.

The following information MUST be included in all acoustic reports:

- A statement of the reason for and scope of the report.
- Details of the proposed development to which the report relates.
- A location and development plan.
- A description of the area and environment surrounding the development site

- The methodology used to carry out the noise survey including the location of any noise monitoring locations, the equipment used and details of its last accredited calibration, and the weather conditions at the time the survey was carried out
- Full table of results.
- Assessment of the results in accordance to the relevant standards and policies.
- Recommendations for noise control measures if needed.
- Full calculations of the noise reductions expected to support any suggested noise control measures.

Environmental Impact Assessment

Certain planning applications may fall within the scope of the Environmental Impact Assessment (EIA) Regulations 2017. Where this is the case an Environmental Statement will be required to support the planning application, as stipulated by these regulations. It is likely however, that additional information concerning each aspect of Environmental Protection will be required to fully assess an application, in addition to the considerations contained in a typical EIA.

Acoustic reports should be submitted as part of the planning application. The information is often essential to allow the Council to assess the impact of the proposed development and make recommendations.

It may be that the Council cannot make a decision about the acceptability of the development until a noise survey has been received. Failure to submit an acoustic report with a planning application may therefore delay the application process.

A suitably qualified and experienced acoustic consultant should carry out the noise survey and complete an acoustic report.

The Council is unable to recommend a consultant. However, a list of acoustic consultants can be obtained from the Institute of Acoustics website by following the Members Register link at:

www.ioa.org.uk

5.2.1 Noise survey

Examples of where these are required include:

- Before construction, to establish the existing noise climate at the site of a proposed development where reliable prediction is impracticable, as an aid to the design of the building envelope, either to protect against external noise or contain internally produced noise;
- During construction, to monitor noise (or vibration) from building activity, either to assess the likely nuisance to the local community;
- At the end of a building contract to check the insulation of the building envelope or the noise levels produced by the services; and
- As part of a planning requirement.

A noise survey is used to determine the existing noise environment on or around a particular development site. It is an important part of a noise assessment, as it is the baseline against which any predictions of the noise impact of a development will be compared.

The date, time, and location used to measure noise levels and the methodology used are of the utmost importance to ensuring the survey is accurate and representative of the particular environment in question.

It is important that the survey considers the noise environment around a development at the most appropriate times and on the most appropriate day of the week.

For example:

a) A noise survey for a residential development lying near a busy road should consider the noise levels around the development site during rush hour, during the day, and during the night.
b) A noise survey for a proposed music venue should be carried out at the quietest times the premises will be in operation to ensure the noise survey will be representative of the environment at the most sensitive times when the venue is likely to have its greatest impact.

Depending on the development site and its environment it may be that a longer survey will be required (anything from 24hrs to one full week or more).

Visits will often be necessary to the site to determine where those measurements can be taken and assess any factors that might pose a problem which can include access and safety matters. A discussion and plan of the locations of measurement points around the development site should be provided.

5.2.2 The data

Tables of data associated with the noise survey should be provided in terms of location of measurement points, time taken, and measured or predicted level.

Where there are noise sources with time associated factors, such as a busy road with significant rush hour vehicle movements but possibly many fewer cars traveling on it between these hours, a local rail line with noisy individual night time train passes, local bar/club/take-away adjacent with opening times into the early morning, etc. then a more focused noise survey is needed to establish the impact of these sources (see section 5.3).

Consideration of L_{Amax} values is particularly important for developments near to busy transport networks/hubs and large commercial or industrial premises/sites, where there are potentially high incident noise levels for short time periods which may affect sleep disturbance.

A noise survey may show only one or two exceedences over a long time period, some may indicate frequent exceedences which will represent a large number of potentially sleep disturbing events.

In this case, although a noise insulation scheme might deal effectively with the average L_{Aeq} levels, it may not be designed, or be capable of dealing with these intermittent, but possibly

excessive numbers of exceedences of the L_{Amax} criterion which could have a significant impact on sleep during the night time period.

5.3 Noise control

All reasonable noise control measures should be designed and implemented to ensure that noise level requirements are met. Where possible noise should be controlled at its source. e.g. selecting a quieter equipment specification.

Developers can also consider the design and layout of a development to see if changes would reduce the levels of noise emitted from the development or protect residents from the impact of externally generated noise.

For example, increasing the distance between the noise source and noise sensitive building, orientating a residential building so that bedrooms do not face or overlook a busy road, or placing non sensitive buildings or structures between a noise source and noise sensitive use.

Any proposals to reduce noise at source, by the design and layout of a development, or by building treatments such as acoustic glazing or ventilation should be supported by full calculations to indicate the likely level of noise reduction.

Where it is necessary to keep windows closed to achieve the required internal noise levels it may be a requirement to provide additional ventilation to ensure that residential properties can be adequately ventilated if residents choose to keep their windows closed for noise reasons.

Any ventilation will need to meet the requirements of Part F of the Building Regulations which will be assessed by the Building Control Department. Where additional ventilation is required it should ideally be capable of achieving the same noise reduction as the closed glazing and building structure and minimising the potential for overheating.

5.3.1 Measures to deal with noise reduction

The control of noise is key to ensuring future noise problems are avoided and to ensure that any additional noise has a limited effect on people's health and quality of life.

5.3.1.1 Building orientation

A building should be orientated in such a way as to minimise noise exposure. For example, buildings can be arranged so that they form a natural acoustic barrier against noise sources. This is particularly effective where one side of the development has a dominant noise source, such as a busy road/factory.

The facade facing a noise source should be constructed with suitable acoustic mitigation measures built in. Acoustically treated forced ventilation may also be necessary to minimise the need to open windows.

These techniques can be used to great advantage, particularly if designed in conjunction with the layout of the rooms, allowing bedrooms or living rooms to face away from a noise source (see section 5.3.1.3).

5.3.1.2 Screening

Complete enclosure of the noise source or receiver is the most effective form of barrier (providing it is impervious and sufficiently heavy). The walls and roof of a building usually perform this function for a noise sensitive development whereas acoustically enclosing plant or equipment may be applicable for noise making developments.

Barriers or acoustic screens that are not complete enclosures (e.g. screens/fences) are normally most effective when tall, long, sound-absorbent and close to either the noise source or receiver.

Whether they are an existing feature, such as a railway cutting or embankment; a purpose-designed acoustic barrier, such as a solid boundary fence or earth mound; a purpose-designed feature of the building, such as a courtyard; or the building itself, which attempts to arrange sensitive internal spaces away from any noise source, barriers can prove extremely effective in mitigating or attenuating noise.

They protect low-rise buildings better than high rise buildings. Generally, the taller the barrier the better, but there are physical limits above which the barrier will not realistically offer any additional protection. They should usually extend well beyond the site boundary to ensure adequate protection is offered.

Acoustic barriers are usually constructed from timber, although any solid material with a sizeable mass per unit area will provide acoustic shielding. Barriers can even be made from transparent/opaque materials such as plastic, for areas where visual amenity may be of importance.

It is vital that an acoustic barrier does not have any gaps within it, as even a small gap or hole in the barrier at ground level is sufficient to render it ineffective.

If a barrier or enclosure is proposed or required as part of a development, full calculations will be necessary in addition to any related product specification data.

5.3.1.3 Building layout / design

When considering the layout of a proposed building, it may be better to locate non habitable rooms, such as kitchens, bathrooms and stairwells on the noisier aspects of the building. This allows these non-sensitive rooms to act as an acoustic barrier to the more sensitive, habitable rooms, which are located at the quieter side of the building.

For semi-detached/terraced houses and flats/apartments, the positioning of rooms relative to those in the adjacent residences is important to ensure that noisier areas such as kitchens, living rooms and bathrooms do not share party walls, ceilings or floors with bedrooms residing in separate occupancy.

Such incompatible adjacent room types are highly likely to give rise to noise complaints in the future. If the layout of a building is such that these incompatible room types are adjacent to each other, either vertically or horizontally, then it is likely that uprated acoustic measures will be required in the walls and/or floors to mitigate against noise transfer.

Building Regulations Approved Document E considers impact noise through floors and provides appropriate mitigation measures to counter the effects of footfalls, but it does not consider impact noise through walls that would be commonplace in kitchen areas through the closing/slamming of kitchen doors and drawers. This can be a significant source of noise if a kitchen in one property is adjacent to a bedroom in an adjoining property.

5.3.1.4 Sound insulation schemes

The required sound insulation should be determined on the basis of the assessment of:

1) the level and characteristics of the noise outside the building
2) the design criteria noise levels in the rooms and other spaces of the building.

A suitable sound insulation scheme should be suggested which meets the required Council internal noise criteria.

In its simplest terms, when the attenuation factor for the building element is subtracted from the measured noise level, the resulting figure should be at or less than the appropriate noise criterion target level.

Therefore if, for example, the night time average is 50dBL_{Aeq}, then the glazing must be capable of attenuating external noise by at least 20dB in bedrooms to achieve a level of 30dBL_{Aeq} in the bedroom at night time.

If the average daytime measured external level is 65dBL_{Aeq}, then a reduction of 30dB is needed to bring noise levels internally in living rooms down to 35dBA, which requires a higher specification window. If this latter specification were applied to the whole development, then both living room and bedroom noise reductions would be satisfactorily achieved.

The impact of trickle vents if to be fitted to the window panels needs to be considered, and either a higher specification window panel and/or fitting of acoustic trickle vents to restore internal room levels to within the required noise criteria would be necessary.

5.3.1.5 Windows and doors

The windows and external doors of a building should be to a specification that ensures they provide sufficient insulation against external noise.

To achieve a good standard of insulation external doors should be close sealed with no gaps in or around them and have sufficient mass to resist external noise.

Where necessary, higher standards may be achieved by providing entrance porches with double doors. Providing they are properly fitted; standard thermal double-glazed window units will generally reduce external noise levels by approximately 30dB.

The amount of noise that is reduced by a feature such as a window is known as the Sound Reduction Index (R_w).

Sound reduction indices – R_w, R_{tra}, C_{tr}

Where no particular environmental noise predominates, then consulting a manufacturer's table of sound reduction figures for typical glazing specifications, you can determine the glazing panel which will achieve the level of sound insulation needed. This is expressed as the R_m or R_w. R_m is the 'mean reduction index', and R_w the 'weighted reduction' and incorporates a correction for the ear's response and is often the index quoted.

If the main element of noise is likely to be traffic noise, then another corrective factor needs to be considered, and that is some 'weighting' of the sound reduction levels which accommodates typical traffic frequencies more closely. This is specified as the R_{tra}, Traffic Noise Reduction Index.

Example:

- A development close to a very busy main road is proposed and the noise survey carried out. The night time external noise measurement is 57dBL_{Aeq} and therefore a reduction of at least 27dB is needed to meet bedroom criteria. Looking at a manufacturer's glazing specification, a glazing panel of 4:12:4 will achieve a suitable reduction if in a general noise environment of mixed noise sources.

  BUT because the significant noise source here is traffic, this glazing specification fails to achieve a suitable reduction because the 'R_{tra} is 25dBA, (57-25=32dBA). A more suitable glazing panel would have a specification of 10:12:4 achieving an R_{tra} of 29dBA (57-29=28dBA).

In this case, if the R_{tra} figure was not quoted, the report would not be satisfactory.

Building Regulations and BS EN ISO 717-1 (standard for acoustic testing) introduce a 'correction factor' for low frequency noise, the C_{tr}.

Glazing (and other structural building components) specifications may now quote sound insulation data in terms of R_w with a C_{tr} correction. For example, a manufacturer's 6/16/6.8 glazing unit has an R_w of 38dB and C_{tr} of –6dB.

In a general noisy environment it will be acceptable to quote the R_w rating alone, but when considering specifications in environments where low frequency noise is the principal area of concern, which can include traffic and noise from bars/clubs etc., then the C_{tr} correction should be applied.

Traffic noise can often result in reverberant noise being passed through glass into a building. This is usually due to the glazing panels being constructed of the same thickness of glass meaning that when the outer pane vibrates, it causes the inner pane to vibrate as well.

Acoustic glazing often has different thicknesses of glass incorporated into the glazing unit, meaning each pane has a different reverberant frequency and therefore noise is not transmitted through it as easily.

Increasing the thickness of the panes of glass (for example from 4mm to 6mm) provides an improvement in noise attenuation, as does increasing the air gap between the panes. For example, panes of 10mm and 6mm with a 12mm gap between them will reduce noise levels by about 34dB.

Where external noise levels are very high, standard thermal double-glazing may fail to provide sufficient acoustic attenuation. If this is the case, then higher performance acoustic glazing, which utilises secondary glazing can be considered. This is usually characterised by an air gap between the panes of at least 100mm and can be constructed with secondary sashes.

Again, it is advisable for the two panes to be of different thickness and performance can be further improved if the sides of the air space between the panes are lined with sound absorbent material. Under some circumstances, triple glazing may be sought as a means of noise attenuation, but these measures are only usually required in proximity to sites exhibiting a significant noise impact.

If the rigorous calculation is used as per BS 8233: 2014 and included in the report (for each room type, façade and/or floor level, L_{Aeq}, L_{Amax}, day and night time) then the R_{tra} and C_{tr} correction would not need to be quoted.

Acoustic glazing is only of benefit when the windows are kept closed; this is obviously not always practical, especially if overheating is an issue. Partially opening the window will typically reduce the acoustic performance to 10-15dB.

This is of great concern where the uprated acoustic performance is to protect occupiers of a bedroom, where opening the window to increase ventilation and comfort will instead introduce unacceptable levels of noise which may make sleep difficult.

Windows may also be fitted with acoustic trickle vents, but these are primarily for background ventilation as opposed to rapid ventilation or summer cooling. It may therefore be necessary to introduce alternative acoustically treated mechanical ventilation to bedrooms and some lounge areas, the aim being to increase ventilation rates in a room without physically having to open the window.

Please refer to Appendix B for further technical information.

5.3.1.6 Ventilation & Overheating

The Building Regulations (outside the scope of this guidance) recommend that habitable rooms in dwellings have background ventilation. Along with the specification of glazing for the development a scheme of how such ventilation is to be provided should also be included.

Occupants should be provided with a supply of fresh air in habitable rooms without having to open the windows (whilst also having the option to do this for purge ventilation, or at the occupants' discretion i.e. to reduce the potential for overheating).

If partially open windows were relied upon for background ventilation, the insulation would be reduced to 10-15dB. The indoor noise level criteria for bedrooms and living rooms do not need to be achieved when windows are opened to achieve Part F purge ventilation requirements.

Where ambient noise levels are high a scheme of ventilation will need to be provided that does not compromise the acoustic attenuation afforded by the glazing. This may come in the form of individual window trickle vents or acoustic trickle vents.

Whilst these types of vents do not usually replace opening windows, they aim to minimise the need to open windows, providing a more comfortable internal noise level. The use of acoustic trickle vents can be used to permit adequate background ventilation as required by the Building Regulations Part F. Although it is worth noting that ventilation requirements can vary from dwelling to dwelling.

Purge ventilation is the manual control of ventilation in rooms or spaces at a relatively high rate to rapidly dilute pollutants and/or water vapour. It may be provided by natural means (e.g. an openable window) or by mechanical means (e.g. a fan). It is an intermittent need i.e. painting & decorating, smoke from burnt food BUT is also used to improve thermal comfort.

These vent types usually have an acoustic performance in excess of that of uprated glazing, whilst still allowing background ventilation to occur.

Where ambient noise levels are more extreme and the opening of windows is likely to be required to increase ventilation rates, then it may be necessary to consider forced acoustically treated mechanical ventilation.

This method utilises acoustically treated fans (quiet running) that are capable of providing normal and summertime flow rates, so occupants do not need to open windows during hot summer days.

If combined with a boost facility, then this may reduce the need to open windows for summer cooling or rapid ventilation purposes. Mechanical systems may include fans within individual rooms or may be incorporated as part of a larger scheme, which provides 'whole house' ventilation. This may operate in conjunction with kitchen and bathroom extraction systems to provide both input and output air to the building, sometimes with heat recovery to pre-heat the incoming air during colder periods.

These systems usually filter and acoustically shield the incoming air to prevent external noise entering a building. Sometimes 'make up' air is brought in from the quieter side of the building to utilise the natural acoustic shielding that the building itself provides. Ducted systems with intakes on the quiet side of the building might be required in very noisy situations, or where appearance rules out through-the-wall fans.

Mechanical ventilation is often utilised in Air Quality Management Areas where there is the need to reduce both transportation noise and polluted air from the occupiers of the buildings. Proofing against noise will usually satisfy many air quality issues; reconfiguration of the system to provide make up air from the furthest point away from a transport source or emission will typically satisfy many air quality issues.

When undertaking residential environmental noise assessments noise break-in calculations (as per BS 8233: 2014) must be made to determine what ventilation strategy is required to achieve the internal noise level criteria.

Based on the results of the break-in calculations, the acoustician should advise the developer / design team when trickle ventilators are not a suitable background ventilation strategy, and include a suitable recommendation for a mechanical scheme in the acoustic report to accompany the planning application.

In areas where there are particularly high noise levels and attaining the internal target levels for bedrooms may be particularly difficult, consideration will be given to the installation of sealed glazed units with the provision of mechanical ventilation. It is up to Building Control and developers to ensure that adequate provision for ‘purge ventilation', as required under the Building Regulations Part F is met.

Please refer to Appendix C for further technical information.

Overheating

Overheating can be taken to mean ‘the phenomenon of excessive or prolonged high temperatures in homes, resulting from internal or external heat gains, which may have adverse effects on the comfort, health or productivity of the occupants.

An entirely new Approved Document O was released in December 2021 covering overheating and comes into force on 15 June 2022. This Approved Document covers the overheating mitigation requirements of the building regulations as set out in Part O of Schedule 1 to the Building Regulations and in a number of specific building regulations. Technical guidance is contained in Approved Document O. Approved Document O applies to new residential buildings.

Many buildings require closed windows to provide good internal acoustic conditions whereas opening a window is the normal way to keep a building cool. These opposing requirements are becoming a major issue in the design of buildings, in particular for housing, especially if we are to avoid the widespread use of mechanical cooling to reduce a development’s carbon footprint.

TM59 (CIBSE: Design methodology for the assessment of overheating risk in homes) sets out a methodology for predicting temperatures inside dwellings and provides overheating compliance criteria. It also provides a standardised approach to predicting overheating using dynamic thermal modelling. TM59 acknowledges that the methodology is necessarily prescriptive to enable it to be consistently applied. The design aim should be to avoid the need to open windows during sleeping hours.

An overheating assessment might not always be undertaken for a project and without this information it is difficult to identify noise impacts that may occur during the overheating condition. It is recommended that either where a condition has been imposed to control internal noise levels for residential development or where overheating may be an issue, the guidance provided in the AVO Guide is followed.

The AVO (Acoustics, Ventilation and Overheating) guide was published to address the competing aspects of thermal and acoustic comfort and how these can be managed. It seeks to help those involved in building design and/or the Planning process to understand the likely degree of noise disturbance when windows are opened. It recommends an approach to acoustic assessments for new residential development that take due regard of the interdependence of provisions for acoustics, ventilation, and overheating.

5.3.1.7 Plant and equipment

Noise from external plant, equipment or servicing items are assessed when determining planning applications. Typical equipment in both commercial and residential developments includes items such as air conditioning plant, retail refrigeration plant or lift motors.

Industrial developments are much more varied with the types of plant and equipment being entirely related to the industry in question.

The design aim here should be to meet the criterion in section 3.6.1.5.1. Consideration should initially be given to selecting the most low noise emitting models of plant and equipment possible. If this is not feasible, then it may be advisable to consider relocating noisy plant and equipment to a less noise sensitive area of the site and/or away from multiple reflecting surfaces.

It may also be possible to erect acoustic shielding around any necessary plant and equipment to contain noise and prevent it causing problems off-site. Some equipment may require additional acoustic mitigation measures to control the impacts from tonal noise or intermittent operation.

The use of any plant and equipment overnight usually causes an increase in noise sensitivity, so it may be advisable to limit use during night time periods if possible.

Consideration of the above measures at an early stage of the planning process is likely to progress an application more swiftly.

5.3.1.8 Vibration

Significant vibration within the City, with the exception of temporary construction works, is only likely to be generated by the movement of trains or trams travelling along railway lines.

Ideally, track form and wheel/rail interface would be in the optimum condition to minimise vibration generation and /or curving noise. However, wear and tear will over time change the condition of the track surfaces. Design and maintenance are therefore essential elements of any new lines / operations.

Road traffic is unlikely to generate any significant vibration, providing the road wearing surface is in reasonable repair. The exception to this is where there is a significant proportion of Heavy Goods Vehicles (HGV) traffic present, as this can create vibration issues regardless of road surface condition.

A vibration assessment (which is usually based on BS 6472: 2008) will be required where railway/tram lines are within 20m of a proposed development site. It is important that vibration issues are considered, and measurement data supplied in the report, together with mitigation proposals if vibration without these works has been identified as a potential problem.

Building services, including air conditioning and air handling plant, may generate vibration and in turn, re-radiate noise within buildings. All building services plant and equipment should be supported on proprietary anti-vibration mounts. As such, planning permission granted for the installation of services, plant and equipment may include a condition to assess or control plant vibration.

BS 5228-2 indicates that construction activities (particularly piling) generally only generate vibration impacts when they are located less than 20 metres from sensitive locations. The effect depends on the type of piling, ground conditions and receptor distance. 'Best Practicable Means' (BPM) should be adopted as a minimum in order to mitigate against construction phase noise effects.

Ground borne noise may also be an issue and should be factored into any assessment/design where necessary. As this is a highly specialised area of acoustics it is advisable that the appropriate consultant is engaged if this has been identified as a potential impact.

5.3.1.9 Quality control & workmanship

Quality control and workmanship should always be considered very carefully. Noise control measures can fail to perform adequately if they are not built as the designer intended. Such failures can have serious implications for noise control e.g. incorrect fitting of windows, floating floor systems, incorrect mounting of plant/equipment etc. will reduce acoustic performance.

Effective sound insulation and noise control often require careful detailing on the part of the designer and a high standard of workmanship on the part of the contractor. Correct execution of the detailing should be checked on site and the completed development should be fully commissioned where required before handover. As a result, post completion testing/reporting will likely be required as part of a planning condition, which will include noise measurements of the indoor environment once the building is completed.

It is expected that at least 10% of rooms in buildings are subject to noise validation testing. Measurements should be taken in accordance with the Association of Noise Consultants' Measurement of Sound Levels in Buildings (and with the overheating mitigation strategy in use, where this applies). There is also a section on considerations when evaluating a building for post construction compliance in a 'Guide to Demonstrating Compliance with the Noise Requirements of Approved Document O', July 2022.

Noise control is only one aspect of environmental design and designers should be aware that the solution to a noise problem can cause difficulties elsewhere e.g. thermal insulation, solar gain/overheating, cold bridging, ventilation and condensation. These issues should be considered at the very early stage of the design process.

The in-situ sound reduction performance of building elements is often less than the specified performance tested under laboratory conditions.

6.0 References

Acoustics, Ventilation and Overheating (AVO) Residential Design Guide (January 2020) IoA, ANC & CIEH

BS 4142: 2014 +A1 2019 *Methods for rating and assessing industrial and commercial sound*

BS 5228: 2009 +A1 2014 (parts 1 & 2) *Code of practice for noise and vibration control on construction and open sites*

BS 6472: 2008 *Guide to the evaluation of human exposure to vibration in buildings*

BS 7385: 1990 *Evaluation and measurement of vibration in buildings*

BS 7445-1: 2003 *The description and measurement of environmental noise: Guide to quantities and procedures*

BS 717-1: 2013 *Acoustics. Rating of sound insulation in buildings and of building elements. Airborne sound insulation.*

BS 8233: 2014 *Guidance on sound insulation and noise reduction for buildings*

Braiden, John (2015) 'Low frequency entertainment noise' memo

Davies, W.J *et al* (2005) Noise from pubs and clubs – Phase 1

Institute of Acoustics (2002) – Good practice guide on the control of noise from pubs and clubs – Draft Annex 2

McCullough *et al* (2004) A practical evaluation of objective noise criteria used for the assessment of disturbance due to entertainment music

Moorhouse *et al* (2005) Proposed criteria for the assessment of low frequency noise disturbance, Defra NANR45 (updated in 2008 and 2011)

Noise Policy Statement for England (2010) Department for Environment, Food and Rural Affairs

National Planning Policy Framework (2012) Department for Communities and Local Government

National Planning Policy Guidance - noise (2014)

Professional Practice Guidance (ProPG): Planning & Noise – New Residential Development Guidance (May 2017) IoA, ANC & CIEH

The Building Regulations (2010) Resistance to the passage of sound, Approved Document E

The Building Regulations (2010) Ventilation, Approved Document F

The Building Regulations (2021) Overheating, Approved Document O

World Health Organisation (1999) *Guidelines for Community Noise*

World Health Organisation (2018) *Environmental Noise Guidelines for the European Region*

7.0 Glossary of acoustic terminology

Acoustic absorption
Is measurable and is defined by a coefficient between 0 (totally reflective) and 1 (totally absorbent) at each frequency. Although an anomaly in the standard laboratory test procedure can lead to absorption coefficients higher than 1, this is not achievable in real installations.

Acoustic trickle vent
Work by making air/noise pass over one or several layers of sound absorbing material.

Acoustic mechanical ventilators
Are a similar mechanical version of the acoustic trickle vent and assist high levels of noise insulation when combined with sealed glazed units. Often installed when external noise levels are particularly high, e.g. houses close to motorways.

Ambient noise
This is the totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far. It is usually measured in terms of L_{Aeq}.

Acoustical material
A material used to alter a sound field. The material may be used to absorb, damp or block acoustical energy.

Airborne noise
A condition when sound waves are being carried by the atmosphere.

Damping
The process of dissipating mechanical vibratory energy into heat. In noise control, a damping material is usually applied to a vibrating surface to reduce the noise radiating from that surface.

dB(A)
The unit used to define a weighted sound pressure level, which correlates well with the subjective response to sound. The 'A' weighting follows the frequency response of the human ear, which is less sensitive to low and very high frequencies than it is to those in the range 500Hz to 4kHz. In some statistical descriptors the 'A' weighting forms part of a subscript, such as L_{A10}, L_{A90}, and L_{Aeq} for the 'A' weighted equivalent continuous noise level.

Decibel (dB)
This is the unit to measure sound. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro-Pascals to 100 Pascals). We therefore use a logarithmic scale to describe sound pressure level, intensities and sound power levels. Subjectively, an increase of 10 dB corresponds to a doubling in the perceived loudness of sound.

Directivity Index
The difference between sound pressure level in any given direction in the acoustic far field and the average sound pressure level in that field.

Equivalent Continuous Sound Level L_{eq} or L_{Aeq}

The continuous equivalent sound level, L_{Aeq} is a notional sound level. It is the sound level, which, if maintained for a given length of time, would produce the same acoustic energy as a fluctuating noise over the same time period. The A-weighted L_{eq} is widely used to measure any environmental noise which varies considerably with time and is denoted as the L_{Aeq}.

Far field
That part of the sound field in which sound pressure decreases inversely with distance from the source. This corresponds to a reduction of approximately 6 dB in level for each doubling of distance.

Flanking transmission
Noise that reaches an observer by paths around or over an acoustical barrier. Where a source and receiving point are within the same building, or in an adjoining structure, be aware of ‘flanking’ (structural) noise transmission, sound energy that may pass through roof voids, ducting and pipe-work or the building fabric itself, such as walls and floor joists, and may therefore simply bypass an acoustically treated structure.

Frequency
Frequency is the rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A 1000Hz is often denoted as 1kHz, e.g. 2kHz = 2000Hz. Human hearing ranges approximately from 20Hz to 20kHz. For design purposes the octave bands between 63Hz to 8kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

Frequency bands
Sound can be measured over discrete bandwidths across the frequency range. The coarsest bandwidths often used are octave bands followed by finer third octave bands. The Preferred Octave Band Centre Frequencies and associated bandwidths are:

(drone) 31.5Hz 63 125 250 500 1000 2000 4000 8000Hz (high pitched)

In all situations, low frequencies are harder to attenuate than higher frequencies.

Insertion loss
The reduction of the sound level attained by inserting a silencer or attenuator in an acoustic transmission system.

Loudness
Loudness is the subjective human definition of the intensity of a sound. Human reaction to sound is highly dependent on the sound pressure and frequency. In subjective terms the ear can distinguish a difference in 'loudness' between two simple noises sources when there is a 3 dBA difference between them. Loudness is not a measure of annoyance. Again, for simple sources, when two sounds differ by 10 dBA one is said to be twice as loud as the other i.e. subjectively adding just 10 dBA to a noise makes it sound twice as loud.

Noise
Noise is commonly defined as unwanted sound and is generally audible over a vast pressure range from 20 micropascals to over 100 million micropascals. The decibel scale

conveniently expresses this large pressure change over a range of 0 to 140 decibels. A decibel is not an absolute unit but is a measure of the ratio of the sound level under investigation against a reference sound pressure level. The decibel is written as dB.

Noise barriers
A noise barrier can be constructed from almost any non porous material. Since sound is energy, an effective barrier must have enough mass (weight and density) and a low resonant frequency to stop (or reflect) this energy. Thus, a barrier with more mass will act as a more efficient barrier. If using a barrier to attenuate noise it should be erected as close to the source or receiving position as possible, not in the middle between them. Additionally, some of the sound energy may refract into the acoustic shadow area behind a barrier; this is particularly the case with low frequency sound energy.

Noise Rating curves
Developed by the International Standards Organisation in 1971 to rate noisiness with the 1000 Hz octave band as reference point - at NR 70, for instance, the curve has a level of 70 dB at 1000 Hz. Compared to NC curves, the NR curves permit higher levels at lower frequencies and dictate lower levels at higher frequencies. NR + 5 dB is roughly equivalent to the A-weighted sound pressure level e.g.: NR 35 equates approximately to a sound pressure level of 40 dBA.

Noise reduction
The reduction in sound pressure level caused by making some alteration to a sound field.

Radiation
The process whereby structure borne vibration is converted into airborne sound.

Reverberation
Reverberation is the echoing of previously generated sound caused by reflection of acoustic waves from the surface of enclosed spaces.

Reverberation Time, RT
The RT is defined as the time taken for an impulsive sound to die away to one thousandth of its original sound pressure level - that is, to decrease by 60 dB. The sound waves are reflected many times from each surface in the room, and are partly reduced at each reflection, the amount of reduction depending on the acoustic absorption of the surface.

Sound
Pressure waves that are travelling in the air or other elastic materials.

Sound absorption or attenuation
Involves the conversion of sound energy into heat as it passes through a structure (door, wall, window, acoustic panel etc.) or even through the air. Porous absorbent material such as Rockwool™ attenuates higher frequencies well but is a poor low frequency absorber.

Sound insulation
Is the reflection of sound energy from the surface of a structure such that it does not pass through that structure. A good insulator will have high mass and low stiffness.

Sound Reduction Index
(SRI), Insertion Loss (IL) and Sound Reduction (R or R_w) (especially in relation to glazing specifications).

Sound Level Meter
An instrument used to measure sound pressure level. Sound level meters are commonly either Type 1, precision instruments, or Type 2, general purpose instruments. Both types can have weighting and filter networks to provide dB readings by octave band in the A, B, or C scales.

Sound Power Level (Lw)
A measure of the total airborne acoustic power generated by a noise source, expressed on a decibel scale referenced to some standard (usually 10-12 watts).

Sound Pressure Level (Lp)
A measure of the air pressure change caused by a sound wave, expressed on a decibel scale referenced to 20μPa. The threshold of hearing is 0dB, while the threshold of pain is approximately 120dB. Normal speech is approximately 60 dBA and a change of 3dB is only just detectable. A change of 10dB is subjectively twice, or half, as loud.

Statistical Level: *Lmax,T*
The maximum noise level identified during a measurement period. Experimental data has shown that the human ear does not generally register the full loudness of transient sound events of less than 125ms duration and fast time weighting (F) has an exponential time constant of 125ms which reflects the ear's response. Slow time weighting (S) has an exponential time constant of 1s and is used to allow more accurate estimation of the average sound level on a visual display. The maximum level measured with fast time weighting is denoted as $L_{Amax,\,F}$. The maximum level measured with slow time weighting is denoted $L_{Amax,\,S}$.

Statistical Level: L90 or LA90
Sound pressure level that is exceeded for 90% of the measurement time. Consequently, it is indicative of the general background noise level in the absence of any higher-level short duration events that occur during the period.

Structure-borne noise
Mechanical vibration in a structure which can ultimately become audible sound. Until such time as radiation occurs, these vibrations are inaudible and of little concern.

Transmission loss
The reduction in sound level that is caused by placing a wall or barrier between the source and receiver. Transmission loss is expressed in decibels.

Table 4: Typical sound levels

Noise level, dB(A)	Example

0 - 10	Threshold of hearing
10 - 20	Broadcasting Studio
20 - 30	Bedroom at night
30 - 40	Residential area at night
40 - 50	Domestic fan heater at 1m
50 - 60	Typical Business offices
60 - 70	Conversational speech
70 - 80	Average traffic on street corner
80 - 90	Heavy lorries at 6m
100 - 110	Burglar Alarm (1 metre)
110 - 120	Ships engine room (full power)
120 - 130	Jet aircraft on take-off
130 - 140	Threshold of pain

APPENDIX A

EXAMPLE
BS4142 'Typical' background noise level calculation

	Measured LA90 levels													P
Time	8-9 Oct	9 to 10 Oct	10 to 11 Oct	11 to 12 Oct	12 to 13 Oct	13 to 14 Oct	14 to 15 Oct	15 to 16 Oct	16 to 17 Oct	17 to 18 Oct	18 to 19 Oct	19 to 20 Oct	20 to 21 Oct	arithmetic average
23:03	43.1	50.8	53.9	52.7	41.5	44.7	38.7	39.9	51.2	48.1	51.0	42.9	44.4	46.4
23:18	43.3	54.8	56.3	55.8	40.2	46.5	38.3	39.6	58.8	52.6	50.3	43.5	46.6	48.2
23:33	43.6	58.9	58.4	62.8	39.1	50.0	38.0	39.0	64.0	51.3	48.2	43.6	50.4	49.8
23:48	43.7	62.1	59.6	62.8	37.8	47.4	37.2	38.2	61.8	52.0	50.1	44.9	51.9	50.0
00:03	42.5	52.8	51.1	54.4	38.3	46.6	35.3	38.9	48.7	48.0	48.8	45.2	46.4	45.9
00:18	41.8	50.0	47.3	46.7	39.7	46.0	34.7	37.1	45.4	47.3	45.8	42.1	45.5	43.8
00:33	40.5	47.7	48.0	44.0	37.4	46.1	35.3	36.5	47.1	47.4	45.9	40.4	42.4	43.0
00:48	40.9	48.5	46.4	44.1	36.9	44.5	34.3	36.4	49.1	48.5	46.5	41.6	45.0	43.3
01:03	39.2	48.0	45.6	47.2	36.9	44.8	33.6	34.4	51.0	44.4	45.5	41.2	45.8	42.9
01:18	39.8	53.7	43.4	44.7	36.0	48.0	32.7	34.3	52.6	45.7	47.0	40.7	47.5	43.5
01:33	40.5	49.8	45.6	45.7	35.7	49.9	33.0	33.8	56.6	45.4	47.3	40.5	47.2	43.9
01:48	40.1	55.5	48.2	47.2	35.6	47.0	32.1	36.5	57.5	46.2	47.5	41.4	47.0	44.8
02:03	39.6	55.9	47.6	46.8	34.4	47.1	34.5	34.0	56.2	49.2	45.8	40.9	50.3	44.8
02:18	41.1	57.8	49.6	47.7	34.0	49.3	32.1	34.1	58.4	48.6	47.0	40.3	49.4	45.3
02:33	47.6	57.0	51.1	48.3	33.8	52.3	32.0	34.0	60.8	47.5	49.1	39.4	49.5	46.3
02:48	43.1	59.3	48.8	47.5	33.1	54.8	32.5	33.3	61.8	49.6	48.5	38.7	54.0	46.5
03:03	40.4	57.2	48.6	46.4	33.4	51.3	32.8	32.9	54.6	46.4	47.7	39.2	52.8	44.9
03:18	40.6	44.4	49.8	49.3	34.0	39.7	33.3	33.6	38.1	48.5	47.9	38.1	43.3	41.6
03:33	40.2	39.1	48.7	51.0	34.0	38.5	32.9	34.6	37.5	51.7	47.6	38.8	41.9	41.3
03:48	39.6	38.4	52.3	49.7	33.9	40.0	33.8	34.8	38.1	51.4	49.2	38.3	42.3	41.7
04:03	39.4	39.0	53.8	51.8	35.1	40.7	32.7	35.7	37.8	50.8	51.0	38.4	42.1	42.2
04:18	39.3	38.6	54.2	54.9	36.7	39.6	34.0	35.0	38.6	48.6	52.4	39.5	43.0	42.6
04:33	39.9	39.3	52.1	53.1	37.4	38.4	34.9	36.5	38.8	49.6	51.8	40.2	44.6	42.8
04:48	39.9	40.1	52.7	54.2	37.7	38.3	34.6	37.6	45.3	49.3	55.7	39.8	44.2	43.8
05:03	40.2	40.0	51.7	58.4	38.4	40.3	36.1	39.3	46.9	48.7	55.6	40.3	43.5	44.6
05:18	41.1	40.8	53.9	53.6	38.7	40.8	36.6	39.4	47.2	50.5	56.1	43.4	45.4	45.2
05:33	41.5	42.7	53.7	45.2	42.8	41.7	38.7	39.8	47.4	50.3	43.5	43.1	45.3	44.3
05:48	43.2	42.9	55.2	42.2	42.7	41.8	38.9	40.8	47.8	48.2	40.8	44.0	48.9	44.4
06:03	43.8	43.7	55.7	40.2	42.4	43.1	39.3	41.6	48.0	42.3	40.9	44.8	50.2	44.3
06:18	44.9	45.2	42.7	37.5	44.6	44.5	40.9	43.3	48.2	41.8	40.7	45.4	51.0	43.9
06:33	46.0	46.1	42.3	36.6	44.6	45.4	43.4	44.5	48.4	42.7	40.9	46.0	52.5	44.6
06:48	47.6	46.8	43.5	37.3	45.1	46.2	46.1	45.4	49.4	42.1	41.8	47.3	51.8	45.4

Arithmetic Average of Column P	44.6
Minimum value column P	41.3
Maximum value column P	50.0
Mean value of full data set	44.6
Minimum value full data set	32.0
Maximum value full data set	64.0

41dB is taken as the typical background as it is the minimum value of the averaged individual 15 minute periods

APPENDIX B

GLAZING
Technical Design Considerations

- Air gaps in windows have a profoundly detrimental effect on the performance of the window. Sealed windows provide the best insulation. Weather-stripping openable windows using neoprene or rubber weather seals can help eliminate air gaps, although the sound insulation is not as good as a sealed window. In addition, frequent opening of the window can lead to a deterioration in the ability of the weather-stripping to completely seal the gaps.

- There is very little variation in acoustic performance over the usual interpane spacing range of 6 to 20mm, because of the 'mass - spring - mass' resonance of the two panes. The two masses (the panes) are effectively joined by a spring, the air gap. Hence, the insulation provided by 6/12/6 glazing is not much better than 6 mm single glazing. Significant increases in acoustic insulation begin to occur only above interpane spacing of 50mm.

- The best isolation of panes occurs above 100mm where the two panes are in separate frames.

- Lining the reveals between the two panes further reduces resonance and so further improves the sound insulation.

- At small interpane spacing, the thickness of the glass is an important factor. Increasing the glass thickness, hence the mass, improves the performance at low frequencies. However, the benefit is only realised if the windows are fixed or are effectively weather-stripped as the influence of air gaps is overriding.

- For road traffic noise, where there is a dominance of low frequencies, reduction in noise is not greatly improved when only the thickness of the glass is improved. This effect can be offset by:
    - Using laminated glass (where the presence of the interlayer affects the bending wave in the glass panel).
    - Using differing pane thicknesses (preferably 30%) will also improve overall noise reduction potential of the glazing unit.

- A reduction in window area by a half, will usually give a 3dB improvement in sound insulation.

- Subdividing the cavity of a double window to form triple or multi-pane windows with the same total width of air space does not significantly improve the average sound insulation (although high frequency performance is increased at the expense of low frequencies). However, triple windows formed by additional air spaces do produce a gain in sound insulation.

- With fixed glazing, resilient mounting of the glass at its edges, e.g. in neoprene gaskets, gives an improvement in sound insulation (in middle frequencies) by damping resonances (sympathetic vibration) of the panes.

Summary

Air tightness, pane thickness, laminated glass, interpane spacing, absorbent reveals, area of glazing, resilient mounting are cumulative in their effects on sound insulation, and the benefits of each can be added to achieve optimum performance.

APPENDIX C

VENTILATION
Technical Design Considerations

Building Regulations

Any new residential acoustic insulation scheme must satisfy the requirements of Part F of the Building Regulations with regard to ventilation. The main method of supplying natural ventilation in accordance with the Building Regulations for habitable rooms is:

a) rapid ventilation;

b) background ventilation.

Both these methods are profoundly detrimental to the sound insulation of the window unit as a whole. Alternative approaches include extract mechanical ventilation or passive stack ventilation. Documents giving recommendations for such systems are detailed in Part F1 of the Building Regulations.

Many of the available acoustic products are incapable of meeting these requirements and in some cases more than one vent may be required in rooms. If there is any doubt as to compliance with the Building Regulations, then product data sheets are available, and these should be checked with the Building Surveyors Office. Options available to provide ventilation in accordance with the Building Regulations include:

Trickle Vents

Consist of a series of holes or long slots which are cut into the window frame with a cowl on the outside, and a closeable cover on the inside.

Poor insulation properties. Approximate $D_{n,e,w}$ = 21dB

Acoustic Trickle Vents

Fitted internally / externally over the existing trickle vent or purpose designed vent within window frame.

Moderate insulation properties. Approximate $D_{n,e,w}$ less than 39dB.

Acoustic Wall Vents (acoustic air bricks)

Consist of a sleeve or box fitting through the wall containing material with acoustic absorption properties such as mineral wool/fibre-glass.

Good insulation properties. $D_{n,e,w}$ up to 50dB.

Mechanical Ventilation Units

Such units are for situations where there are very high noise levels, where opening a window for rapid ventilation would cause unacceptably high noise levels. They consist of a wall mounted unit, under the control of the occupier.

Good insulation properties. $D_{n,e,w}$ up to 50dB.

British Board of Agreement Approved Products (BBA)

Some acoustic vents are approved by the British Board of Agreement (BBA) under the Noise Insulation Regulations 1975. Some products (notably Silavent) which comply with these regulations do not have a single figure performance specification, instead they have a figure at each 1/3 octave frequency. However, since they have one of the highest specifications for such products, they will be suitable for most situations.

ADF (2010) is a reference to BRegs Approved Document F (Ventilation). This is the national standard for ventilation in buildings that is applied for the purposes of BRegs compliance. This was updated in 2021 and comes into force on 15 June 2022.

The Domestic ventilation compliance guide (**DVCG**) is the accompanying guidance.

Both documents are available as a free download.

ADO (2021) is a reference to BRegs Approved Document O (Overheating). This is an entirely new national standard for overheating in new residential buildings that is applied for the purposes of BRegs compliance. ADO comes into force on 15 June 2022 and is available as a free download.

Further reading:

The Air Quality Standards Regulations SI 2010/1001

The Building Regulations 2010 SI 2010/2214

Association of Noise Consultants & Institute of Acoustics (2020) Acoustics, ventilation and overheating residential design guide

BR364 Solar shading of buildings, Second edition. (2018) Building research Establishment

TM59 Design methodology for the assessment of overheating risk in homes. (2017) Chartered Institute of Building Services Engineers

Guide to Demonstrating Compliance with the Noise Requirements of Approved Document O (July 2022)