ProPG: Planning & Noise

Professional Practice Guidance on Planning & Noise

New Residential Development

SUPPLEMENTARY DOCUMENT 2
GOOD ACOUSTIC DESIGN

May 2017

1. Introduction

The use of good acoustic design is an inherent part of the recommended approach that is described in the ProPG and will help to deliver national planning and noise policy objectives. Good acoustic design should help produce sustainable buildings that provide healthy conditions for future occupants, that are sensitive to the likely expectations of future occupants and to the acoustic characteristics of the location, that are efficient in the use of resources and energy both during construction and subsequent occupation, and that are matched by an appearance that demonstrates good aesthetics as far as possible.

Too often in the past the internal noise levels within a noise-sensitive room have been regarded as the only factor that matters in the acoustic design of a noise-sensitive building; and this has led to schemes being put forward that simply relied on the building envelope to achieve a high sound insulation performance, when other means could have been used to achieve an overall good design.

It is acknowledged that the inherent challenge of introducing noise-sensitive development in noisy locations can limit the extent to which good acoustic design can be achieved in harmony with the other factors that influence the overall quality of a scheme and that compromises may need to be made e.g. accepting that it may not always be possible to achieve acoustic standards with windows open or accepting that noise levels in parts of the outdoor amenity areas may not be optimal.

A good acoustic design will be one that continues to minimise noise impacts and to avoid significant noise effects for the lifetime of the development or as long as is practicable taking into account other economic, environmental and social impacts. Ideally new development should also help to mitigate any existing adverse impacts elsewhere, for example by acting as a barrier between noisy infrastructure and any existing noise-sensitive uses that do not benefit from incorporated mitigation.

The LPA should be satisfied that any proposal for new housing has followed a good acoustic design process. LPAs should require applicants to demonstrate in an Acoustic Design Statement (**see ProPG Section 2**) how the acoustic design process was conducted and how the proposed design evolved. Where a number of different designs were considered, applicants should set out the reasons why the favoured design has been selected. For example, where the scheme relies on windows being closed to achieve good internal noise conditions, the Acoustic Design Statement should include or refer to an explanatory statement detailing why this approach has arisen and how the use of layout, orientation, spatial design and non-building envelope mitigation has been used to minimise the need for reliance upon closed windows.

2. Useful sources of information

There are a number of existing sources of information on the acoustic design of dwellings that provide relevant guidance to help steer good acoustic design and these are outlined below.

2.1 BS8233 - Guidance on Sound Insulation and Noise Reduction for Buildings (BS8233:2014)

BS8233:2014 contains useful advice relevant to the planning and design of new development, including new noise-sensitive development such as housing. BS8233 advocates a systematic approach to acoustic design, as follows:

i. Assess the site, identify significant existing and potential noise sources, measure or estimate noise levels, and evaluate layout options.
ii. Determine design noise levels for spaces in and around the building(s).

iii. Determine sound insulation of the building envelope, including the ventilation strategy.
iv. Identify internal sound insulation requirements.
v. Identify and design appropriate noise control measures.
vi. Establish quality control and ensure good quality workmanship.

Section 5 of BS8233:2014 contains guidance on the sequence of stages to be followed in the planning and early acoustic design of a new development. Section 5.4 of BS8233:2014 outlines a general approach to determining appropriate noise control measures including the following suggested steps (which may be iterative):

i. Check the feasibility of reducing noise levels and/or relocating noise sources.
ii. Consider options for planning the site or building layout.
iii. Consider the orientation of proposed building(s).
iv. Select construction types and methods for meeting building performance requirements.
v. Examine the effects of noise control measures on the requirements for ventilation, fire regulation, health and safety, cost, CDM (construction, design and management) etc.
vi. Assess the viability of alternative solutions.

The designer should then decide which of the following options can be applied to reduce noise levels:

i. Quietening or removing the source of noise.
ii. Attenuating the sound on its path to the receiver.
iii. Obstructing the sound path between source and receiver.
iv. Improving the sound insulation of the building envelope.
v. Using agreements to manage noise.

Much detailed guidance is included in BS8233:2014 and this informs and supports the four Elements that have been included in the ProPG Stage 2 Full Assessment. The advice in BS8233:2014 will help to encourage good acoustic design and it should always be taken into account by LPAs in plan-making and decision-taking.

2.2 Sound Control for Homes

Effective design for noise control requires a good understanding of the behaviour of sound. Practical information on the transmission of sound within buildings and propagation across the ground is given in the Building Research Establishment document BR 238/CIRIA Report 127 "Sound Control for Homes" (1993).

This document gives practical advice on the control within dwellings of noise from outside sources and noise transmitted within and between dwellings. It covers a number of aspects of the acoustic design of housing, including:

i. Appraisal of noise affecting the site.
ii. Planning to control external noise.
iii. Planning to control internal noise.
iv. Selection of appropriate forms of construction to control external and internal noise.
v. Detailing for noise control.

Sound Control for Homes was first published in 1986, then revised in 1993 and contains references to a previous version of Approved Document E and to Circular 10/73 and to a then draft PPG24 - it has therefore become out of date in several areas. However, it contains much useful information and, in particular, detailed advice on planning to control external noise that has withstood the test of time.

2.3 Building Regulations - Sound Insulation

The sound insulation between adjoining dwellings is controlled by the Building Regulations, which require minimum standards of insulation for certain walls, floors, and stairs. Building Regulations are mentioned here because it is important for LPAs to understand their limitations as regards the acoustic design of dwellings. Many of these limitations can be overcome by encouraging good acoustic design as part of the planning process.

Simply meeting the minimum standards of airborne and impact sound insulation associated with Building Regulations may not eliminate disturbance if adjacent rooms are incompatible. Internal noise should be controlled by good internal planning combined with appropriate standards of airborne and impact sound insulation.

Therefore, in addition to meeting Building Regulation requirements it is good practice that dwellings should be planned to ensure that adjacent rooms are compatible in terms of noise sensitivity and noise production. Where good room-to-room sound insulation is required, the area of the intervening partition should be kept to a minimum and flanking paths should be eliminated where possible.

The sound insulation requirements of the Building Regulations can be inadequate where certain types of commercial use adjoin residential use. The level of sound insulation performance required will be dependent upon the use type, for example a higher level of airborne sound insulation performance will typically be required for a proposed commercial catering unit located below a residential flat than will be required for a small café. A high level of airborne and impact sound insulation, often only achievable by complex design methods that structurally isolate the noise generating and noise-sensitive premises, will be required where music and dancing activities adjoin a residential use. Each case will need to take into account the specific circumstances of the proposed development.

Perhaps most importantly, Building Regulations in England do not currently take account of the external acoustic environment and there are no specific Building Regulations that directly control the ingress of external noise, this being left to the market and the planning system to regulate. In reality there are other Building Regulation requirements regarding, for example, structural design and thermal insulation (in particular the requirement for double glazing) that indirectly secure a certain standard of acoustic insulation – but this standard will not be adequate in every situation and therefore the planning system has an important role to play to ensure there is effective design for noise control.

Where there are specific concerns about sound insulation issues, specialist assistance (**see ProPG Section 4**) should be sought regarding the application and limitations of Building Regulations to particular cases.

2.4 Building Regulations – ventilation etc.

Ventilation requirements for dwellings (and other buildings) are covered under the Building Regulations ‘Approved Document F – Means of Ventilation, 2010 Edition[1] (ADF). Unfortunately, this document contains very little information on the potential interactions between ventilation and the acoustic design of dwellings.

‘Whole dwelling ventilation’ (see Table 1 below) is required continuously (therefore it cannot be provided by open windows) and to help demonstrate good acoustic design the internal noise level guidelines in Figure 2 of the ProPG (taking account of the relevant notes) should be achieved whilst ‘whole dwelling ventilation’ is provided.

[1] Incorporating 2010 and 2013 amendments

It should also be noted that the internal noise level guidelines are generally not applicable during 'purge ventilation' as it occurs infrequently and for short periods of time. Internal noise levels when windows are opened for purge ventilation should be reduced as far as practicable, however, this should be achieved inherently by following a good acoustic design process as described in the ProPG.

It is also important that the potential impact on future occupants of the thermal comfort/cooling strategy is appropriately considered, especially if open windows are relied upon to provide relief from overheating.

ADF requires that:

'There shall be adequate means of ventilation provided for people in the building'

The document then goes on to state that:

'Ventilation is simply the removal of 'stale' indoor air from a building and its replacement with 'fresh' outside air.'

'Ventilation is required for one or more of the following purposes:

a. *Provision of outside air for breathing;*
b. *Dilution and removal of airborne pollutants, including odours;*
c. *Control of excess humidity (arising from water vapour in the indoor air);*
d. *Provision of air for fuel-burning appliances (which is covered under Part J of the Building Regulations).*

'Ventilation may also provide a means to control thermal comfort but this is not controlled under the Building Regulations. Part L addresses minimising energy use due to the effects of solar gain in summer.'

ADF describes three types of ventilation provision and associated ventilation rates. The types of ventilation are summarised below:

TYPE OF VENTILATION	LOCATION / REASON FOR VENTILATION	WHEN IS THIS REQUIRED?
Whole Dwelling Ventilation	**To provide fresh air to the building and to dilute and disperse residual water vapour not dealt with by extract ventilation as well as removing water vapour and other pollutants which are released throughout the building**	**Continuously**
Extract Ventilation	**From rooms where most water vapour and/or pollutants are released, e.g. due to activities such as cooking, bathing or photocopying. This is to minimise their spread to the rest of the building.**	**Continuous or intermittent**
Purge Ventilation	**Throughout the building to aid removal of high concentrations of pollutants and water vapour released from occasional activities such as painting and decorating or accidental releases such as smoke from burnt food or spillage of water.**	**Occasionally**
Note 1 – 'Whole Dwelling Ventilation' is often confused with 'background ventilation', a term used in the 1995 version of ADF. In the current ADF, the term "background ventilator" refers to trickle vents.		

Table 1 – ADF – Types of ventilation required

In addition to the above ADF also states:

'Purge ventilation provisions may also be used to improve thermal comfort, although this is not controlled under the Building Regulations.'

With reference to the provision of purge ventilation within habitable rooms, the approved document provides the following note. '*There may be practical difficulties in achieving this (e.g. if unable to open a window due to excessive noise from outside).*' However, no objective guidance is provided in the Approved Document as to what constitutes "excessive noise" or how to resolve the practical difficulties.

3. General principles of Good Acoustic Design

3.1 Introduction

Careful planning of a development from site location, through concept design, site layout and materials selection can greatly improve acoustic conditions. Following a good acoustic design process can substantially reduce the requirement for, and the costs of subsequent acoustic measures that may need to be retrospectively applied to the development, or that may even mean that a particular development cannot proceed.

In requiring good acoustic design, there is a hierarchy of noise management measures that LPAs should encourage, including the following, in descending order of preference:

i. Maximising the spatial separation of noise source(s) and receptor(s).
ii. Investigating the necessity and feasibility of reducing existing noise levels and relocating existing noise sources.
iii. Using existing topography and existing structures (that are likely to last the expected life of the noise-sensitive scheme) to screen the proposed development site from significant sources of noise.
iv. Incorporating noise barriers as part of the scheme to screen the proposed development site from significant sources of noise.
v. Using the layout of the scheme to reduce noise propagation across the site.
vi. Using the orientation of buildings to reduce the noise exposure of noise-sensitive rooms.
vii. Using the building envelope to mitigate noise to acceptable levels.

It should be remembered that good acoustic design is a process that begins as soon as land is under consideration for development. The timeline for good acoustic design stretches from the conceptual design stage, through quality control during construction, and beyond to post construction performance testing.

Both internal and external spaces should be considered in the acoustic design process. Care should be taken to ensure that acoustic mitigation measures do not result in an otherwise unsatisfactory development. Good acoustic design must be regarded as an integrated part of the overall design process.

Whilst the general principles of good acoustic design are broadly applicable to most types of noise and many types of noise-sensitive development, the additional advice provided below relates primarily to new residential development and to noise from road and rail, specialist advice may be required for other types of noise source.

3.2 New land release

When considering redevelopment of larger greenfield or brownfield sites, or the subdivision of land located near busy roads or rail corridors, any potential acoustic opportunities and constraints should be considered at the concept planning stage. At this stage there is more opportunity to address acoustic matters for example through setbacks, building orientation, layout, building height controls or noise barriers.

In some cases, particularly for larger sites, it might be appropriate to try to design open spaces adjacent to the busy road/railway corridor to setback residential uses to reduce noise exposure. These open space areas could also include appropriate bunding to reduce adverse noise impacts across the wider site.
In other cases it may be more appropriate to locate carefully designed buildings closer to the busy road/railway corridor and use the buildings themselves to provide an acoustic shadow for the remainder of the site, the objective here would be to achieve good acoustic conditions for both internal and external spaces.

The use of modern noise modelling software, in the hands of a capable specialist, will allow a developer to predict the acoustic conditions in a number of different development scenarios, thus allowing different approaches to be explored.

3.3 Building location, design, orientation and room layout

While low rise buildings may sometimes benefit from shielding provided by local topography, barriers or other buildings, high rise buildings usually receive less noise shielding and noise mitigation needs to be considered carefully at the outset in the layout and design stage.

Sleeping areas and other habitable areas should be placed on the side of the building furthest from the source of noise. Conversely rooms which are less sensitive (kitchens, bathrooms, storage rooms, corridors, stairwells, etc.) should be placed on the noisy side of the building. An additional way of minimising the intrusion of noise is to minimise the number of doors and windows on the noisy side of the dwelling. Having to keep windows closed to provide the required façade sound insulation is the last resort for good acoustic design. Sealed facades should never be necessary to prevent the ingress of general anonymous noise.

3.4 Buildings as noise shields

On larger developments, a “barrier block” can be used to protect the residential development from noisy roads or railways. A barrier block is a building which itself forms a noise barrier. A continuous frontage (using a solid wall to extend to the boundary if necessary) is one way to lower noise levels in the rest of the property. Site planning and internal layout of buildings should also be considered. This is likely to be more easily achieved where a number of properties are being developed concurrently.

Main considerations when designing a “barrier block”:

- The block should run along the edge of the site closest to and parallel to the noise source and wrap around the sides of the property to protect the sides.
- The block should preferably be used for non noise-sensitive purposes, such as for parking cars or refuse storage.
- Any noise-sensitive rooms in the barrier block should face away from the noise source.
- Rooms on the ‘noisy’ side of the block may need special sound insulation and mechanical ventilation.

Staggered terrace houses, for example, can be carefully arranged to shield most windows from traffic noise. Care should be taken to ensure that angled buildings do not reflect sound back into other buildings on a site. Articulated facades and vegetation may help to diffuse reflected noise but will do little to inhibit noise directly from the source.

3.5 Podiums and balconies

Traffic noise can be substantially reduced by building residential apartments on top of a podium or commercial building space. If the residential tower is set back the podium acts to provide increased distance from the road thus shielding noise from the road to the lower apartments.

When considering balconies in building design it is important to note that the standard jutting balcony may act to reflect noise directly into the interior of the building.

Where balconies are required, solid balustrades with sound absorption material added to the underside of balconies above is a good means of reducing noise entering the building.

Providing enclosed balconies (or winter gardens) is another means of reducing the noise entering a building. Where enclosed balconies are used, ventilation may need to be considered. By installing acoustic louvres ventilation requirements and noise reduction can be addressed.

It should be noted that although balconies should preferably be located away from the noise source, where this occurs on the northern side of a development it may result in space that is not used and that is of low amenity, depending on other factors such as available views and availability of alternative outdoor space nearby. The northern aspects of high rise buildings may be better suited to the winter garden option.

3.6 Courtyards

There are several ways noise can be reduced in external amenity areas. One way is to increase the distance between the road and the external amenity area. Another is to provide a screen or noise barrier. Careful use of shielded courtyard building layouts is a good way of reducing traffic noise affecting external courtyard areas. Additional soundscape features such as water fountains can also be introduced to provide both acoustic and psychological masking. Buildings in ‘C’ shaped layouts can also be effectively utilised to create outdoor areas protected from noise where the available space restricts use of a full courtyard design.

3.7 Noise barriers, mounds, bunds, screens and fences

A noise barrier is often an effective way to reduce traffic or railway noise. Where space allows, raised mounds of earth can be effective noise barriers and can be enhanced by placing a low wall or fence on top. Fencing built on top of mounds can save the space a larger mound might take and reduce the amount of fencing material required.

Screening structures may include:

- An existing feature, such as a natural slope or an elevated road.
- A purpose designed feature such as a solid boundary fence.
- A purpose designed feature of the building, such as a garage or a partially enclosed carport.
- A purpose designed building which acts as a barrier block.

Topography can play a major role in determining the potential noise impact. A low rise building which is sited below the level of a noise source will be impacted less than a building which is sited above the noise source, especially if a noise barrier (e.g. a mound or wall) is provided near the source / at the top of the slope.

Careful consideration of site design can mitigate the effects for sites above a noise source by, e.g. positioning a garage in the noise affected areas and using noise walls to buffer noise. Additional care is needed when noise sources are elevated.

Solid walls and solid fences with no openings can reduce noise. Noise barriers are most effective at protecting outdoor areas and ground floor levels of buildings. Single-storey dwellings are therefore easier to shield from noise than the upper floors of two-storey dwellings. Where a gate is required in a barrier ensure it is carefully designed to minimise noise transmission. In some areas, measures to avoid graffiti should be considered when designing noise barriers.

Main considerations when designing a noise barrier (all other things being equal):

- The closer the noise barrier is to the noise source, the more effective the barrier.
- The lower the height of the development, the more effective the barrier.
- The taller the barrier, the greater the noise reduction.
- Barriers are more effective when the site slopes away from the source.
- Wider barriers tend to be more effective – barriers should ideally extend far beyond the ends of the development.
- Any holes or discontinuities in a barrier wall will significantly reduce its noise reduction ability.
- Material used should have a suitable surface density, eg a high performance barrier must have a surface density of at least 20kg/m^2.

3.8 Building elements

Overview

The following subsections give an overview of some of the key building elements in the acoustic design of residential buildings. It should be noted that current Building Regulations in the UK do not specifically address the ingress of external noise to buildings. This is primarily because good acoustic design needs to take account of the prevailing acoustic environment and therefore needs to be site specific.

Specialist advice on building element design may be required for new residential development exposed to high levels of aircraft noise.

Projects involving the transmission of ground-borne noise for example from underground trains will usually require specialist assistance.

Walls

Masonry walls typically have better airborne noise insulation properties than other elements in the building envelope. Generally, walls are not a significant noise transmission path. Therefore priority should be given to the windows, doors, roof and ventilation openings as these elements will not insulate as well as the walls.

Walls of lightweight construction provide less noise insulation than masonry walls to low frequency noise. Whether the walls are masonry or of light-weight construction, the wall’s sound insulation performance will be weakened if it contains ventilators, doors or windows of a lesser insulation capacity. To improve sound insulation, ventilators can be treated with sound-absorbing material or preferably located on walls which are not directly exposed to the external noise.

Windows

In acoustic terms windows are one of the weakest parts of a facade. An open or acoustically weak window will severely negate the effect of an acoustically strong facade. Whenever windows are incorporated in a building design their effect on acoustic performance of the building facade should be considered. Reducing the numbers of windows and appropriately positioning them away from the road or rail line can be beneficial.

Proper sealing is crucial to the success of noise reduction of windows. To prevent sound leaks, windows should be caulked (with a flexible sealant such as mastic or silicone) thoroughly from the inside, and outside between the wall opening and the window frame. Where trickle ventilators are required as part of the ventilation strategy, the effect on the overall façade sound insulation with windows closed must be considered.

The ventilation requirements of the building may sometimes conflict with thermal, noise insulation and air quality requirements and specialist advice may be required.

Doors

The main factors influencing an improvement in the acoustic performance of doors:

- The heavier (thicker or more dense) the door, the better the noise insulation.
- Airtight seals should be used between the door frame and the opening aperture in the facade.
- Airtight seals should be used around the perimeter of the door.
- Cat flaps, letter box openings and other apertures should be avoided.

Roofs

The main factors influencing an improvement in the acoustic performance of a roof:

- Increase the mass of the ceiling (or roof).
- Provide sound absorbent insulation material in the roof cavity.
- Avoid gaps, as far as ventilation requirements will allow.
- Use parapets as they help to shield the roof from noise better than traditional eaves.
- Flat roofs will usually be less exposed to road noise than pitched roofs.

3.9 Ventilation and cooling design

Ideally, internal design noise levels should be met with windows open. However in noisy locations, windows will need to be closed and fitted with high quality seals in order to achieve them. In this scenario, any systems used to provide "whole dwelling ventilation" should be in the open position when noise levels are assessed. When used as part of the ventilation strategy then acoustically treated inlets and outlets may need to be located away from the façade(s) most exposed to noise (and any local sources of air pollution). The consideration of heating, cooling and ventilation proposals should align with wider planning objectives for sustainable design.

All schemes for ventilation must, of course, comply with Building Regulations. The acoustic design calculations for the building envelope must take into account the acoustic performance of the proposed means of ventilation. Some useful information is contained in "BRE Information Paper IP4/99: Ventilators: Ventilation and Acoustic Effectiveness (Oct 1999)". It may be helpful to refer to additional guidance e.g. the DCLG's Domestic Ventilation Compliance Guide.

3.10 Design Noise Levels for External Amenity Spaces

BS8233:2014 (Section 7.7.3.2 Design criteria for external noise) contains the following additional guidance:

"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB LAeq,T, with an upper guideline value of 55 dB LAeq,T which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB LAeq,T or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space."

4. Good Acoustic Design Award Scheme (awaiting development)

Lord Taylor's review of Government planning practice guidance (December, 2012) included the following recommendation: "*Best practice in the form of exemplar schemes from around the country is constantly evolving, so this kind of 'best practice' material is not best managed by Government but by practitioner bodies. It should be removed from current guidance and excluded in future. Government guidance should instead highlight the organisations where such material may be found….In many areas annual awards of one kind and another are given to exemplar schemes. DCLG might wish to consider working with LGA and practitioner bodies to encourage (or sponsor) award schemes of this sort…We believe that supporting this approach is the best way Government can support the dissemination of best practice.*"

In order to encourage good acoustic design process the ANC, in association with the IOA and CIEH are considering the development of a GAD Award Scheme that will recognise examples of good acoustic design in new residential development.

The Award Scheme will seek to draw attention to the best in planning practice and development. The ANC, IOA & CIEH believe that encouraging best practice is a key way that we can help Government to achieve the aims and objectives of the NPSE and the NPPF.

In the longer term, the sponsors are considering establishing an online space to highlight case studies of new residential development schemes that demonstrate good acoustic design. The intention is to create a resource for practitioners that highlights new, innovative and evolving best practice and that will be regularly updated.