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Acoustic design and testing for health and wellbeing

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Summary

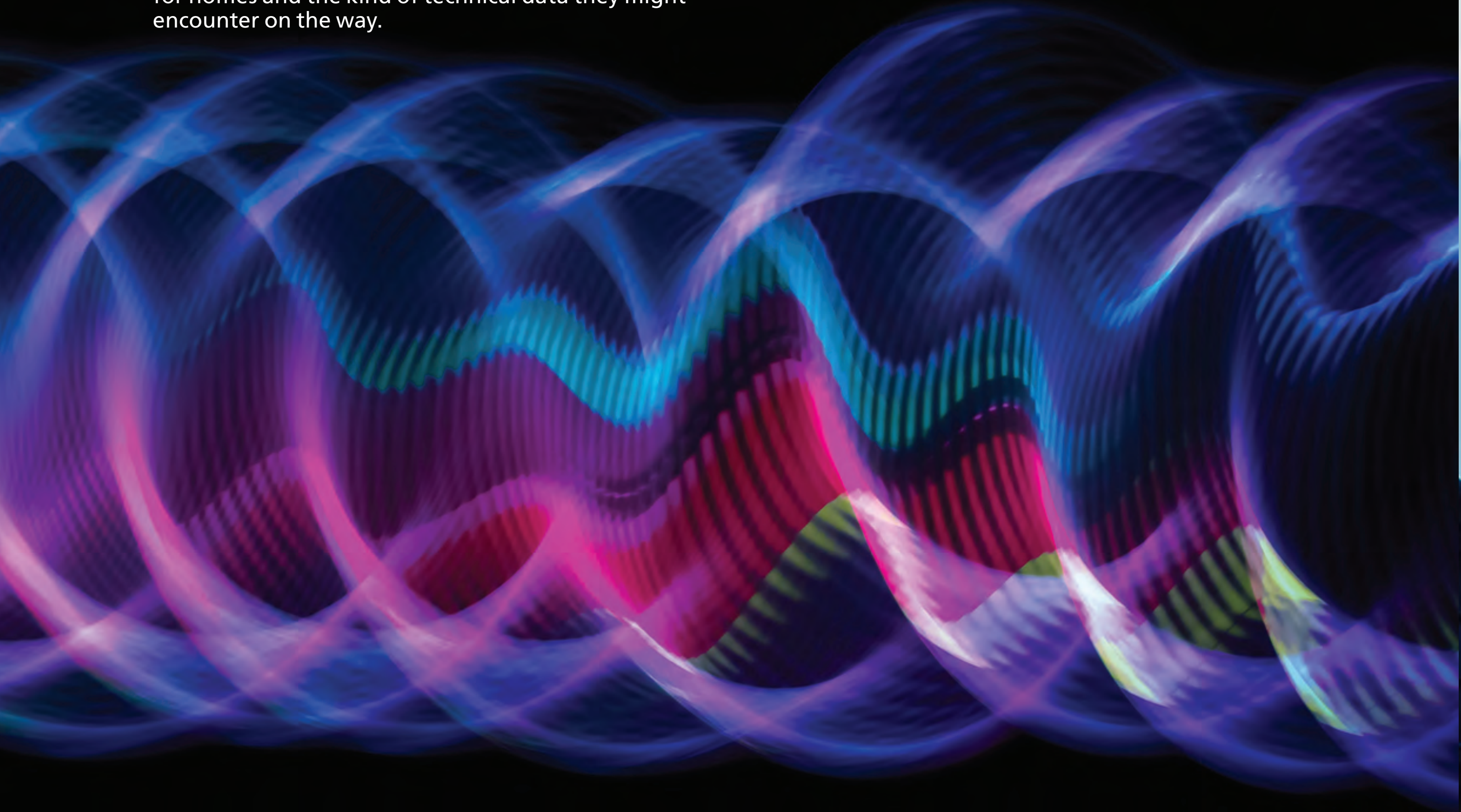
Good acoustic conditions are fundamental to the quality and enjoyment of our homes, workplaces and other buildings that we occupy. Sound affects us both physiologically and psychologically. Noise, or "unwanted sound", can increase heart rate, blood pressure, respiration rate and even blood cholesterol levels. Conversely, pleasant sounds help create a sense of wellbeing and can help to relax us.

Efficient use of land means that high densities and mixed residential and commercial uses are now the norm for new developments in cities. When increasing distance is not an option in preventing exposure to high levels of noise, acoustic separation through building design becomes a vital part of successful high density living. A sensitive design will protect occupants from noise without unreasonably constraining the way they live their lives.

Domestic noise problems may arise either from sound travelling from one premises to another, such as music, voices and footsteps, or from noise entering from outside, such as road and aircraft noise. The two are regulated in different ways. Sound insulation issues are dealt with through Building Regulations. Exposure to outside noise is dealt with through the planning system. Both require careful consideration, as poor acoustic design is difficult and expensive to remedy when a building has been completed.

This guide identifies the basic elements of acoustic design and the Standards which are most commonly used when considering the impact of noise on residential properties. It is intended to help housebuilders, building owners, designers/architects, planners, landlords and householders take the first steps towards understanding acoustic requirements for homes and the kind of technical data they might encounter on the way.

High densities bring commercial and residential properties closer together



Introduction

Good acoustic conditions are a key element to the quality of the spaces which we occupy, be they homes, workplaces, schools or other buildings such as hospitals. Sound has both physical and psychological effects on us, particularly if it is unwanted. Unwanted sound, which we call noise, can have a range of physical effects. Noises which we find particularly annoying, such as neighbour noise, can cause serious stress. Even the kinds of noise we get used to, such as traffic noise, can lead to increases in heart rate, blood pressure, respiration rate and blood cholesterol levels. Pleasant sounds such as music or nature sounds, on the other hand, can help to relax us and create a sense of wellbeing.

The constant drive to build from innovative and sustainable materials combined with more people sharing the same spaces within our cities mean that we are becoming less physically separated both from one another and from other sources of noise. Sustainable development for the future entails making efficient use of land to provide the homes and workplaces needed on the land available. Higher densities and mixed residential and commercial uses are now the norm for new developments in cities.

In 2014/5, local authorities recorded nearly 390,000 noise complaints between them, a rate of 7.1 per 1,000 of the population (PHE). As not everybody who is bothered by noise complains to their local authority, this underreports the degree to which people are bothered by noise.

In the 2012 National Noise Attitude Survey (DEFRA, 2014), householders were asked questions about noise in their homes. The following results were obtained:

- 83% of the survey respondents reported hearing road traffic noise, and the same proportion reported neighbour noise. One quarter of these groups reported 'moderate', 'very' or 'extreme' levels of annoyance with these noise sources in each case.
- Noise from aircraft, airports or airfields was heard by 72% of the sample respondents, with 13% reporting moderate to extreme annoyance, although the study noted that social groups more likely to be annoyed were overrepresented in the sample group in this case. Noise from building, construction, demolition, renovation of roadworks was heard by 48% of the survey respondents and associated with moderate, very or extreme levels of annoyance by 11%.
- 48% of survey respondents reported that noise spoilt their home life to some extent.

Noise, therefore, affects a great many people's lives. High density living means that using distance to achieve separation from noise is rarely an option. In its absence, acoustic separation through building design is a vital part of successful high-density living.

Demolition and construction are common noise sources

Sources of noise disturbance – sound insulation

Domestic noise problems can be broadly broken down into two categories:

- Sound insulation – defined as the noise travelling from one premises to another;
- Environmental noise – noise entering the home from outside.

Sound insulation

One of the most common sources of noise disturbance is the transmission of sound through walls or floors, either through excessive noise from one side or through poor sound insulation performance of separating walls and floors. Poor sound insulation leads to disturbance and loss of privacy as the sounds of normal occupancy in one property room are clearly audible in another.

It is seldom possible to hear nothing from neighbours in high density living such as flats. However, neither should reasonable levels of living noise from one home materially interfere with another. Where sound insulation problems exist, the other building occupants often have no idea that the noise they are making can be heard by their neighbours and regarded as a nuisance.

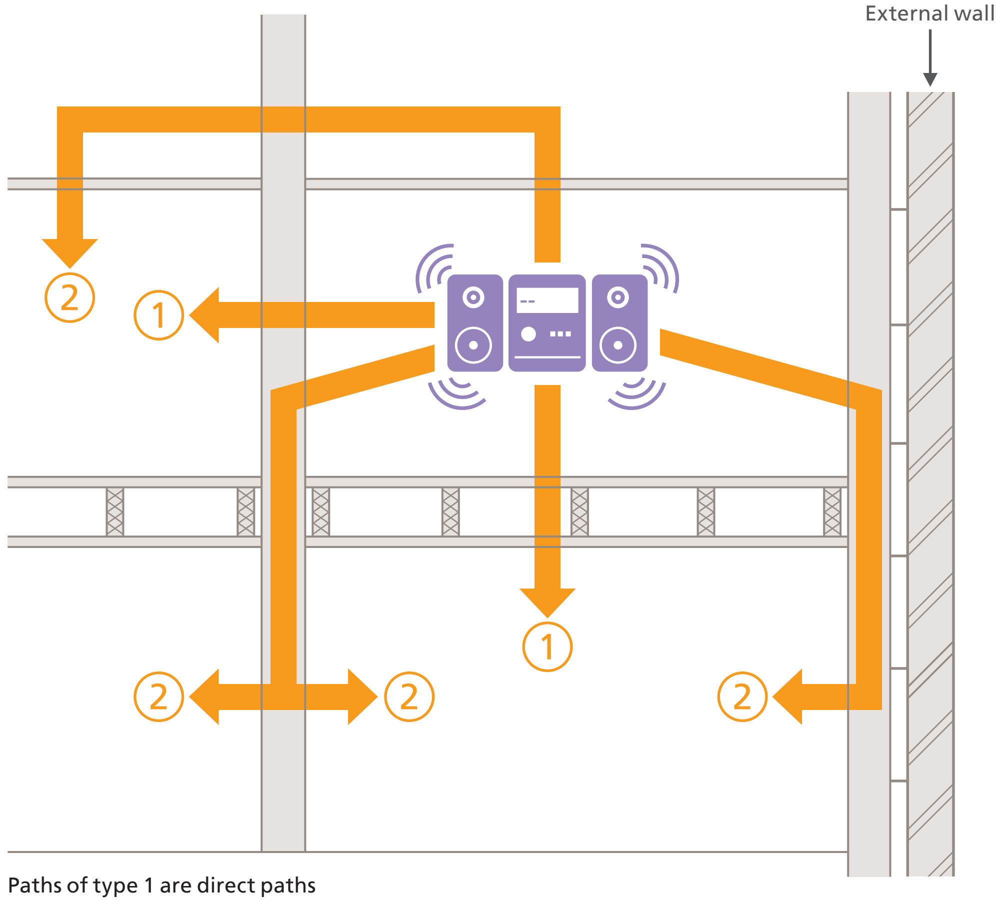
In a newly built or converted home, poor sound insulation is one of the best ways to convince an occupant that their home is badly built. It is also extremely difficult to resolve without either major rebuilding or sacrificing a substantial amount of space to remedial work.

Sound transmission routes

Airborne sounds such as music and voices travel between properties in a combination of direct transmission and indirect transmission.

- Direct transmission – transfer through the wall or floor separating two properties.
- Indirect transmission – paths which bypass the wall or floor in question. For example, passing through an adjoining (flanking) wall instead.

Normally the direct path will dominate. Controlling this route of transmission through effective use of mass and isolation will reduce the amount of sound transferred to a reasonable level. However, some combinations of building materials can allow flanking transmission to dominate. In those circumstances, improving the wall or floor will yield very little improvement. Timber floors, for example, are prone to this problem if combined with a lightweight masonry shell or adjoining walls.



Paths of type 1 are direct paths
Paths of type 2 are flanking paths

Direct vs flanking noise paths

Impact sound can also travel both directly and indirectly. Common sources of impact noise are footfalls and dropped items on a floor. However, other types of impact sound can be structure-borne through a building. For example, although the operation of a light switch is not particularly loud in the room it is fitted in, it may be heard clearly on the neighbour's side of the wall if that wall is not properly designed or constructed. Also, although they might not be considered impact noises as such, wall-mounted boilers, pumps or fan heaters can cause disturbance through structure borne noise in an adjoining property if they are not fitted on appropriate vibration isolating mounts.

Design and material selection

Problems with sound insulation arise from a combination of:

- Incorrect design;
- Use of the wrong materials; and
- Poor workmanship.

When selecting a particular construction such as a wall or floor, it is important to consider evidence of its performance, and what that evidence actually shows. This will be discussed further later.

For simple schemes using tried-and-tested construction methods, guidance such as the BRE Good Building Guides (BRE 2013) provides straightforward explanations of sound insulation issues as a first step. For new-build properties, consideration might be given to the solutions provided by Robust Details Limited (**www.robustdetails.com**) which avoid the need for pre-completion testing. However, innovative solutions and challenging environments will need the services of an acoustic consultant to avoid expensive mistakes.

Regulation

Although sound insulation has been included within the building regulation system since 1965, it has not always been satisfactorily addressed in new buildings or in cases of changes of use. This led to the introduction of a requirement for pre-completion sound insulation testing in 2003.

Approved Document E to the Building Regulations sets out minimum standards for sound insulation performance between domestic properties, which include houses, flats and rooms for residential purposes such as student rooms. The standards are different for newly built homes and converted homes as it is more difficult to achieve good sound insulation when altering an existing structure, for example converting a house into separate flats.

Walls are tested for airborne sound. Floors are tested for both airborne and impact sound. The minimum standards for sound insulation in houses and flats, and in rooms for residential purposes such as student rooms, are provided below. They also apply to stairs, but stairs are not a testable space as sound behaves differently in long, thin spaces.

Developments should be tested at a rate of two walls and two floors per ten dwellings, assuming that they are all of the same construction. If there are different construction types in the development, they should be sub-grouped so that all construction types are tested. Rooms should be just about finished, with doors, skirtings and window vents in position.

Performance standards for separating walls and floors in houses and flats

			$D_{nT,w} + C_{tr}$ (dB) (Minimum value)	$L'_{nT,w}$ (Maximum value)
Purpose built	Airborne	Walls and floors	45	
	Impact	Floors only		62
Material change of use	Airborne	Walls and floors	43	
	Impact	Floors only		64

Performance standards for separating walls and floors in rooms for residential purposes

			$D_{nT,w} + C_{tr}$ (dB) (Minimum value)	$L'_{nT,w}$ (Maximum value)
Purpose built	Airborne	Walls	43	
		Floors	45	
	Impact	Floors only		62
Material change of use	Airborne	Walls and floors	43	
	Impact	Floors only		64

Depending on the expectations of the occupants, these minimum regulatory requirements may not always be sufficient to avoid complaints.

The test methods for airborne and impact testing are explained below. Where measurements relate to testing under The Building Regulations 2010, the test procedures defined in Annex B of Approved Document E (2003 Edition) should be followed.

Omnidirectional loudspeaker used in sound insulation tests

Airborne sound insulation testing

Airborne testing is required for both separating walls and floors. Rooms are tested in pairs, and should both be habitable rooms such as living rooms or bedrooms if possible.

Broad-spectrum (pink) sound is generated by an omnidirectional speaker in one of the rooms, normally the larger of the two, and sound is measured in both this room (source room) and the other room (receive room). These measurements are used to establish the difference in noise level between the two rooms at a range of third octave band frequencies between 100 Hz and 3150 Hz. Frequencies as low as 50 Hz and as high as 5000 Hz may also be measured, but are not part of the calculations which follow. Multiple measurements are carried out with the loudspeaker in at least two positions and with the microphones in a series of different positions in order to capture a representative average of the noise levels in each of the two rooms.

Reverberation time and background noise are also measured in the receiving room. Reverberation time measures the amount of time it takes for sound to decay in a room once the noise source stops. It is used to calculate how much of the sound in the receiving rooms is being reflected back from the walls, floor and ceiling and adjust it to a standard amount so that results measured in different rooms can be compared with each other. Background noise is the amount of sound which is already present in the receive room before the speaker in the source room is switched on. It is used to correct for the effects of noise which is not generated as part of the test.

Relevant standard: BS EN ISO 140-4:1998[1]

The measurement results are then used to calculate a Standardized Level Difference (D_{nT}) at each one-third octave band frequency. The resulting curve of results between 100 Hz and 3150 Hz is fitted to a standardised reference curve. The value of the reference curve at 500 Hz is the single figure value ($D_{nT,W}$). A low frequency correction, C_{tr}, is then applied to the result. This is required by Approved Document E because low frequency sound such as music is such a common cause of noise complaints.

The value represents the difference in noise levels between the two rooms, and therefore a higher value is a better result, and the results should exceed the values in the tables above.

Relevant standard: BS EN ISO 717-1:1997

[1]BS EN ISO 140-4:1998 has been superseded by BS EN ISO 16283-1:2014, but is still used for pre-completion dwelling tests.
[2]BS EN ISO 140-7:1998 has been superseded by BS EN ISO 16283-2:2015, but is still used for pre-completion dwelling tests.

Impact sound insulation testing

Impact noise testing is carried out in vertical pairs of rooms. A tapping machine is placed in a series of positions on the floor of the upper room to simulate footsteps, and noise in the same set of third octave frequency bands is measured at a series of microphone positions in the room below.

Background noise and reverberation time measurements are carried out and used in the same way as for airborne sound measurements to ensure that only sound coming directly through the floor is used.

Relevant standard: BS EN ISO 140-7:1998[2]

Tapping machine used in sound insulation tests

The measurement results are then used to calculate a Standardized Level Difference (D_{nT}) at each one-third octave band frequency. The resulting curve of results between 100 Hz and 3150 Hz is fitted to a standardised reference curve. The value of the reference curve at 500 Hz is the single figure value ($L'_{nT,W}$).

This time the value represents an absolute level of noise in the room below, and therefore a lower value is better and the result should be below the values given in the tables above.

Relevant standard: BS EN ISO 717-2:1997

Robust details

Robust Details is a scheme designed to offer an alternative to the testing requirements of Approved Document E for purpose-built houses and flats built using a series of approved construction methods. These methods have been established by testing to be a reliable way of achieving a higher performance standard, and therefore developments registered and built in accordance with the scheme do not require testing to demonstrate compliance with Approved Document E.

Sources of noise disturbance – environmental noise

Environmental noise disturbance is unwanted sound entering from outside a building rather than from another place in the same building. Typically from road, rail, air or industrial sources, it does not tend to generate the same number of complaints as neighbour-generated noise heard due to poor sound insulation, largely because it is less intermittent, easier to become accustomed to and less likely to be ascribed to unreasonable behaviour. However, there are other environmental noise sources such as open air concerts which attract more complaints.

High levels of environmental noise are associated with a substantial number of adverse effects (WHO 2018). These include:

- Health problems such as increased rates of heart disease and metabolic disease;
- Sleep disturbance; and
- Reduced learning and performance.

Regulation

Noise sources from outside the building are regulated through the planning system at the time a new development is proposed. Many proposed urban developments will require a noise report, either assessing the likely noise environment of the new homes, assessing the impact of the proposed development on existing homes, or both.

Planning for new homes

The UK government provides qualitative guidance documents for controlling environmental noise to new homes through the following resources:

- Planning Policy Framework (DCLG 2012)
- DEFRA's Noise Policy Statement for England (DEFRA 2010)
- DCLG's planning practice guidance web-based resource (DCLG)

These documents use an approach based on principles used by the World Health Organization in a toxicology context. There are three effect levels for environmental noise:

- The **No Observed Effect Level** (NOEL) – this is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
- The **Lowest Observed Adverse Effect Level** (LOAEL) – this is the level above which adverse effects on health and quality of life can be detected.
- The **Significant Observed Adverse Effect Level** (SOAEL) – This is the level above which significant adverse effects on health and quality of life occur.

The levels may be different for different noise sources, and it is acknowledged in the Noise Policy Statement that further research is required to increase understanding of what may constitute a significant adverse impact on health and quality of life from noise. By not using fixed levels, as existed with previous guidance, it is possible for NOEL, LOAEL and SOAEL levels to evolve with the findings of future research into noise and health.

The Noise Policy Statement requires all reasonable steps to be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. However, it expressly states that this does not mean that such adverse effects cannot occur. This prevents noise from overriding local needs or other requirements from the property, for example by classifying large areas of towns unsuitable for development where there is a pressing need for homes, or by forcing sealed-window solutions in noisy areas where residents may prefer to have the option to open them at the cost of some noise ingress.

Railway lines can pass very close to housing

LOAEL and SOAEL values

Some local authorities have published local guidance suggesting values for LOAEL and SOAEL which might be used for developments in their area. These are often local authorities with large noise sources such as airports within their boundaries. Other local authorities do not have such local guidance, and LOAEL and SOAEL levels are derived from sources of guidance or from published research into noise and health.

Commonly-used sources of information on the health impacts of noise are the World Health Organisation documents, Guidelines for Community Noise (WHO 1999) and Night Noise Guidelines for Europe (WHO 2009). These review the current available research on the impact of noise upon health. A new set of guidelines was published by the World Health Organisation in 2018, Environmental Noise Guidelines for the European Region (WHO 2018). The values most relevant to homes in these most recent guidelines are provided below.

Airports can have take-off and landing flight paths close to homes

Environmental Noise Guidelines for the European Region guideline values most relevant to homes (exposure at the most exposed façade, outdoors)

Noise source	Time of day	Level in dB	Criterion
Road traffic	Day, evening and night	53	L_{den}
	Night only	45	L_{night}
Railway noise	Day, evening and night	54	L_{den}
	Night only	44	L_{night}
Aircraft noise	Day, evening and night	45	L_{den}
	Night only	40	L_{night}
Wind turbine noise*	Day, evening and night	45	L_{den}

*The value for wind turbine noise is given as conditional and no night value is provided due to the limitations of the research available.

L_{den} is a weighted equivalent continuous sound pressure level over the day, evening and night period, essentially an average. L_{night} refers to the night period only, normally taken to be 23:00 to 07:00. Both are yearly averages.

The previous 1999 WHO Guidelines for Community Noise also had a recommendation of 55 dB for outdoor areas. This does not have an equivalent in the 2018 guidelines. The new guideline values are outdoor ones but include night time data, which is not particularly relevant to gardens.

Another key source of guidance values is BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings (BSI 2104). This document provides recommended maximum values for unoccupied rooms in a range of spaces as well as practical guidance on managing noise issues. For dwellings, the Standard makes the following recommendations:

Indoor ambient noise levels for dwellings published in BS 8233:2014

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB L_{Aeq},16hr	–
Dining	Dining room/area	40 dB L_{Aeq},16hr	–
Sleeping	Bedroom	35 dB L_{Aeq},16hr	30 L_{Aeq},8hr

The descriptors used in BS 8233 are L_{Aeq} and L_{Amax}, both measured in decibels. The main descriptor is L_{Aeq}. This is the equivalent continuous noise level, essentially the average noise level measured over the reference period. However, as the decibel is a logarithmic scale, it tends to be slightly higher than a mean would be. The L_{Amax} is the highest noise level measured over the reference period.

The values published in these sources might reasonably form initial suggestions for LOAELs unless other, more relevant, published research or guidance sources exist. As the L_{den} criterion includes weighting factors, some conversion calculations might be needed.

Research into appropriate levels for LOAEL and SOAEL is ongoing. BEL (BEL 2009) and AECOM (AECOM 2013) have both carried out reviews for DEFRA with a view to strengthening the knowledge base supporting LOAEL and SOAEL and the Health Protection Agency appointed an ad hoc expert working group to review current evidence on noise and health (HPA 2010).

Consideration of noise together with other issues

While it is important that interior noise levels are not so high as to prevent reasonable use of rooms, particularly rest in bedrooms, they should also not be too quiet. This is because some background noise provides acoustic privacy. If an external wall is too good at keeping out external noise, it may make neighbour noise even more noticeable in a quiet room, or render noise from a household refrigerator or boiler disturbing.

Guidance values are useful, but noise levels should not be considered in isolation. When designing new homes it is also important to consider the actual living conditions of the final occupants. For example, while it is technically possible to achieve reasonable interior noise levels in extremely noisy environments, very often it is only by effectively sealing the building façade and providing mechanical ventilation. This provides less than ideal conditions for the occupants, who may find themselves unable to open a window on a hot day, or committed to using air conditioning with associated mechanical noise, running and energy costs.

Similarly, an outdoor area may be noisier than the 55 dB(A) recommended for outdoor living areas in the 1999 WHO Guidelines for Community Noise, but if the development is designed so that the area is still significantly quieter than the surrounding streets, it is likely to be valued by the occupants.

For this reason, acoustic requirements should be considered early in the design process so that the building design resolves rather than creates challenges. The following measures may be considered.

- Locating rooms sensitively – put kitchens or bathrooms on noisier façades and bedrooms on quieter ones.
- Using the building itself to screen noise from busy roads and provide quieter gardens and balconies.

It is important that buildings are acoustically well designed and built to provide the necessary quiet and privacy for their occupants. Well-designed buildings can lead to better neighbour relations, a greater sense of community and offer areas of sanctuary even within a busy urban environment.

Planning for new noise sources

Where a proposed new noise source is something like a road, the Noise Policy Framework would be the most appropriate way to assess its impact. However, if a new industrial or commercial noise source is proposed, more specific guidance exists in BS 4142: 2014. This provides a detailed framework for measuring or predicting the potential for new sources of noise to annoy existing residents.

Measuring road noise with a sound level meter

Noise survey criteria

A noise survey should be carried out at a time and for a duration when it will reliably characterise the noise environment at a specific location and when meteorological effects will not compromise the measurements.

Heavy rain should be avoided unless it is part of a long term measurement and wind speeds of more than 5 metres per second are liable to lead to measurement of wind effects across the microphone rather than actual noise levels. Measurement positions should normally be either at a distance far enough away from buildings and solid structures for noise reflections to be avoided or at a distance of one metre from the building and a correction factor applied for reflected sound.

Parts 1 to 3 of BS 7445 (BSI 2009, 1991, 1991) provide guidance on the description and measurement of environmental noise. Individual standards may also contain their own comprehensive guidance, for example BS 4142:2014.

The role of laboratory testing

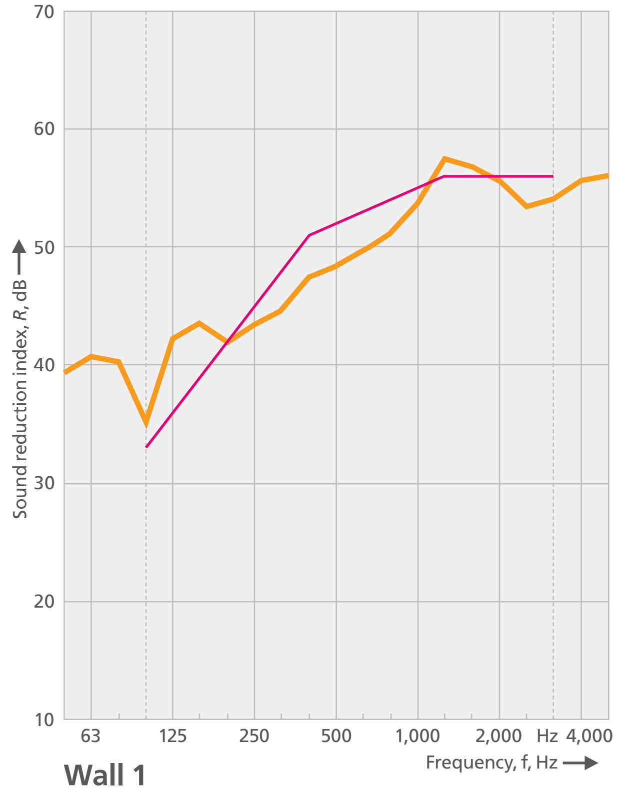
Laboratory test data are a vital first step in identifying acoustic solutions to real-life problems like these. Test laboratories such as BRE use controlled conditions to establish exactly how much sound gets through a wall, floor, window, door or vent. Tests are carried out in accordance with British and International Standards so that results are consistent and reliable, and can be compared with each other. UKAS (United Kingdom Accreditation Service) accreditation means that a laboratory undergoes rigorous checks of its testing procedures to ensure accuracy and consistency.

Manufacturers pay for their products to be tested so that they can demonstrate how they perform acoustically and try to improve them. However, when designing a development for good acoustics, it is vital to understand what a datasheet can and can't tell you. Getting it wrong can lead to expensive problems, and expert acoustics advice is highly recommended when planning design solutions.

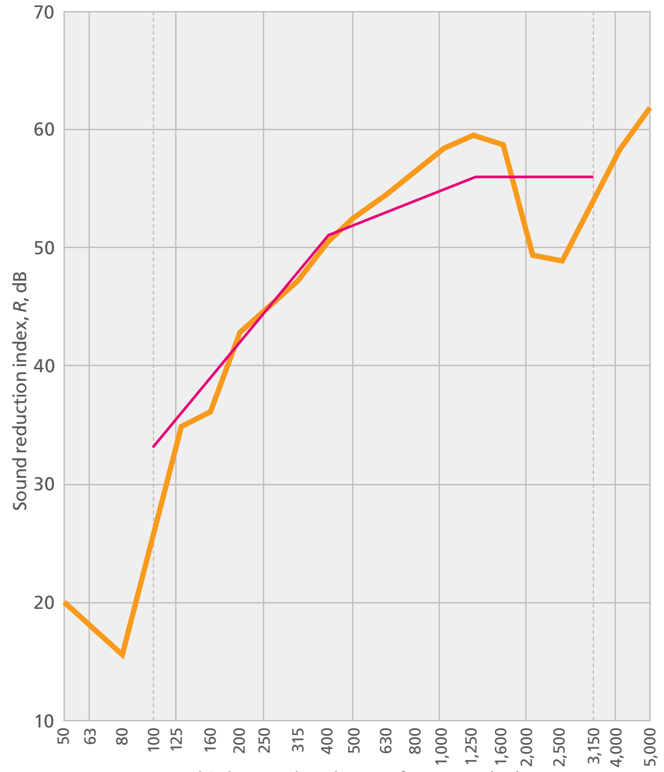
A typical test data sheet will provide a single figure value. It might be an R_w for airborne sound through wall, floor, door or window, a $D_{n,e,w}$ for airborne sound through a vent or an $L_{n,w}$ for impact noise through a floor. The value is achieved by measuring sound insulation performance across a range of frequencies between 100 Hz (low frequency sound) and 3150 Hz (high frequency) and fitting a standardised curve to the resulting graph. The value of that reference curve at 500 Hz becomes the single figure value. For airborne sound, a higher result indicates better sound insulation. But that single figure value is essentially a blunt instrument, and there are a lot more things to consider before making a decision to use that product.

– One number does not tell the whole story

Two constructions can have the same the same single figure value and differ vastly in the way they perform at different frequencies.



Wall 1



Wall 2

Airborne sound insulation test results for two walls. Both have an R_w of 52

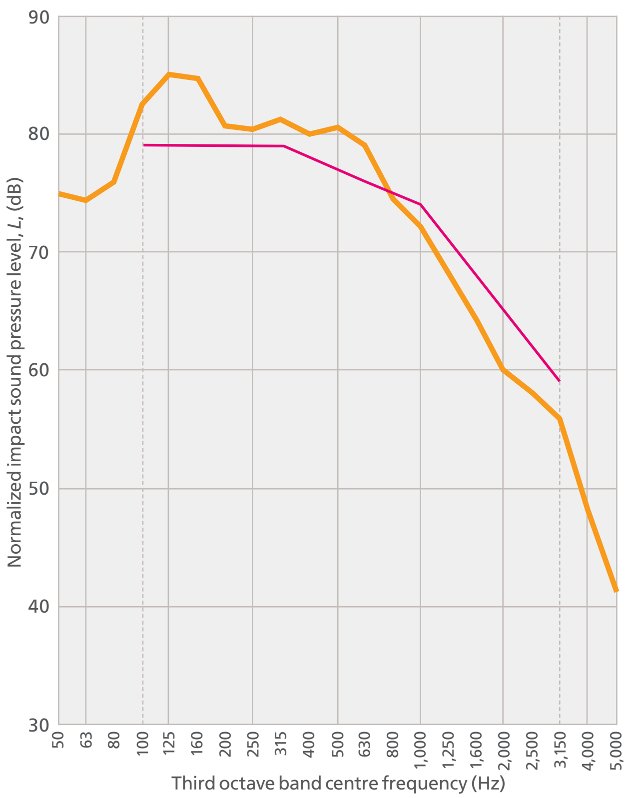
The airborne sound insulation graphs on the previous page are for two walls tested in a laboratory. Both have an overall result of 52dB, R_W. The graphs show sound insulation (R) against frequency (low frequency on the left increasing to high frequency on the right). Both walls tested stop high frequency airborne sound much better than low. This is usually the case, as low frequency sound travels through materials more easily, and an airborne sound insulation test result will normally show an ascending curve from left to right. However, Wall 2 is much lower on the left side of the graph than Wall 1, meaning it performs more poorly at low frequencies. This would mean that more low frequency sound would be transmitted through this wall from one property to another. A wall which has very low sound insulation performance at this end will be worse at stopping the bass from music or films. However, Wall 2 is slightly better than Wall 1 at some of the high frequencies. This means that it will be more effective at stopping high frequency sounds like a baby crying or a telephone ringing.

An interesting feature on Wall 2 is the pronounced high frequency dip in performance. This means that the construction naturally vibrates when noise at this frequency excites the surface and is therefore less effective at stopping it. If the proposed activity in a building will make a lot of noise at this frequency, then it may not be a good choice of construction method.

Selecting the correct solution is a matter of knowing what kind of sound the construction will need to stop in practice and how it will work with the other elements of the design.

– Lower might be better

Airborne noise transmission is measured by level difference – how much noise doesn't make it to the other side. The bigger the difference between the two rooms, the better the result. That principle doesn't work for impact sound, which travels through the structure a different way. This type of sound is measured by running a tapping machine which drops a series of hammers onto the floor and measuring the noise resulting in the room below. The less noise that is measured in the room below, the better. Therefore, a low $L_{n,w}$ result is better than a high one. An impact test result will typically show a descending curve rather than an ascending one, as the tapping action will generate more low frequency sound than high in the room below. The graph to the right shows the impact sound transmission performance of a timber floor. This floor was much more effective at the higher frequencies than the lower ones.



Impact sound insulation test results for a timber floor with an $L_{n,w}$ of 77

– Not all sound travels the same way

A laboratory report measures airborne sound travelling from one side of a test sample to the other (a floor test will measure impact noise too). It doesn't normally measure the ability of a wall to control structure-borne sound carried through a building, for example noise from lift doors opening and closing. These kind of situations require expert guidance.

– A laboratory is not the same as the outside world

Test laboratories take great care to measure sound travelling through the test construction, or being emitted from a noise source, and nothing else. Flanking noise is suppressed. Background noise levels are quiet and reverberation is controlled. The result therefore represents the construction working as well as it possibly can. It will not perform as well in practice, however well it is built. When construction methods and materials are selected, this loss of performance needs to be allowed for.

The construction of other elements, such as a flanking wall or floor will also be relevant to the final performance in practice. Some wall or floor combinations work very well together, but others less so.

It is becoming more and more common to use controlled laboratory testing to examine specific issues or wall and floor combinations within a project at the design stage, rather than using a collection of manufacturer's data. This way, a developer can consider the value of specific components or parts of systems at the outset of the project. By varying different components in a system, such as wall finish or insulation infill, a construction can be value engineered without an unexpected loss in performance occurring when installed on-site.

Heating, Ventilation and Air Conditioning (HVAC) systems such as Mechanical Ventilation with Heat Recovery (MVHR) units are often tested under laboratory conditions in order to understand the sound levels generated by them. This allows a designer or consultant to determine the amount of noise that will be heard by the occupants of the home or building, and ensure that any solution is not as disturbing as the problem it is intended to solve. Often the testing is conducted by manufacturers using standard settings or conditions, but tests are also carried out for project specific installations to improve the accuracy of the consultant's predictions. The settings used in these scenarios will accurately simulate elements of the intended installation such as duct run lengths and room layout to ensure representative loads are applied to the units.

– Little things can matter a lot

Test walls don't have plug sockets or pipework in them, or windows and doors in flanking walls close to the junctions. These create acoustic weak points, which affect performance in practice and need to be considered.

Detailing is very important where sound insulation is concerned, as an otherwise well performing wall or floor construction can significantly underachieve if edges are poorly sealed, isolating layers are compromised or manufacturer's installation guidelines are disregarded.

– Sometimes you need to know more

A competent acoustic design consultant will know a lot about what elements work well with each other, pitfalls to avoid and what a laboratory test result means in practice. However, sometimes standard test information may not give enough confidence for an unusual situation. In these circumstances, laboratory testing can be carried out in bespoke spaces and conditions to give an indication of the final performance of a design at a stage when it can still be changed if needed.

The BRE sound transmission testing suite

Case studies

Bespoke façade testing for low frequency sound performance

Noise coming from a nearby nightclub was a major concern for a new residential development. The construction proposed by the acoustic specialist was simply too large to fit into a laboratory. High quality test data were needed to ratify the results of computer modelling which had been undertaken.

Full-scale mock-up of several of the proposed façade build-ups were built on site at an early stage, to ensure that the design solution would be effective and could deal with the low frequency noise from the club. Ten sound level meters were used to measure both inside and out simultaneously. A large loudspeaker was used to generate very high levels of sound to understand how the construction behaved at different frequencies, including the low frequencies of concern.

The test was performed in accordance with the latest Standards to ensure that accuracy was as high as practicable.

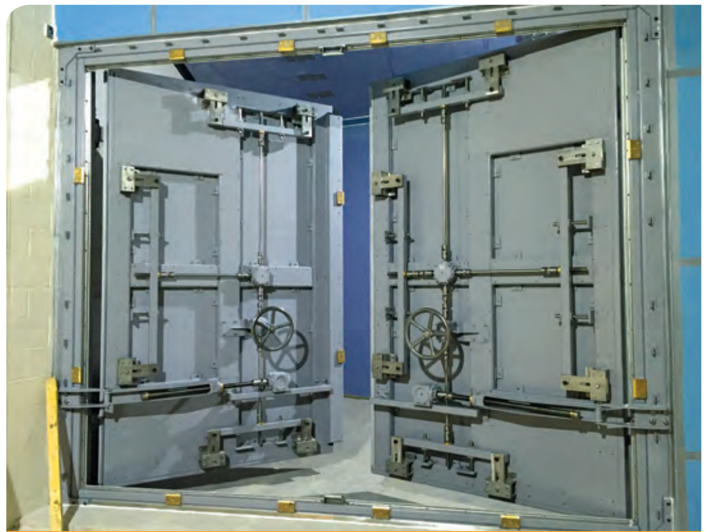
Measuring how much noise passes through a building façade using a large scale mock-up

Oversized doors

A series of doors intended for a major engineering project were much too large to fit in a normal sized test laboratory. A bespoke, temporary laboratory was therefore designed and built on the client's premises in order to test the doors. This unique facility enables the doors to be constructed at full size and, through a removable wall and roof, to be safely positioned in place within the test aperture between two test rooms.

Test equipment identical in specification to a permanent laboratory is used to measure the sound insulation properties of the doors.

The test laboratory was commissioned in line with the latest laboratory standards to allow a high level of confidence in the test results.



Sound insulation testing of large doors using a bespoke temporary laboratory

Conclusion

Good acoustic conditions are fundamental to enjoyment of the homes and other buildings we occupy. High levels of noise affect our health as well as our sense of wellbeing.

Cities bring homes, workplaces, schools and hospitals close together, along with roads, railways and other infrastructure. Effective acoustic separation allows us to enjoy the spaces we occupy while allowing for modern high density living.

Good acoustic design is achieved by an in-depth knowledge of the way sound behaves and the way different construction methods perform across the audible frequency spectrum.

Testing is the foundation upon which the practice of acoustic design and prediction is built. With knowledge of the way sound passes through different materials in different circumstances, buildings capable of dealing with the challenges of a high density environment can be constructed.

BRE can provide bespoke acoustic testing programmes which support building design work and evaluate construction specifications to give confidence that new buildings will truly perform.

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