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A Guide To Acoustics In Buildings for specifying movable wall systems

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ACOUSTICS IN BUILDINGS

A GUIDE TO THE SPECIFICATION OF MOVABLE WALLS

When considering what type of movable partition to use within a building it is important to bear in mind all aspects of the specification, particularly in relation to:

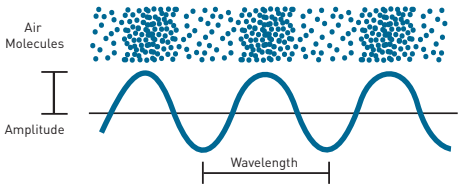
- **The expected level of on-site performance regardless of how individual rooms/areas are to be used.**
- **The ease of operation of the movable wall.**
- **The ability to store the panels when the rooms are opened up.**

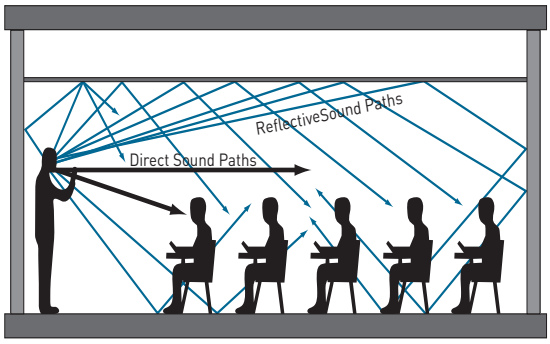
Although the above are important in relation to general use, many other factors can have a significant impact on the overall performance of a product. It is of critical therefore that these factors are given full consideration before a specification is issued so that the installation provides the levels of acoustic performance that is acceptable in operation.

Before considering the complexities of controlling sound in buildings it is important to have an understanding of the basic principles and terminology of acoustics and how performance values are arrived at.

What is Sound?

Sound is a form of energy created when air is disturbed in some way causing changes in air pressure that radiate from the source of the sound in waves. Sound can be airborne; typically that of a human voice or impact: for instance the sound of heavy footsteps on a floor.





Sound waves vibrate at different rates or frequencies as they move through the air and are measured in cycles per second or Hertz; the faster a sound wave passes a given point, the shorter the wavelength and in turn the higher the frequency. Vibrations in the air caused by the sound determine how loud it is; the stronger the vibrations the greater the 'amplitude'. The length or duration of a sound i.e. it's reverberation time or echo, is determined by the extent to which the energy is expended on contact with surfaces within a room.

How is Sound Measured?

Sound is measured in decibels using logarithmic scales; the human ear is incredibly sensitive and the scale needs to reflect this. The table below shows the increase in sound intensity in relation to decibel levels.

Sound	Db(A)
Near silence	0dB
Sound 10 times more powerful than near silence	10dB
Sound 100 times more powerful than near silence	20dB
Sound 1000 times more powerful than near silence	30dB

Decibels ratings are used to measure many classifications of sound and are expressed in different ways to represent the different calculations used and measurements taken. When dB ratings represent sound reduction the dB figure used is the difference between the original sound on one side of a structure and the resulting sound once it has passed through the dividing element (after various adjustments).

Loudness

Loudness is the human impression of the strength of a sound. The loudness of a noise does not necessarily correlate with its sound level and can be affected by the presence of another noise at a similar frequency.

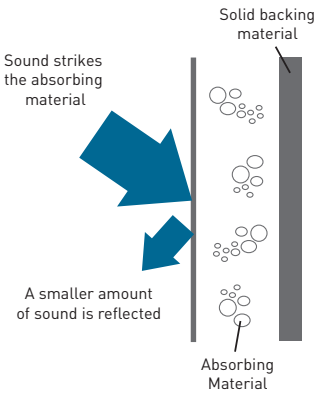
How are we affected by Sound and Levels of Noise?

The human ear can hear sounds across the frequency range 20 to 20,000Hz; however it is most sensitive in the range 100 to 5000 Hz. There is a great deal of variation in the hearing abilities of individuals and the awareness of sounds can depend not only on physical but also psychological factors. Noise can be described as unwanted sound; however the level at which noise is tolerable is subjective - a specific noise that one person finds upsetting may go unnoticed by another.

The table below gives dB levels for a range of recognisable sounds: -

Type of Sound	Sound Pressure levels in Decibels dB(A)
Threshold of hearing	0dB
Rural area at night	30dB
Whispered conversation at 1.5m	40dB
General office environment	50dB
Conversational speech at 1.5m	60dB
Busy Office environment	70dB
Family car accelerating at full power at 7.5m	80dB
HGV accelerating at full power at 5m	90dB
Pneumatic drill at 10m	100dB
Rock band at full power in a concert hall	110dB
Jet Engine	120dB

What is Sound Absorption?



Sound absorption describes the ability of materials to restrict the reflection of sound, doing this by converting the energy of sound into heat. The greater the sound absorption the shorter the reverberation time or echo produced. Sound absorption is measured as a co-efficient from 0 to 1.0; the best rating being 1.0.

What is the Difference between Sound Insulation and Absorption?

Put simply sound insulation affects people in the room adjoining a sound source while absorption affects those within it.

	Sound Absorption	Sound Reduction
Control	Sound reflection within a room	Sound transmission between rooms
Effect Upon	Performing and listening conditions	Privacy and disturbance
Benefits	Room occupants	Room neighbours

Sound Insulation in Buildings

The movement of sound around a building is a complex process that can be affected by a whole host of factors both within and around a site. There are also various ways of measuring and expressing levels and performance. Problems can occur with the level of acoustic control in a building and this may be because: -

- The building design does not lend itself to acoustic control.
- The specification of individual components is incorrect.
- The interaction between individual elements is not given full consideration.
- One of the parties or suppliers involved has used inappropriate information to gain a commercial advantage.

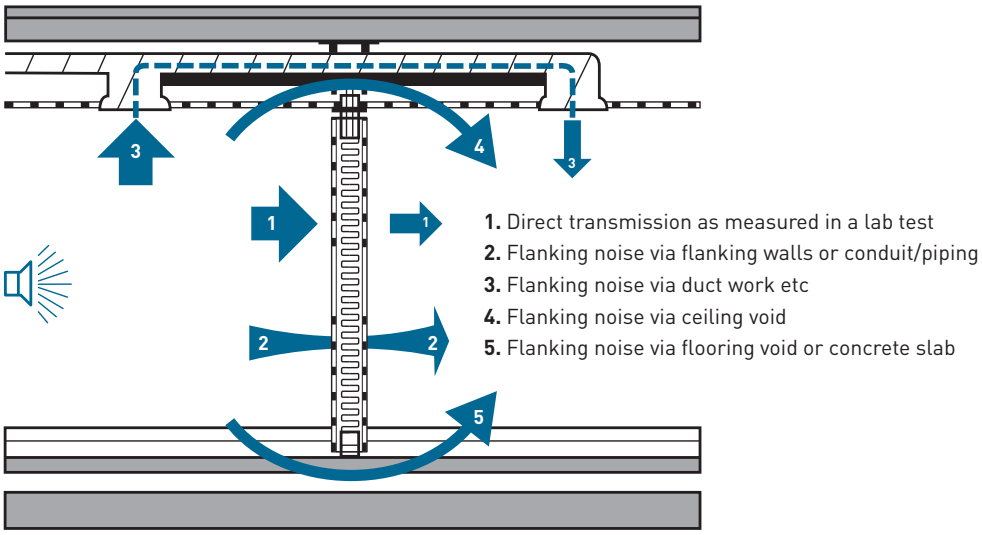
The Role of the Partition Wall

In commercial buildings the layout of an office is required to create areas that provide varying degrees of function and privacy. In relation to sound insulation, a partition is expected to deal with airborne sound and prevent or reduce noise travelling from one room to another. The type of activity to be carried out and the level of mutual noise disturbance that can be tolerated determines the appropriate standard of privacy between rooms.

Where a partition is made up of different elements i.e. including doors and glazing, with different sound reduction characteristics the overall level of reduction will be lower than that of the highest rated part regardless of the relative size of lower rated product.

Flanking Transmission

When sound travels through a partition between rooms this is known as Direct Transmission, however, the overall level of sound transmission is not governed simply by the insulation of the intervening partition. It is critical to consider the surrounding structure through which sound energy may travel – the leakage of sound through this path is known as Flanking Transmission. Areas typically prone to sound leakage in commercial buildings are: -



- Abutting Walls, window mullions and columns.
- Continuous suspended ceilings, access panels and common voids.
- Continuous raised access floors and common voids.
- Continuous perimeter piping or conduit systems.
- Ventilation grills and connected ductwork and air diffusers
- Doors common to corridors

The importance of restricting flanking transmission cannot be over stated. .Areas of weakness can have a disproportionately negative effect on overall performance in walls where a high dB rating is specified.

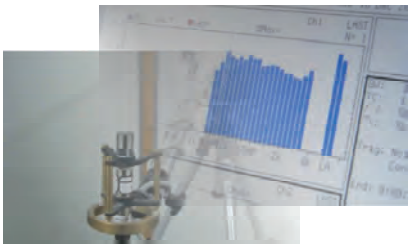
Sound Reduction Index & Standardised Level Difference

The sound reduction index (R) is essentially a simple one that expresses the difference between the sound intensity hitting one side of a structure and the resulting sound measured on the other side. The two quantities most commonly used to identify the performance of building products and in particular movable walls are: -

- The weighted sound reduction index: dB (Rw) – generally used in laboratory tests.
- The weighted standardised level difference: dB (DnTw) – generally used in on–site tests.

The (Rw) rating is used to specify the performance of a particular structure, material or product and is useful when choosing products. The (DnTw) rating describes the acoustic performance of a completed part of a building. The method for calculating weighted values is defined in BS EN ISO 717-1:1997.

Laboratory Testing



Laboratory tests only measure the performance of the material or component in question. Purpose designed isolated chambers are used to ensure that all the sound energy measured has passed through the test sample and not through the flanking structure with results expressed as dB (RW) The method for carrying out lab tests is described in BS EN ISO 140-3: 1995. When studying test reports in relation to movable walls it is important to consider the following: -

- That the materials used in the fabrication of the test specimen are still current.
- That the construction and installation of the specimen are consistent with that to be supplied.
- That the test report is from an accredited laboratory.
- That the test conducted was for a fully operational movable wall and not an individual panel without head track.
- That the test conducted did not include acoustic sealants between individual panel elements.
- That the sound reduction value is expressed as dB(RW).
- Tests carried out at UKAS accredited laboratories for UK manufactures.

On-Site Testing

Laboratory test figures published by building product manufacturers are useful in helping specifiers compare one product or range with another. However this does not provide a true indication of the potential site performance as many other factors will affect it. On site testing includes the impact of both direct and indirect flanking transmission with test values expressed as dB (DnT,w,). The method for carrying out on site tests is described in BS EN ISO 140-4: 1995.

Acoustics & Building Regulations

Part E of the Building Regulations was updated in 2003 to include details of minimum levels of acceptable sound performance in certain types of buildings, particularly schools (Building Bulletin 93 [BB93] provides more detailed guidance for acoustic planning and design in schools). However there is little mention of In commercial buildings legislation covers maximum noise levels from a health and safety perspective but there is no regulation for minimum levels of sound reduction; however the use of specific areas such as conference/meeting rooms etc. makes the need for good levels of sound insulation in practice no less important. Below is a list of the recommended maximum noise levels acceptable in various environments: -

Area	Recommended Maximum Noise Level (dB)
Offices	40 – 45dB
Large Offices	45 – 50dB
Classrooms	40dB
Large Lecture Room	35dB
Music Room	30dB

Sound Reduction in Practice

Before deciding on what type and standard of product to use, it is important to understand what sort of difference mean sound reductions will make. Once rooms have been allocated for specific purposes approximations can be made on the level of sound that is likely to be present. Privacy levels for individual rooms also need to be considered in order to arrive at the level of sound reduction required.

Typical dB (A) levels for human speech

Normal conversation @ 1m	60-65dB
Loud speech @ 1m	65-75dB
Shouting @ 1m	80-85dB

The table below shows the type of effect various levels of sound reduction will have.

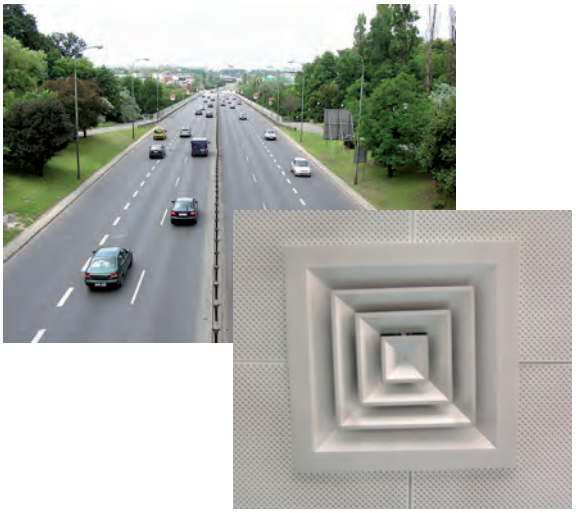
Mean Sound Reduction

20dB	Normal speech readily audible
25dB	Loud speech clearly audible
30dB	Loud speech clearly audible under normal circumstances
35dB	Loud speech audible but difficult to distinguish
40dB	Loud speech faintly audible but cannot be distinguished
45dB	Shouting audible but cannot be distinguished
50dB	Shouting barely audible
55dB	Shouting not audible

Background Noise

Background noise in buildings normally arises from sources like external traffic or equipment within the building. Machines like air conditioning units or fans can operate at moderate levels that make noise that is unobtrusive and is only noticed when turned off. This sort of noise is often unnoticed as it is steady and conveys little information about events around it.

As an unintended consequence of normal activities, background noise can be beneficial in masking more sounds from an adjacent room without being loud enough to be noticed in their own right.



Specifications in Practice

In most buildings there will always be a degree of sound leakage through the structure (flanking transmission) and this is why there are separate sound reduction indices for laboratory and on-site measurements It is generally accepted that even with ideal site conditions the minimum loss of performance between dB(Rw) and dB(DnTw) will be between 4 & 6 dB(Rw).

When deciding on an right product to be used, the preferred site performance figure dB(DnTw) should be added to the minimum expected loss of 4 to 6 dB(Rw), to arrive at the lab test dB(Rw) figure required. Where high ratings are specified, the loss of rating between lab and on site results may be greater than above; in this case and where products needs to be tested once installed, an acoustic consultant should be employed to provide a more accurate prediction of site performance .

Specifying Movable Walls

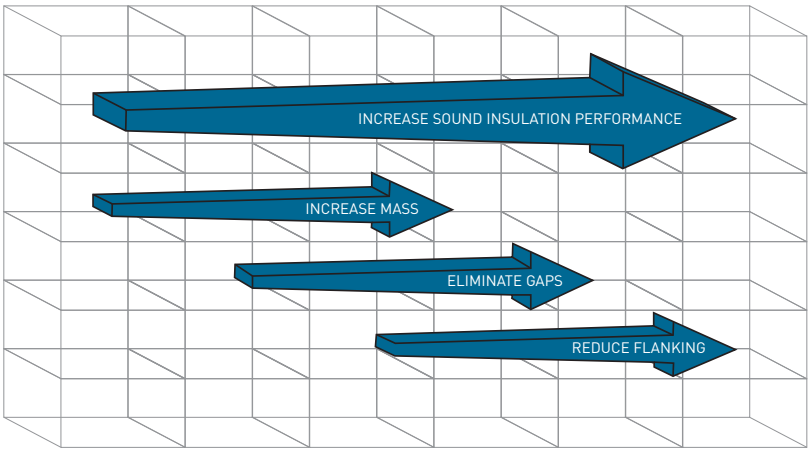
Movable walls are an increasingly important part of building design, allowing architects and designers the freedom to fully utilise space within buildings while providing end users with flexibility of usage. Focus on acoustic control and product performance is essential in the development of specifications that deliver buildings that are fit for purpose. The desired flexibility can only be achieved in practice if the Movable Wall product chosen reconciles the expectations users have with the space concerned.

End User Expectations

Building users expect movable walls to be able to:-

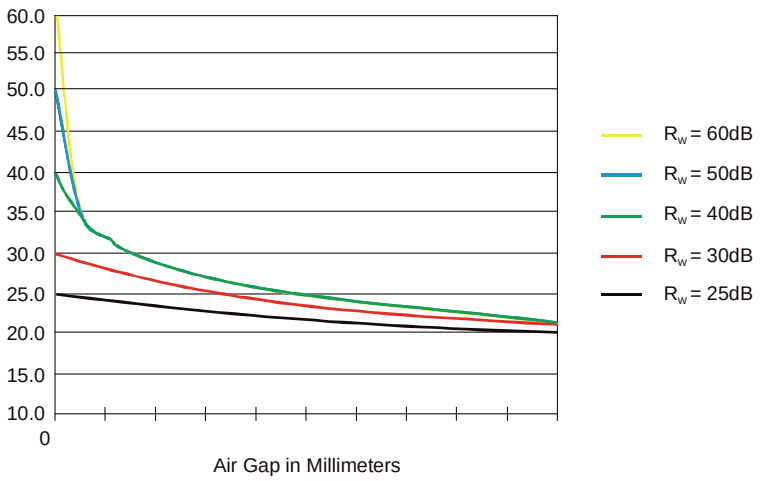
- Prevent the transfer of sound from one room to another regardless of what is happening in different areas.
- Be quick and easy to operate.
- Be easily and unobtrusively stored away when larger areas are required.
- Look aesthetically pleasing or match the surrounding colour scheme.
- Be durable with minimal maintenance.

A good understanding of a product range will provide solutions to the appearance and operation of a movable wall; however the specification/ and standard of the building or area where the product will be used will determine the levels of sound insulation. The mass/weight of a wall is also important in achieving acoustic performance, but, the elimination of gaps together with a reduction in flaking transmission is equally if not more important.



High Performance Movable Walls

In buildings where a very high degree of sound insulation is required, there may be a need for ratings in excess of 50dB(DnTw). Due to the influence of site conditions and flanking structures, this is unlikely to be provided by a single movable wall. In such cases two movable walls would need to be installed independently with the tracks separated by about 300mm. The existence of gaps, even a few millimetres, has an increasingly dramatic effect on overall sound insulation as the dB(Rw) rating of the product rises.



Where high performance walls are installed regular maintenance is essential to ensure that all seals continue operating to the highest standards.

Site Conditions

In order for a movable wall to provide sound reduction at optimum levels it needs to be installed into openings that are tailor made for it. Identifying potential areas of weakness should take place prior to installation as once in place it can be extremely difficult and costly to rectify problems. In an ideal situation the head track of the chosen system will fit directly to the structural soffit, however in practice most products are fitted beneath suspended ceilings.

SubFrame - As the highest sound rated products tend to be top hung, a suitable sub frame for the head track to be fixed to, will need to be installed.

Suspended Ceilings Voids - As a continuous ceiling void is a potential route for sound energy to cross from one room to another, an acoustic barrier constructed to provide at least the same dB(Rw) rating as the movable wall should be installed directly above the ceiling track and sealed with a suitable sealant.

Floors - In order for the top and bottom panel seals to operate efficiently, the floor along the line of the movable wall should be level. Barriers similar in performance to those fitted in the suspended ceiling void should be installed beneath flooring panels.

Abutments -Columns and external walls should be plumb, to allow ease of installation and operation.

Flanking Structure - The nature and design of the flanking structure is key to the successful installation of a movable wall. Wherever possible and ideally at design stage flanking structures should be broken to minimise transfer of sound energy.

Trunking & Conduits - Where the inclusion of cable trunking, pipe work and conduits within the flanking structure is unavoidable, there will be significant differences between dB(Rw) ratings and achievable dB(DnTw) values, unless these pathways are insulated, and attenuators are included with any ducting.

Installation - Movable walls are a specialist product and should only be fitted by trained installers.

Checklist/Summary

Building

- Clearly define the usage of individual areas and identify anticipated levels of noise - dB(A).
- Identify individual rooms that require privacy and determine the levels of sound reduction required for partition walls - dB(Rw).
- Be aware of ambient/background noise levels particularly where levels are low as this can affect the perceived performance of specified products.
- Identify possible flanking paths in the structure and take steps to avoid them at design stage or plan to insulate them to reduce flanking transmission as much as possible.
- Once the above have been considered decide on target dB(DnTw) for the various areas within the building.
- Where possible discuss the project layout with an acoustic consultant specialising in building design. Costs involved with trying to find a solution for acoustic problems once a building is in use are far greater than those for tailoring or altering a design at planning stage.

Choice of Product

- Identify a movable wall product that is: -

  a. Structurally suitable for the area concerned.

  b. Provides a laboratory dB(Rw) rating that in ideal site conditions will provide or exceed the dB(DnTw) rating that is required, and that the relevant test certificate including the full description of the materials used in the test is available.

  c. The acoustic test has been carried out on a working wall of not less than 3 panels, open and closed not solely on the panels alone.

  d. Is capable of meeting the layout and storage requirements for the area concerned.

  e. Is simple to operate and easy to maintain.

Installation

- Ensure that all flanking elements are fully and appropriately sealed or insulated.
- Ensure that the wall is installed by professional experienced installers.
- Ensure that personnel are fully trained on how to lock, move, store and adjust the wall once it is commissioned.

Movable Wall Systems

Movable Wall

Ease of operation, acoustic performance and pleasing aesthetics are combined in System AW to create movable walls that maximise spatial versatility in offices, conference and meeting rooms, training areas, educational establishments, hotels and banqueting suites.

Folding Wall

Hinged sliding folding modules make System MF ideal for those areas having multiple functions or where rapid layout changes are required. The system lends itself particularly to offices, including those with hot desking and hotelling areas, meeting rooms, clubs and restaurants, leisure centres and educational establishments.

Glazed M/W

A double glazed movable wall system combining acoustic performance with ease of operation. Suitable for many different types of location including offices, conference, training and meeting rooms, corridors, schools and hotels.

Single Glazed

An aesthetically pleasing and easy to use fully glazed 'glass to glass' movable wall system designed for use in a wide range of internal environments including hotels, shopping malls, airport terminals and railway stations.

Folding Screens

A double glazed, sliding folding, aluminium framed movable wall system designed to separate exterior and interior environments. Combining thermal insulation and security with ease of operation, the system is suited to use in both residential and commercial locations; including hotels, pavement café, restaurants and stores

Fabric Wall

A tried and tested economical system for quickly and easily dividing a wide range of areas, concertina systems are particularly suited to residential locations, nursery schools and village halls.

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