Acoustics Explained:

This introduction attempts to simplify what is an extremely complex subject. Where acoustic considerations are critical, reference should be made to qualified Acoustic Engineers.

'Acoustic' is a term that is used loosely in connection with door assemblies. When considering the 'acoustics' of a room or space, acoustics relates to a number of considerations.

When sound is generated, the amplitude (*loudness*) refers to sound pressure which is expressed in decibels 'dB'. When striking a surface, some sound will be reflected, some will be absorbed *(converted to heat)* and some will pass through the structure. Sound will lose energy (*amplitude*) with distance in accordance with the inversed square law.

The time taken for the sound pressure to drop by 60dB is measured. This loss of sound pressure related to time is measured as a 'reverberation time'. If the time it takes for the sound pressure to reduced by 60dB is less than 0.3 seconds the room will sound 'dead' with hearing made difficult due to an apparent loss of bass. If the reverberation time is in excess of 5 seconds the reverberation *(or echos)* can give rise to confusion which again makes hearing difficult. The optimum reverberation times may vary according to the intended use of the space. A reverberation time of 1 second might be ideal for a lecture hall providing for clear speech but this might not be a preferred performance for a concert hall where a reverberation time of up to 3.5 seconds would provide for fuller and richer musical sound. For 'general purpose' use Acoustic Engineers will generally try to 'tune' the space to provide for reverberation times between 1.5 ~ 2.5 seconds.

The reverberation times can be adjusted by the use of sound absorbers. i.e. by the use of materials that are less likely to reflect sound. Soft furnishings, carpet and curtains will provide for some sound absorbing properties. Mineral wool provides for a good example of a material that will readily convert sound energy into heat energy thus absorbing sound and consequently reducing the reflected sound. The performance of a sound absorber is measured by a 'coefficient of adsorption'.

The other issue of concern to Acoustic Engineers is the influence of sound created outside of the measured space and the ability of a structure to minimise the influence of an acoustic space by preventing or reducing the transfer of external sound through a structure. This is referred to as 'sound insulation' and it is the measure that generally applies to structures between spaces. e.g. walls, windows and door assemblies. Thus, when referring to 'acoustic' doors we generally mean 'sound attenuating or insulating' door assemblies.

Sound is generated at different frequencies. The 'frequency' is the number of sound waves that pass through a given point in a second and described in 'Hertz' *(Hz.)* where 1 hertz = one wave per second. Differences in frequency can be identified by a change of pitch. An example of a high frequency sound might be a computer bleep *(approx. 2,500Hz.)* while a low frequency sound might be the hum of an electrical generator *(approx. 100Hz.)*. Few sounds are made up of a pure single frequency. Sound is generally produced simultaneously over a range of frequencies. We might refer to the random structure of sound over a range of frequencies as noise, while sound produced over a range of frequencies in a structured manner might be referred to as speech or music. *(See **Fig. 10.1 & 10.2**).*

The average human ear is not a perfect sound receiver. We cannot hear some very low frequency sounds e.g. at frequencies below *(about)* 20Hz. referred to as 'sub sonic'. However, we might feel low frequency sound as vibration. At the other end of the spectrum human hearing may not notice sound at frequencies in excess of *(about)* 20,000Hz. *(20kHz.)*. This is referred to as the 'ultra sound region'. Bats navigate using sound in the ultra sound range and ultra sound can be used for medical purposes to create images. *(See **Fig. 10.2**).*

Even within the audible range *(approx. 20Hz. ~ 20kHZ.)* the human ear is less than perfect, being more sensitive to sound produced at frequencies of about 3,000 ~ 4,000Hz. *(3 ~ 4kHz.)* than sound produced at other frequencies. Thus, if sound is produced at the same amplitude (*or loudness*) at all frequencies, sound in the 3~4kHz. range will be perceived to be predominant. *(See **Fig. 10.3**).*

ISO 140 sets out the range of frequencies used for the purpose of testing for acoustic performances. The test procedure for the measurement of sound attenuation is described by reference to BS EN ISO 10140-2 : 2010+A2:2014. This measures performances over a frequency range of 100Hz. *(Hertz)* to 3,150Hz.

NOTE: A frequency range of 125Hz. ~ 4000Hz. is used for testing in the United States and Australia.

Acoustics Explained contd.:

The basic principles associated with testing for sound insulation performances are quite simple. The 'specimen' is located between a transmitting room and a receiving room. Sound is generated across the full frequency range determined by reference to the test standard in the transmitting room. The sound pressure levels on the receiving room side of the specimen are then measured. The sound pressure levels recorded in the receiving room can then be deducted form the sound pressure levels in the transmitting room with the resultant loss in sound pressure levels measured in decibels recorded at each of the measured frequencies.

For some purposes it is necessary to know the performances at particular frequencies but for most applications an average performance over the measured range is required. To determine this, the decibel reduction over the measured range could simply be averaged out. However, this would be misleading as this would not reflect human perception resulting from the imperfections of human hearing.

To relate to human perception, the average sound reduction is amended to provide for a 'weighted index' identified by the use of the prefix 'Rw'. The weighted index is calculated by reference to BS EN ISO 717-1 : 2013.

In the absence of a vacuum, most spaces will be subject to a background noise.

Typical Background Noise Levels:

	dBA
Library or Museum	40
Private Office	45
Quiet Restaurant	50
General Office	55
General Store	60
Averag Restaurant	65
Mechanised Office	70
Noisy Canteen	75
Factory Machine Shop	80
Main Street (*at kerbside*)	85
Plant Room	90

The sound insulating performances determined by testing can be applied by deducting the measured performance weighted index *(Rw.)* from the source sound. Thus, a sound insulation barrier providing for a performance of *(say)* Rw.30dB will reduce the sound pressure level generated in *(say)* a Plant Room from 90dBA to 60dBA. Conversely, to reduce the sound level in a Plant Room to the background sound level in *(say)* a Private Office, the sound insulation barrier needs to provide for a performance of 90dBA - 45dBA = Rw.45dB.

NOTE: The 'A' suffix indicates a 'weighted' measurement.

On site, sound attenuating measurements relate to the complete barrier between the sound source and the receiving area and will measure the overall performance of the wall, door assembly, window etc. that makes up the barrier. *(**See page 10.4**).*

Other Acoustic Terms:

Octave: An octave is a doubling or halving of a frequency. Doubling would involve going up to the next higher octave while halving involves coming down an octave.

Expressed simply, one octave is a difference resulting from the doubling or halving of frequency *(or pitch)*.

STC: By reference to European tests, the weighted index is expressed by the use of the prefix 'Rw'. For tests carried out in the United States over a slightly different frequency range *(125Hz. ~ 4,000Hz. as opposed to the European 100Hz. ~ 3,150Hz.)* the prefix 'STC' might be used. STC = Sound Transmission Class.

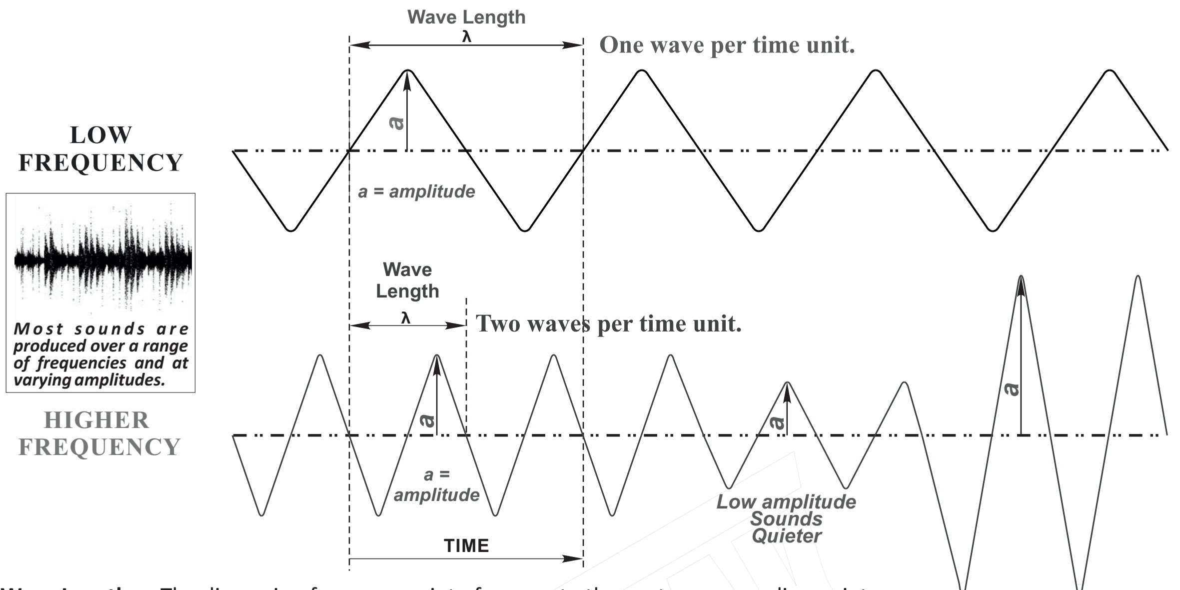
For all practical purposes Rw. & STC may be taken to be equal performances +/- 1dB.

Rule of Thumb:

Sound attenuation is measured using a logarithmic scale. Within the range applicable to most door assemblies, an Rw.3dB variation in performance may be taken to be a doubling or halving of performance. e.g. an Rw.36dB door assembly provides for (*approx.*) double the performance of an Rw.33dB door assembly.

Wavelength Amplitude & Frequency

Fig. 10.1



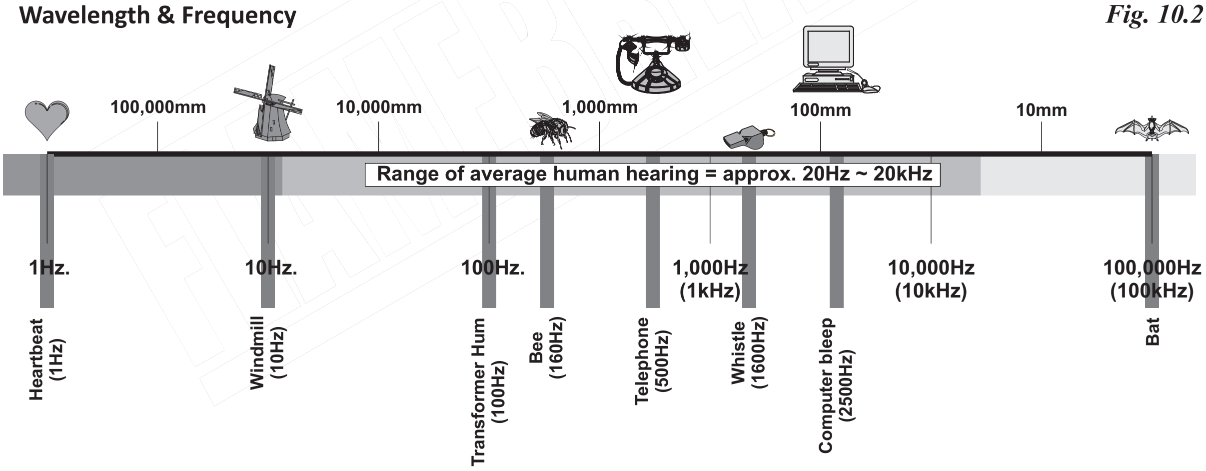
Wave Length = The dimension from one point of a wave to the next corresponding point.

Amplitude = The sound pressure or loudness.

Frequency = The number of sound waves that pass a fixed point in a second. *(Hz. = Hertz.)*

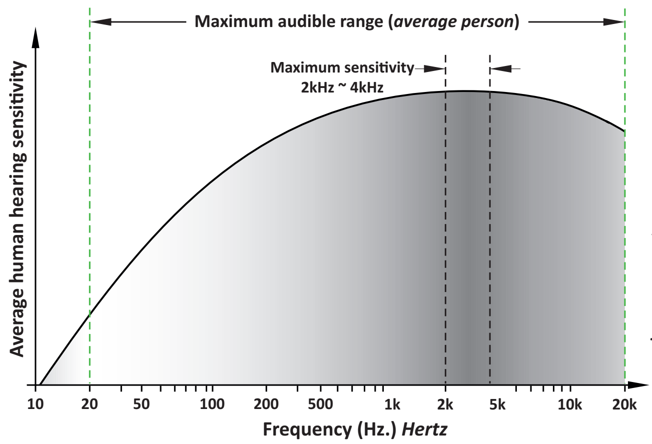
Wavelength & Frequency

Fig. 10.2



Average Human Hearing

Fig. 10.3



Average Human Hearing:

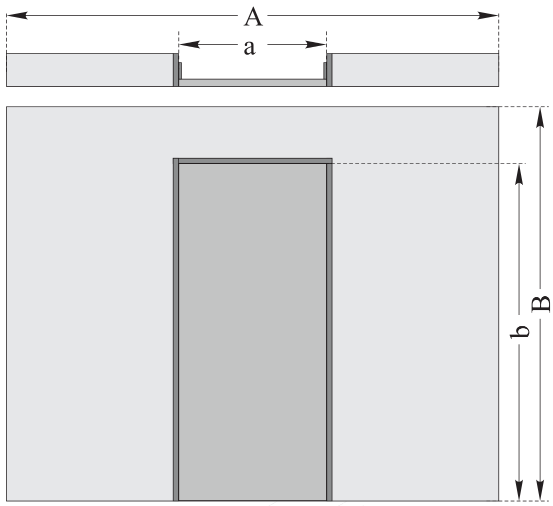
The limits of human hearing depend on both frequency and intensity of the sound (amplitude). The sensitivity of the human ear peaks within the range of approximately 2000–4000 Hz. Humans can detect frequencies over a very wide range, if the signal is strong enough, but what is commonly referred to as the hearing (or audible) range is (approximately) between 20 and 20,000 Hz.

A sound produced at (say) 20dB at a frequency of (say) 3,000Hz. might be heard by a listener but sound with the same amplitude (20dB) at (say) 200Hz. may not be heard.

For sounds produced at the same amplitude over all frequencies, the sounds in the more sensitive frequency ranges will be dominant.

Sound Insulating Barrier:

Sound Insulating Barrier *Fig. 10.4*



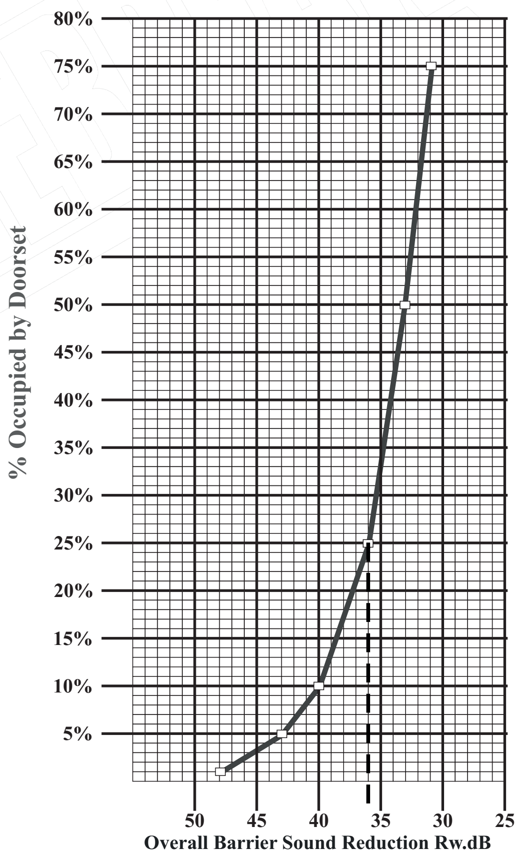
Total area of barrier = AxB = X
Total area of door = axb = y
(100/X) x y = % doorset area.

The objective when considering sound insulation is to reduce the external sound levels to the background levels in the protected area. Thus, if *(say)* a Private Office is located next to *(say)* a Factory Machine shop then, by reference to these typical background noise levels, the barrier between the Machine Shop *(generating 80dBA)* is required to reduce the sound pressure levels by 35dBA to match the background noise levels in the Office *(45dBA)*. i.e. the total barrier between the Machine Shop and the Office is required to reduce the noise levels by 80 - 45dBA = 35dBA.

It should be appreciated that the average performance of the complete sound attenuating barrier is the important thing. A door assembly, as an operable product, is likely to be a weak point in a sound insulating barrier. However, for the example given above, it may not be necessary to use an Rw.35dB rated door assembly design.

The required performance of the door assembly may vary according to the performance of the surrounding structure and the percentage area of the sound attenuating barrier that is occupied by the door assembly.

Sound Insulating Barrier *Fig. 10.5*



This graph illustrates the total sound insulating performance when using an Rw.30dB door assembly in an Rw.53dB wall.

Example: The overall sound attenuating performance of a barrier where an Rw.30dB door assembly occupies 25% of an Rw.53dB wall would be about Rw.36dB.

Sound Insulating Door Assemblies:

Generally any material will provide for a sound insulating performance if used as a barrier between a sound source and a 'protected' area. Some materials provide for better performances than others.

Door assemblies are essentially functional products with a primary purpose to provide for a means for 'traffic' to pass from one side of a wall to the other. For this purpose the door must be open. As the thing that we are trying to stop is the transfer of airborne sound then an open door will not provide for any performance. When the door is closed, the sound insulating performance will be influenced by the residual airflow across (*or around*) the door assembly. To minimise the airflow it is necessary to use sealing systems.

Some door constructions have been specifically developed to provide for excellent sound insulating performances when used with suitable sealing systems. Some of these 'specialist' constructions rely on the mass law technology. i.e. generally increased mass provides for improved sound insulating performances. However, there is not a direct relationship between mass and the sound insulating performance. Adding a dense material such as lead will generally improve performances but this will also change the characteristics of the door assembly resulting in significant improvements at some frequencies but with little or no improvement (*or even a loss of performance*) at other frequencies. Other 'specialist' door constructions rely on air gap technology in a similar manner to that used for glazed units. Essentially the air trapped in a gap will convert sound energy into heat energy with an improvement in sound insulating performances. Use of facing materials that change the stiffness of the door, the use of hardware fittings or glazing that bridge the door thickness can have an adverse influence on doors of this design.

To determine the precise performance of a sound insulating door assembly design it is necessary to carry out testing of a specimen that is identical in all respects to the design that is intended for use. The following factors can influence sound insulating performances:

Door size.
Door assembly configuration.
Facing materials.
Glazing.
Choice of hardware.
Frame section dimensions.
Sealing systems.
Nature of the surround structure.
Method and quality of installation.

The only certain method for determining the precise performance to be expected of a particular design is to test a product that is identical in all respects to the product that is intended for use in the building with the specimen installed into a structure in a manner that replicates precisely the methods intended for use.

FLAMEBREAK™ is essentially a general purpose door core material and has not been designed as a 'dedicated' sound insulating product. However, Pacific Rim Wood Ltd. have carried out an extensive range of tests to determine potential sound attenuating performances and to develop the product to suit the demands of published regulations, specifically:

Building Regulations - (England & Wales) - Approved Document 'E'.

Building Bulletin 93 - Educational Establishments.

To determine potential performances, tests were carried out on behalf of Pacific Rim Wood (UK) Ltd. using a 2040x926mm door leaf size, being the largest size single leaf dimension anticipated by reference to BS4787 Pt.1. The influence of meeting stiles was determined by use of smaller sized doors to create an unequal pair that would fit in the 'standard' frame used for the single leaf door tests.

When tested with glazing, the glass aperture dimensions were carefully calculated to provide for a clear glass area equal to 25% of the single leaf door area.

NOTE: It is important to carefully seal around the glass using suitable mastic to minimise the risk of sound leakage through the beading system.

The use of sealing systems is an essential requirement to provide for sound attenuating performances and these were carefully selected to provide for the following considerations:

1/ The sealing systems should have minimal influence on the operation of the door, with due regard to BS8300 and Building Regulations - *(England & Wales)* - Approved Document 'M'.

2/ It should not be necessary to interrupt sound insulating sealing systems to accommodate items of hardware. *(i.e. provide for a minimal risk of conflict between seals and ironmongery).*

3/ Sealing systems used for sound insulation purposes should also be able to provide for smoke sealing performances *(BS476 : Section 31.1)*.

4/ Sound insulating sealing systems should not conflict with intumescent sealing systems.

FLAMEBREAK™ and Sound Insulation:

To achieve desired performances for operational products such as a door it is necessary to use sealing systems to prevent the movement of air, *(and consequently airborne sound)* through and around the door assembly, when the door is in the closed position.

For lower performances, typically up to Rw.30dB, simple sealing systems can generally be used. For higher performances of *(say)* Rw.35dB + additional sealing may be necessary.

Perhaps the easiest way to appreciate this is to consider a bath full of water into which a bowl with a small hole in the bottom is floated. Where a low pressure is applied to the bowl the water will flow though the hole as a gentle trickle. When greater pressure is applied the water will eventually spout up rather like a fountain. To reduce the flow through the hole at the higher pressure a smaller hole *(i.e. additional sealing)* is required.

An extensive sound insulation test programme was carried out on behalf of Pacific Rim Wood (UK) Ltd. in 2008.

Since that time a number of door seal manufacturers / suppliers have carried out independent testing providing FLAMEBREAK™ users with a range of options.

Fully caulked test data for FLAMEBREAK™ door constructions is advised as follows:

FLAMEBREAK™ Type	Fully Caulked Performance Rw.
430	Rw.30dB
FF630	Rw.30dB
660	Rw.35dB

NOTES:

- ***'Fully Caulked' = the door leaves were sealed on all edges in an inoperative condition using heavy duty sealants. This indicates the maximum potential performance for the base flush door construction.***
- ***The fully caulked performances indicated in this section relates to a door leaf dimension of 2040x926mm. i.e. the largest internal single leaf size anticipated by reference to BS4787 Pt.1.***
- ***Operational performance guidance is given by reference to Section 16 - Appendix by reference to test data provided by seal manufacturers / suppliers.***
- ***It has been established by testing that the sound insulating performance of FLAMEBREAK™ doors can be improved by the use of glazing.***

Acoustic Seals:

There are a wide range of sealing systems available that are suitable for use as 'acoustic seals'.

Most seal manufacturers / suppliers will be able to provide base test data with recommendations to suit particular performance requirements. There are however some general issues to be considered as follows:

- **Conflicts with Hardware:** To minimise the risk of air *(and therefore airborne sound)* leakage, care must be taken to avoid the interruption of sealing systems to accommodate hardware, *(OR, to provide for the making good of seal interruption).*
- **Conflicts with other sealing: e.g. fire / smoke seals.**
NOTE: Generally proven acoustic seals will also meet specification requirements for smoke sealing performances. i.e. seals that are effective at preventing the flow of airborne sound are also likely to be effective in the prevention of the flow of airborne particles.
- **Operating forces:** Efficient seals providing for excellent acoustic performance can often give rise to a *'bath plug'* effect. i.e. additional force may be required during the initial opening of the door.
NOTE: This effect may be more apparent for higher performance acoustic door assemblies using multi bank sealing systems. Automatic opening / closing devices may be required for locations where Building Regulations - Approved Document 'M' - (BS 8300) considerations apply.
- **Minimal Interference:** It is generally recommended that fixed seals are located to ensure that they are in contact with the adjacent door or frame for the minimal amount of the swing of the door. Generally this will result in frame fixed seals being located towards the doorstop face *(lining / frame rebate)* with door leaf fitted seals located towards the opening face of the door.
NOTE: This will generally result in reduce influence on opening forces and will extend the working life of sealing systems.
- **Over Compression:** Care must be taken to avoid over compression of seals. This can lead to seal distortion, undermining of the sealing function, a need for increased operating forces and increased seal wear. Seal manufacturers / suppliers can generally provide for guidance relative to the particular seal type. In the absence of any other guidance, 50% compression of a sealing gasket may be taken as a guide for achieving optimum performance.

Planning Sealing Systems:

Manufacturers / Suppliers of sound insulating seals will generally provide for guidance with regard to the preferred location of their seals.

A good guide for determining the suitability of a sealing system is to identify the sealing efficience relative to a fully caulked performance for doors that are otherwise of the same construction.

NOTE: Whereas the seal efficience system is suitable for applications where the particular requirement is less than the maximum seal tested performance it should not be used where higher that tested performances applications apply.

Example: Where an operational door assembly has been tested to provide for a performance of (say) Rw.35dB and the fully caulked performance of the same door assembly design is (say) Rw.37dB then the sealing system provides for 95% efficiency.

If the same sealing system is used with a door construction providing for a fully caulked performance in excess of Rw.37% then the sealing efficiency may be less than 95%.

The efficiency of the sealing system is likely to be matched or even bettered if the same sealing system is used with a lower performing fully caulked construction. e.g.

Fully caulked = (say) Rw.40dB / Sealing efficiency = <95%
i.e. operation performance likely to be less than Rw.38dB.

Fully caulked = (say) Rw.35dB / Sealing efficiency = or > 95%
i.e. operation performance likely to be better than Rw.33dB.

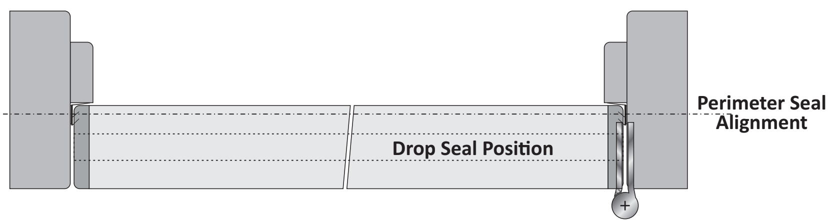
The following details illustrate typical location details for sound insulating sealing systems with guidance with regard to considerations that should be taken into account to achieve optimum performances including:

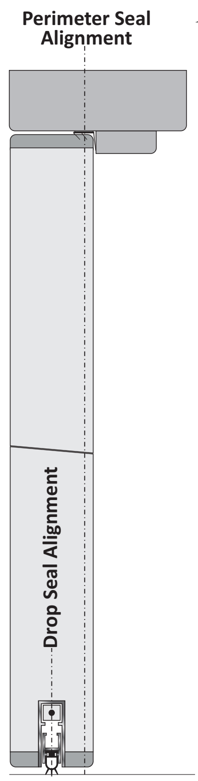
See Section 16 - Appendix for some Sound Insulating Seal Manufacturers / Suppliers data.

Typical Acoustic Sealing - Basic Sound Insulating Sealing

Fig. 10.6

- **Operating forces minimised as door is only in contact with perimeter seals for final degree of closing.**
- **Perimeter seals are aligned in a single plane at the head and jambs reducing the risk of flanking.**
- **Minimal risk of conflict with intumescent seals or hardware.**

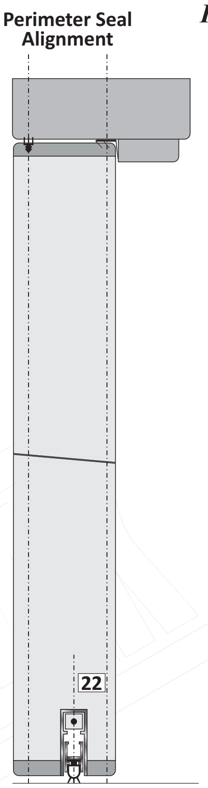




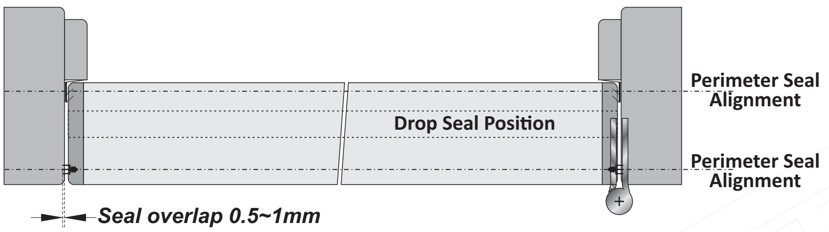
- **Automatic door bottoms can generally be used direct onto smooth / level floor finishes (*e.g. vinyl*). In all other cases it is strongly recommended that threshold strips are to provide for:**
- **Threshold strips provide for good seating for the threshold sealing gaskets and provide for improved durability for Automatic Door Bottom - *(Drop Seal)* gaskets.**

Basic with Supplementary Sound Insulating Sealing

Fig. 10.7



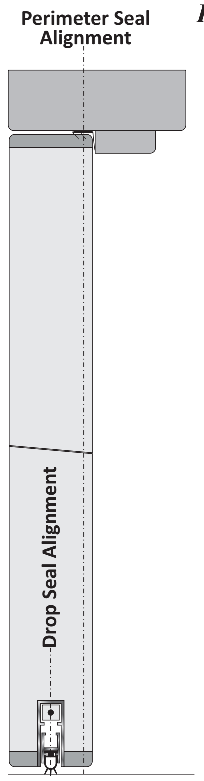
- Operating forces minimises as door is only in contact with perimeter seals for final degree of closing.
- Perimeter seals are aligned in a single plane at the head and jambs reducing the risk of flanking.
- Minimal risk of conflict with intumescent seals or hardware.
- Door leaf fitted supplementary seal is interrupted by hinges. This can be addressed by use of self adhesive 'tear drop' type seals fitted to either the door leaf or frame hinge blade to align with the supplementary seal.



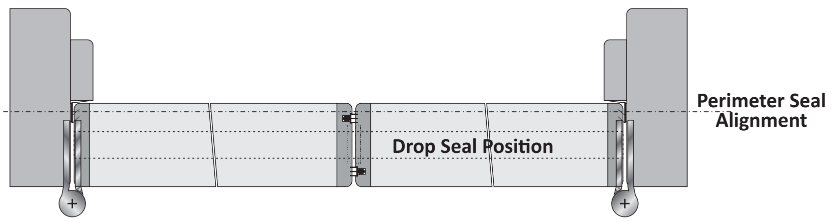
- Automatic door bottoms can generally be used direct onto smooth / level floor finishes (*e.g. vinyl*). In all other cases it is strongly recommended that threshold strips are to provide for:
- Threshold strips provide for good seating for the threshold sealing gaskets and provide for improved durability for Automatic Door Bottom - *(Drop Seal)* gaskets.
- Automatic door bottoms can be located off centre thickness to align as near as possible with perimeter seals.

Typical Acoustic Sealing - Basic Sound Insulating Sealing - Pairs

Fig. 10.8



- Operating forces minimises as door is only in contact with perimeter seals for final degree of closing.
- Perimeter seals are aligned in a single plane at the head and jambs reducing the risk of flanking.
- Minimal risk of conflict with intumescent seals or hardware.
- Locate meeting stile seals as near as possible to align with perimeter seals and to avoid conflicts with other seals and hardware.



- Automatic door bottoms can generally be used direct onto smooth / level floor finishes (*e.g. vinyl*). In all other cases it is strongly recommended that threshold strips are to provide for:
- Threshold strips provide for good seating for the threshold sealing gaskets and provide for improved durability for Automatic Door Bottom - *(Drop Seal)* gaskets.

Seal Types:

Generally Acoustic Seals will fall into two categories:

Perimeter Seals: Seals designed to seal at the perimeter of the door leaf generally at the head and jambs *(unless a 4 sided frame is used)* and meeting stiles for pairs.

There are numerous designs for perimeter seals, some with simple self adhesive fixing others with aluminium or plastic carriers. Reference should be made to the seal manufacturers / suppliers literature to determine the most appropriate seal for the particular application.

NOTE: When locating perimeter seals consideration must also be given to the operation of the door and in particular the 'door growth' during operation that may require the use of a 'leading edge'. See the ASDMA publication 'Guidance and Recommendations for the Coordination of Bespoke Doors Assemblies' ***for further information on this subject.***

The use of pencil rounds or small splays to the edges of door leaves that contact the seals is recommended to provide for a 'lead' for the activation of the seals and for improved seal life.

Threshold Seals: Seals designed to seal the gap between the bottom edge of the door and the floor.

There are two fundamental types of threshold seal. The most common is perhaps the 'Automatic Door Bottom' *(or 'drop seal)*. These are mechanical devices where a gasket is extended from the bottom of the door by the action of a plunger that contacts the frame jambs during the final stages of closing.

The other type is the fixed bottom edge seal.

Fixed bottom edge seals should normally be used with a threshold strip to ensure that the door leaf fitted seals clear the floor for the whole of the swing of the door.

Whereas automatic door bottoms can seal directly onto the floor it is recommended that these are used with threshold strips *(particularly where floors are carpeted)* unless the floor is smooth and level.

Stepped thresholds incorporating seals will generally provide for optimum threshold sealing with these being recommended for use in locations where 'trip hazard' considerations may not apply. e.g. Plant Rooms.

Optimum Performance: Optimum sealing performance is likely to be achieved where the perimeter and threshold sealing gaskets are in a single plane within the thickness of the door.

The influence of Hardware:

Provided that care is taken to select and position hardware to avoid the need to interrupt sealing systems, the choice of hardware will generally have little effect on sound attenuating performances.

Hardware items that require the removal of any of the door core should be kept as small as possible, with gaps around the hardware kept to a minimum.

The main risk to the performance of a sound attenuating door assembly results from the creation of flanking routes through the door that may be created by when using hardware items that pass through the thickness of the door. e.g. lever handles, cylinders / keyholes. The use of lever sets with back plates will generally allow for the use of mastic *(or other sealants)* to restrict the passage of airborne sound. Similar action can be taken with cylinders. For key ways, the use of escutcheons with escutcheon plates will generally provide for a sufficient barrier.

NOTE: Letter plates passing through the door have been successfully tested for performances up to Rw.40dB.

Flanking:

'Flanking' is the term given to the leakage of airborne sound through or around the door leaf and / or the door assembly.

The main causes of flanking are:

- ***Insufficient care and adjustment when fitting seals.***
- ***Worn seals.***
- ***Interruption of seals to receive hardware.***
- ***Inadequate sealing around hardware items that pass through the door.***
- ***Inadequate sealing around glazed apertures.***
- ***Inadequate sealing between the frame and the surrounding structure.***

When fitting seals, the main areas of weakness are at the junctions between horizontal and vertical seals i.e. at the four corners of a single leaf door assembly. Seals should extend to the full shoulder height and width of the frame with the head seal carefully jointed to the jambs seals.

The operating gap at the seal position should suit the dimensions of the seal. Generally, for seals that act on the edges of the door leaf, the seal should overlap the door *(or frame)* by 0.5 ~ 1mm to provide for optimum acoustic sealing with minimal effect on operating forces.

NOTE: This recommendation may vary according to the particular seal type. The particular seal manufacturer / supplier installation recommendations take precedence in the event of any conflict with this advice.

Perimeter Seals:
For perimeter seals acting on the face of a door leaf it is recommended these 'compression' seal gaskets are set to compress not more than 50% unless the seal manufacturers / suppliers fixing instructions advise otherwise.

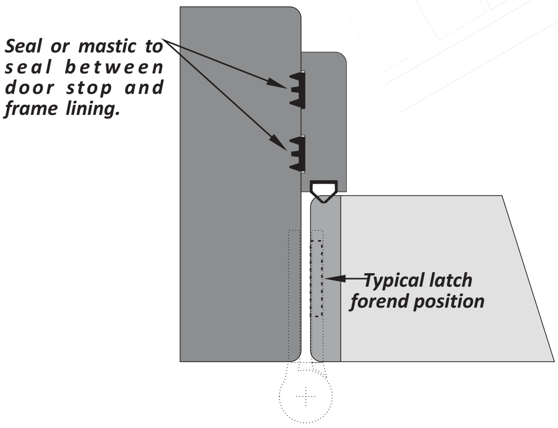
Carefully locating seals, particularly perimeter seals to suit the action of the door can ensure that the seals are in contact with the door / frame for the minimum amount of the swing of the door thus reducing the influence on operating forces and reducing wear resulting from friction.

The use of door leaf and frame designs that provide for a pencil round at junctions where the seals meet the door leaf or the frame are recommended. These will act as a lead to the compression of the seal providing for optimum performance and improve seal durability.

Typical Perimeter seals may include:

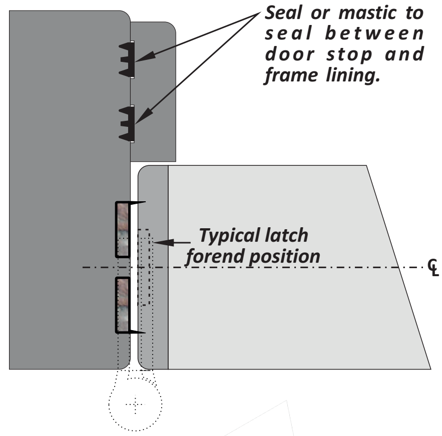
- ***Door stop mounted 'O' seals.***
- ***Combined Intumesce / Blade seals.***
- ***Frame reveal seals and door edge seals located to provide for minimal interference with the operation of the door and to accommodate most hardware installations.***

Door stop mounted 'O' seal *Fig. 10.9*



Door stop mounted 'O' seals provide for a minimal risk of conflicts with hardware and have minimal effect on opening forces. However, increased force may be required to close and latch a door and seals acting on the face of the door only have a poor ability to accommodate any distortions.

Combined Intumescent / sound insulating seal *Fig. 10.10*

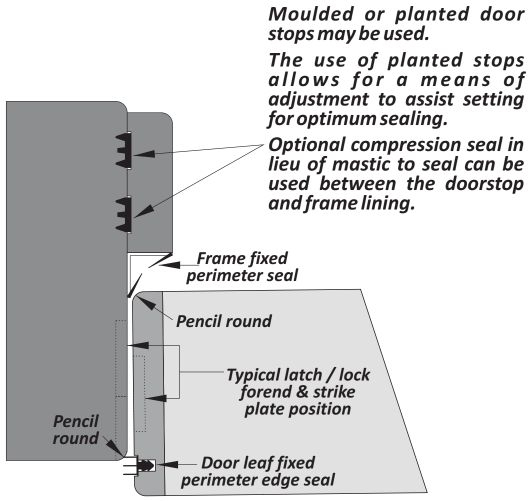


Combined intumescent / blade seals generally must be located to suit fire test / assessment requirements. These locations can give rise to conflicts with hardware.

When used with narrow and / or thick doors the blade seal location can have an adverse influence on operating forces and may undermine the acoustic sealing properties.

The use of separate 'dedicated' acoustic perimeter seals, located by illustrated by reference to ***Fig.10.11*** is recommended for use with FLAMEBREAK™ based door assemblies. These can be used with separate intumescent seals for use with fire doors and will accommodate most hardware fittings with minimal influence on door operating forces.

Typical Frame Design & Positioning of Perimeter seals *Fig. 10.11*



Frame designs that include a pencil round at junctions where seals meet the frame or the door leaf will provide for a lead for the compression of the seal blades in a manner that will generally optimise performance and improve seal durability.

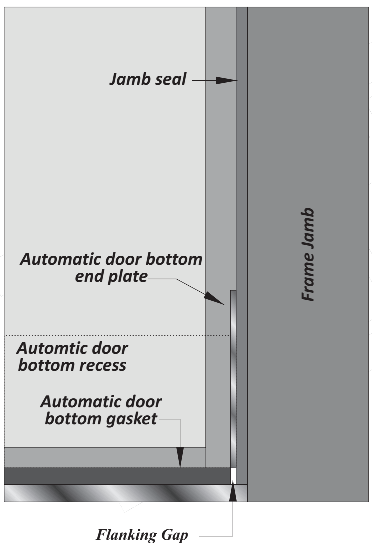
Seal positions should be carefully considered to ensure that the seals are in contact for the minimum amount of the travel of the door as it swings. This will minimise the influence on operating forces and reduce seal wear resulting from friction.

Threshold Seals:

a/ Automatic Door Bottoms - Drop Seals:
The gaskets for automatic door bottoms should be cut to suit the full width of the door to provide for a close fit with the end plates. The automatic door bottoms should be carefully adjusted to ensure that they seal across the full width of the door onto a smooth level floor or onto a threshold strip.

Threshold strips or stepped thresholds with seals should be carefully scribed to the frame with mastic *(or other suitable sealant)* used to fill any gaps that might provide a route for flanking.

Flanking Gaps - Single leaf doorsets. *Fig. 10.12*



For single leaf door assemblies there will generally be a flanking route at the threshold position caused by the essential need to provide for operating gaps.

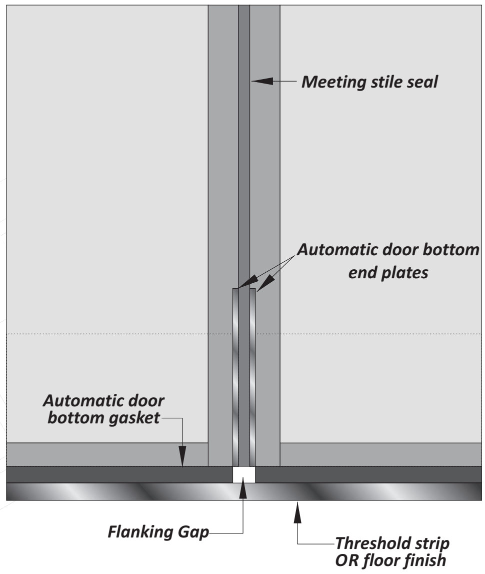
Flanking can be minimised by ensuring that operating gaps, particularly at the threshold are kept as small as possible (recommended 4 +/- 1mm) and that threshold sealing gaskets extend as far as possible to the full width of the door. This is usually limited by the automatic door bottom end plates.

For single leaf door assemblies these flanking routes fall outside fo the normal pedestrian used space. It is therefore sometimes possible to add small additional sealing devices to address this problem.

Automatic Door Bottoms - Drop Seals contd.:

For pairs of doors a flanking gap also occurs at the bottom of the meeting stiles. A stepped threshold with seal *(currently)* provides for the only effective way for sealing this gap.

Flanking Gaps - Pairs. *Fig. 10.13*

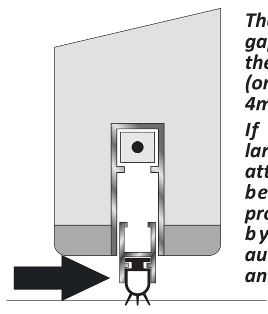


When using automatic door bottoms or fixed bottom edge seals at the threshold there will be a gap at the bottom of the meeting stiles which will be exploited by airborne sound.

This leakage is unavoidable for an operational door but can be minimised by ensuring that under door gaps are kept as small as possible (recommended 4 +/- 1mm) and that threshold sealing gaskets extend as far as possible to the full width of the door. This is usually up to the automatic door bottom end plates.

NOTE: Acoustic seals are used to seal the operating gaps around the door. Some of these, particularly automatic door bottoms, can fill some quite large gaps. However, for acoustic applications operating gaps should be kept as small as possible (unless supported by test data) and should generally comply with BS4787 Pt.1. with a recommended 4mm +/- 1mm under door gap from the bottom of the door to the top of the floor or threshold strip.

Increased under door gap *Fig. 10.14*



The recommended under door gap from the bottom edge of the leaf to the top of the floor (or threshold strip if used) is 4mm +/- 1mm.

If under door gaps are too large, the barrier to the sound attenuating performances may be reduced as the barrier provided at this point is limited by the thickness of the automatic door bottom carrier and gasket.

Fixed Bottom Edge (Threshold) Seals:

Threshold sealing can also be effectively achieved without the use of automatic door bottoms.

Various designs for fixed bottom edge (*threshold*) seals are available:

Multi bladed 'Door Shoes' seal provides for excellent sound attenuating performances.

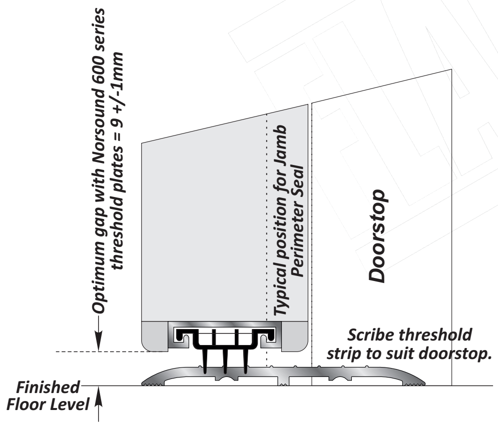
Threshold Sealing - Door Shoe . *Fig. 10.15*

Door shoes provides for a simple yet effective method for threshold sealing without the use of mechanically operated devices.

Fixed bottom of door seals must essentially be used with a threshold strip to ensure that the seal gasket clears the floor during the swing of the door.

It is recommended that the Door Shoe carrier is recessed into the bottom edge of to a depth that is necessary to provide for the gasket blades to overlap the threshold strip by Nom.2 +/- 0.5mm.

Comparative base test data demonstrates that Door Shoes can be used as a direct substitute threshold sealing options using Automatic Door Bottoms (Drop Seals) without detriment to performances.



A simpler low cost alternative can be achieved by using 2No. simple blade seals at the threshold.

A threshold strip must be used with any fixed seals that are fitted to the bottom edge of the door to ensure that the seal blades will clear the floor during the swing of the door.

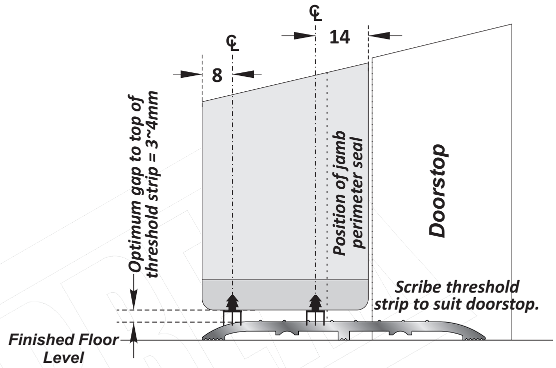
Twin Blade Seals. *Fig. 10.16*

Simple bladed seal provides for a low cost yet effective threshold sealing system.

Fixed bottom of door seals must essentially be used with a threshold strip to ensure that the seals clear the floor during the swing of the door.

More demanding tolerances apply when using small bladed threshold sealing system.

Comparative base test data demonstrates that small bladed seals can be used as a direct substitute threshold sealing options using Automatic Door Bottoms (Drop Seals) without detriment to performances.



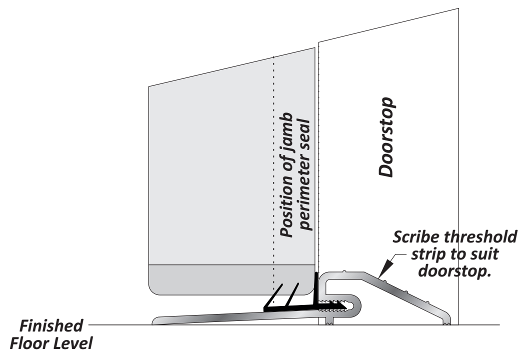
For optimum sound insulating performances consideration can be given to the use of stepped thresholds with seals providing for the following features:

Stepped Threshold with Seal. *Fig. 10.17*

Stepped thresholds with seals can provide for optimum sound insulation performances particularly where the threshold sealing gasket aligns with the perimeter seals to the head and the jambs thus considerably reducing flanking risks.

Where required, these thresholds can be used with additional sealing including Automatic Door Bottoms (Drop Seals) or fixed bottom edge seals fitted to the door leaf.

While providing for optimum sound insulating performances their use must be considered by reference to Building Regulations (England & Wales) - Approved Document 'M' and BS8300 as these can be considered as being a trip hazard for some locations.



Meeting stile sealing:

There are a number of meeting stile options most of which require that the doors are sequentially opened (*and closed*) to provide for optimum sound insulating performances.

NOTE: The twin bladed option can provide for simultaneous opening and closing when used with wide doors of limited thickness but this capability should be checked first by application of the 'Door Growth' formula given by reference to Section 9 - Door Assembly Coordination.

The choice and use of meeting stile seals must be carefully considered with due consideration to the following:

- ***Coordination with perimeter seals.***
- ***Coordination with hardware.***
- ***Coordination with threshold seals.***
- ***Coordination with intumescent seals (if used).***

Any interruption of the sound insulating sealing system will give rise to increased flanking risks with a consequential loss of performance.

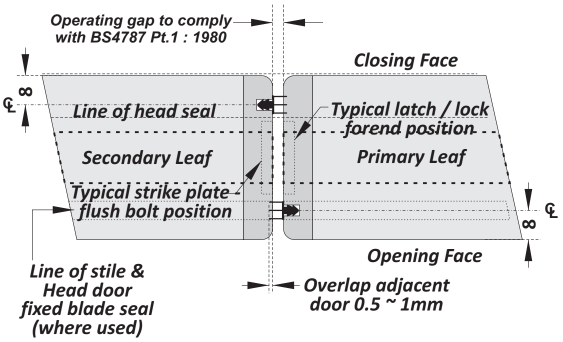
NOTE: Details illustrated are for guidance only, refer to seal manufacturer / supplier data for further guidance with regard to particular seal designs.

Meeting stiles - Twin Blade Seals. *Fig. 10.18*

The use of twin blade seals located as illustrated provides for an economic solution for sealing at the meeting stiles of pairs of doors.

One seal is located towards the opening face is generally sufficient for performances up to Rw.30dB. For performance in excess of Rw.30dB it is recommended that a second seal is located towards the closing face of the secondary leaf.

NOTE: Locating the seals as illustrated ensures that the seals provide for minimal resistance to the operation of the doors (door are in contact with the seals for approx. 9mm in the door thickness during swing). These positions also provide room for the fitting of hardware with the need to interrupt the sealing.



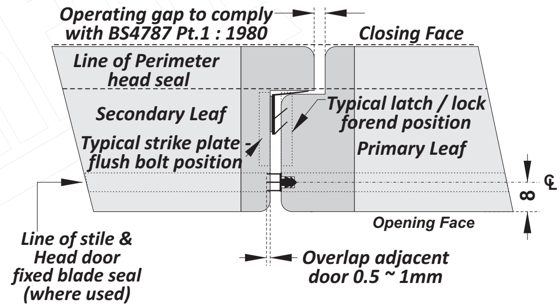
Meeting stiles. Sealing with off-set rebates. *Fig. 10.19*

A number of perimeter seal designs can be used with a 12mm off-set rebate to provide for effective meeting stile sealing for use with both Nom. 44mm and 54mm based door assemblies. However, with Nom. 44mm thickness doors there is an increased risk of conflict with hardware items.

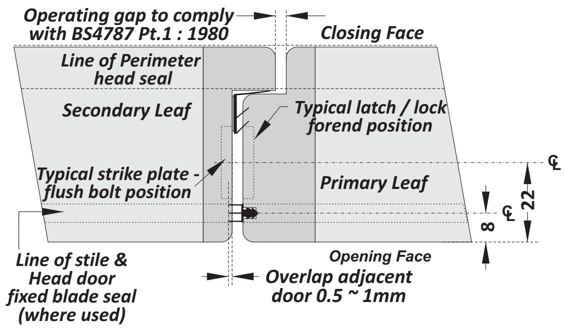
Whereas these meeting stile solutions are better suited for use with Nom. 54mm doors, consideration must still be given to the location of securing hardware (locks / latches & flush bolts). Conflicts of this nature can generally be avoided where the securing hardware is centred Nom. 22mm from the opening face of the doors.

The off-set rebate option using perimeter seals of the type illustrated is particularly useful where it is necessary to apply a leading edge to the primary leaf for operational reasons, the position of the seal can be adjusted to suit the gap at the seal position by the use packing behind the seal.

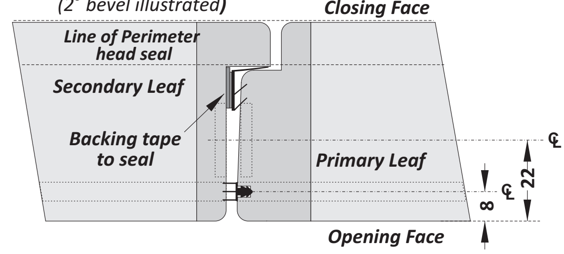
Nom. 44mm Doors



Nom. 54mm Doors



Meeting stiles with leading edge
(2° bevel illustrated)



Meeting Stiles - Astragals:

The use of astragals provides for a method for mounting sound insulating seals to align as near as possible to other perimeter seals that are located near to the closing face of the doors.

There are a number of branded designs for this application usually using aluminium carriers with housing to receive sound insulating gaskets.

An alternative is to use timber astragals used frame fitted with perimeter seals.

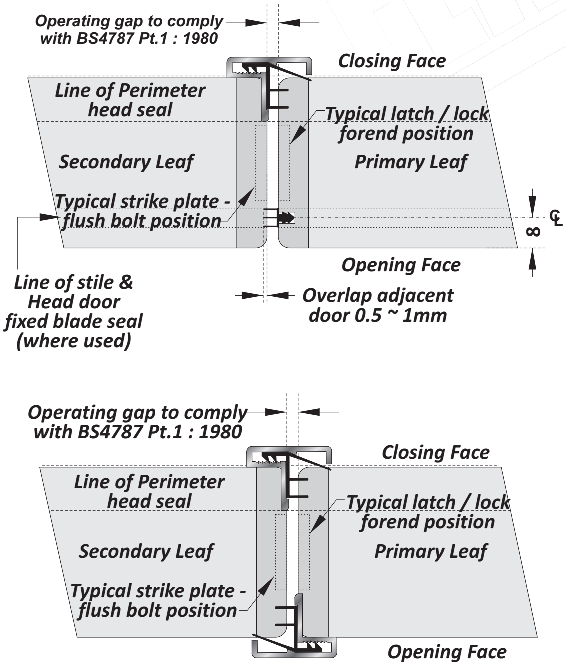
The use of astragals provides for a minimal risk of conflicts with hardware and intumescent seals or with door mounted Automatic Door Bottoms (*Drop Seals*) and is the recommended option for use with fire rated door assemblies.

Astragal with seal Meeting stiles. *Fig. 10.20*

Use of an astragal with seal provides for an alternative to the off-set rebate design.

This option can be a useful solution where it is necessary to apply a leading edge to a Nom. 44mm thickness door as the position of the seal can be adjusted (by packing behind the carrier) to suit.

When fitted to the closing face of the secondary leaf the seal carrier projects beyond the face of the door; the carrier and seal will therefore need to be scribed to suit the frame head doorstop.



Astragal with seal Meeting stiles. *Fig. 10.21*

A timber astragal may be used with frame reveal fitted sound insulating seals.

The perimeter sealing are then continuous at the head, jambs and meeting stiles providing for optimum sound insulating sealing.

As with the astragal with aluminium carrier option, when fitted to the losing face of the secondary leaf the astragal must be scribed to the head door stop.

Timber astragals with seal can also be fitted to the opening face of the primary leaf or to both leaves but fitting to the opening face of the primary leaf only will result in a misalignment of perimeter seals.

Use of astragals provides for a minimal risk of conflicts with items of hardware or intumescent sealing and are generally approved for use with fire rated door assemblies.