Information Sheet 5

Guide to the Selection of Smoke Seals for Doorsets

Intumescent Fire Seals Association

CONTENTS

1. INTRODUCTION

IFSA Information Sheet No. 3 'Guide to the Use of Smoke Seals in Doorsets' was the first data sheet to explain the technology behind the use of smoke seals on fire resisting door assemblies. Whilst it presented a list of factors to take into account when specifying seals, it did not make recommendations as to which type of seal, e.g. compression or wiping, blade or brush, was most suited to the application under consideration.

The intumescent sealing industry has developed a wide variety of door assembly smoke seals over the years, in response to the demand from both the construction industry and building users for products which will perform in different situations. This information sheet lists the merits and application suitability of the main generic types currently available. This Information Sheet has been prepared in order to assist with the selection of smoke seals for the purpose of improving the leakage rate of existing doors to satisfy the regulatory recommended rate of $3m^3/m/hr$ @ 25Pa when tested in accordance with BS476: Part 31: Section 31.1.

Whilst some of the guidance given in respect of Type A seals (referred to later in this guidance sheet) may be applicable to combined smoke and intumescent seals, it is primarily aimed at separate stand-alone smoke seals. When selecting combined intumescent and smoke seals then the manufacturers' recommendations in respect of fitting, including the total length of permitted interruptions, shall be followed explicitly. As it is not possible to illustrate all the variations of generic types of seal, IFSA Members should be consulted for advice on the most suitable seal to suite specific circumstances.

The principals of smoke seal selection discussed herein are applicable to seals fitted to doorsets that have been tested to the ambient temperature criteria of BS EN 1634-3 standard but this document is primarily concerned with seals tested to the BS 476: Part 31: Section 31.1 standard.

Third party certification schemes for smoke seals are designed to ensure consistency of product conformity by independently verifying the seals performance to relevant British and European test standards, and checking that adequate factory production control measures are in place. There may also be a requirement to establish the longevity of a smoke seal by subjecting the seal to a cyclic test within a door assembly.

A smoke seal that is manufactured under the auspices of such a scheme would therefore be expected to be capable of consistent performance as established by test, offering the end user assurance that the smoke seal will be able to perform when required. It is recommended that the independent certification body providing third party certification is accredited by UKAS. Most UKAS accredited bodies that provide third party certification schemes will list third party certificated manufacturers on their website and will be able to provide a list of the certification requirements for a particular scheme.

2. PURPOSE OF SMOKE SEALS

Smoke poses a greater threat to life safety than fire itself and it is for this reason that smoke seals are recommended for the protection of escape routes in the various guidance documents which support UK building regulations for new buildings and those undergoing significant alterations (i.e. Part B (Fire Safety) of Schedule 1 to the Building Regulations 2010).

For example, a study of the various guidance documents such as Approved Document B and BS 9999: 2017 reveals that the majority of the fire resisting doors within a building are also required to have a smoke control function, against predetermined performance requirements, which has to be verified by test. An analysis of the use and distribution of smoke control doors shows that they are recommended for the protection of routes required for providing means of escape in the event of a fire.

Currently, for practical reasons, only seals that restrict the spread of cold smoke are specified. The purpose of smoke seals is to limit, but not totally eliminate, the movement of cold smoke from one compartment or space to another. Cold smoke seals are not generally able to prevent the passage of higher temperature smoke which may cause some cold smoke seals to melt. However, at higher temperatures the intumescent seals activate to limit, but not eliminate the movement of hot smoke.

The more recent BS EN 1634-3 test standard for smoke leakage does provide a method for establishing smoke control at elevated temperatures (200°C). Doorsets that have been successfully tested to this standard can be classified as S_{200}. Smoke at elevated temperatures is a requirement in some EU countries but is not generally specified in the UK. For the purpose of this guidance sheet only smoke seals that limit smoke leakage at ambient temperatures is discussed.

A fire only sealing system usually consists of an outer casing (e.g. PVC or aluminium) used to protect the intumescent core, and are typically provided with a high performance self-adhesive system for installation within a rebate either in the door leaf and or door framing section. A typical combined fire and smoke sealing system may include a brush and or a series of integral fins, which are essentially thermo-fused on the rigid casing or positioned within a retaining grove with the fire seal component.

3. INSTALLATION OF SMOKE SEALING SYSTEMS

The recommended acceptable smoke leakage performance of a smoke control door assembly is given in Approved Document B to the England & Wales Building Regulations and also in BS 9999: 2017, which in turn also refers to the relevant parts of BS 8214: 2017 (Timber-based fire door assemblies, Code of practice). There are differences between the recommendations but both are deemed to be satisfactory to demonstrate compliance with the regulations.

While each recommendation requires the testing of a door assembly in accordance with BS476: Part 31: Section 31.1, there is a divergence in requirements at the threshold. Approved Document B, for example, allows performance to be evaluated without any reference to smoke transfer which may result from the threshold gap.

Approved Document B, Table B1, Provisions for fire doors

Unless pressurization techniques complying with BS EN 12101-6: 2005 Smoke and Heat control systems – Part 6: Specification for pressure differential systems – kits are used these [smoke control] doors should also either:

a) *Have a leakage rate not exceeding 3m^3/m/hr (head and jambs only) when tested at 25Pa under BS 476 Fire tests on building materials and structures Section 31.1, Methods for measuring smoke penetration through doorsets and shutter assemblies, method of measurement under ambient temperature conditions or*
b) *Meet the additional classification requirements of Sa when tested to BS EN 1634-3 Fire resistance tests for door and shutter assemblies Part 3 – smoke control doors*

BS 8214: 2017 calls for the threshold performance to be separately considered and provides the following options with varying degrees of effectiveness.

BS 8214, Section 12.3 Smoke Seals

When installed, the threshold gap should, where practicable, be sealed by a flexible edge or automatic drop seal, either with a leakage rate not exceeding 3 m^3/h per metre at 25 Pa when tested to BS 476-31.1 or BS 1634-3, or just contacting the floor, giving an even contact with the floor but not exhibiting significant increased frictional forces that could interfere with the closing action of the door. Where this is impracticable, the threshold gap should not exceed 3 mm at any point.

More recent research by IFSA Members shows that it is vitally important to incorporate a smoke seal of known performance at the threshold and failure to do so can completely negate the beneficial contribution of seals around the rest of the door assembly.

Examples of appropriate perimeter and threshold sealing systems are illustrated and reviewed on the later pages of this Information Sheet. In practice, the fitting of a stop has little effect on the performance of a seal because the door normally does not make contact over the whole of the stop surface. The test method does not specify whether the stop is a good fit or not and the test results may be better than achieved in practice because of a particularly well fitting stop. Manufacturers' advice should always be taken on the installation and compatibility of sealing systems.

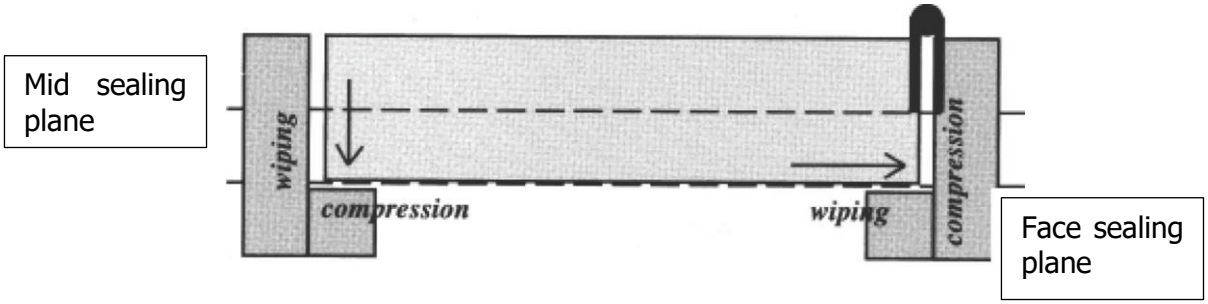


Figure 1: Movement of door relative to frame during final action of closing

4. GENERAL GUIDANCE

There is no perfect seal which accommodates all the requirements. All seals have some good features and some disadvantages which make them more suited to some applications and less to others. The following general issues are important when choosing the most suitable product for specific applications:

4.1 Smoke leakage performance

The supplier of the smoke seal should provide test evidence in accordance with BS 476: Part 31: Section 31.1 to demonstrate that the seal has been incorporated in a test on a fire door assembly where the leaf has similar physical characteristics, e.g. thickness, weight, construction and stiffness as the leaf in the assembly to which it is to be fitted. It is important to check that the smoke seal was tested on an assembly of the same configuration as the intended use and, in particular, that the perimeter gaps were representative. Conventional seals should be fitted in a plane either contacting the outer face of the door or parallel to this plane within the thickness of the door because gaps at the corners allow significant leakage.

As a door leaf makes contact with the seals, the mode of operation depends on the position of the seal in the frame or door edge. Figure 1 shows that when the seals are fitted in one plane, for the reasons just explained, the deformation is different at the closing jamb from that at the hanging jamb. Seals which are particularly good in a wiping mode may not be so good in a compression mode and vice versa. Various types of seal have been developed in an effort to cope with these differing requirements and provide effective sealing.

5. DURABILITY

It is important that smoke control doors that are in constant use are fitted with seals that are able to withstand the daily cycling for a reasonable period without damage. Cyclic endurance testing does not form part of the BS476: Part 31: Section 31.1 test procedure, but is included in the performance assessment criteria required by some Third Party Certification schemes, whereby the seal is subjected to 100,000 open/shut cycles and the seals have to maintain the required leakage rate specified in BS 476: 31.1 ($3m^3$/m/hour at 25Pa), both before and after the cyclic testing.

5.1 Ability to accommodate variable gaps between the door edge and frame and distortion of the door leaf

This is most important in retrofit situations when buildings are being upgraded as existing doors tend to be less well fitting. The gaps can vary significantly around the door edge and the door may be, to some degree, warped. Some seals are able to accommodate variations in fit more than others and this is noted in the recommendations that follow. These problems are more easily controlled when supplying new door assemblies which are factory assembled. Even new doors can shrink after installation, however, due to loss of moisture and, hence, the door leaf to frame gap can increase, with consequent effects on the seal fit.

5.2 Effects of the door's ability to self close

Where the building design prevents the movement of air, for example, due to sealed windows or small unventilated lobbies, then smoke seals can make it more difficult to open and close a door. Similarly, seals offer varying degrees of friction or closing resistance. Both of these issues are taken into account in the specification recommendation given in Information Sheet No. 3. Certain generic types of seal do have a greater effect on closing than others and this is highlighted in the recommendations.

Guidelines on the opening forces for access are given in Approved Document M and BS 8300: 2009 + A1: 2010, which are also incorporated within the requirements of some Third Party Certification schemes for fire and smoke seals.

5.3 Interruption by items of hardware

Care must be taken to ensure that selected smoke seals can achieve the performance criteria recommended in codes and guides to regulations, of $3m^3/m/hr$ maximum smoke leakage. Interruptions by hinges and other hardware can significantly affect the performance of a seal. Those seals which can meet the requirements, even with multiple interruptions, will tend to make the door assembly harder to operate in everyday service because it is more important to ensure maximum compression or deflection of the seal in this case. Some generic types of seal do not require interruptions which generally make it easier for these to meet the recommended leakage rate. This is taken into account in the following comments.

6. SPECIFIC GUIDANCE ON GENERIC TYPES OF SMOKE SEALS

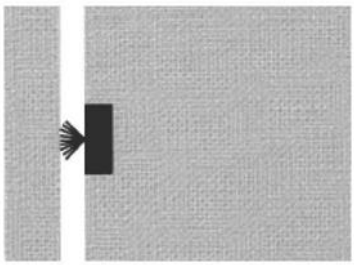
The guidance given on the following pages is only intended to be general in its nature because variations exist between products of the same generic type. Information on smoke leakage performance is not given and, therefore, evidence of performance needs to be obtained from the supplier before specifying the selected type.

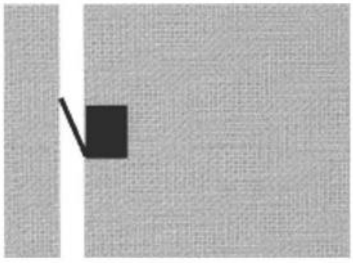
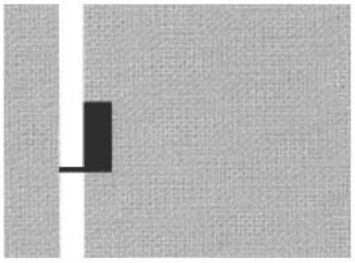
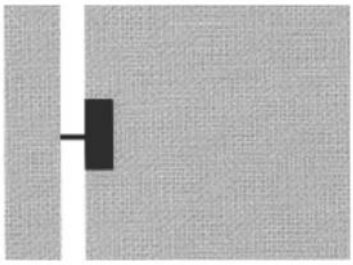
An additional consideration, particularly when retrofitting smoke seals, is that certain designs of smoke seal may be able to tolerate leaf twist and/or large perimeter gaps at the leaf edge and maintain the required leakage rate, but if the door is also fire resisting, the gaps and/or leaf twist may well be outside of acceptable tolerances from a fire resistance perspective and the door assembly may need to be considered for replacement. If there is any doubt as to the suitability of an existing door for smoke for fire resistance performance, specialist advice should be sought, prior to undertaking retrofit work.

7. SEALS FOR FITTING TO HEAD AND JAMBS OF DOOR ASSEMBLIES

7.1 TYPE A: DOOR EDGE/FRAME REVEAL FITTED SEALS

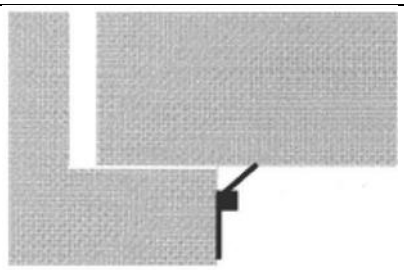
These seals operate in a wiping mode which means that there is a significant resistance to opening and closing unless the door to frame gap is accurately controlled and does not vary significantly around the perimeter of the door. Very tight gaps may cause damage to the seal and hinder closing. If the seals are part of a combined intumescent fire and smoke seal they are likely to be interrupted by hardware and are not likely to meet the current maximum leakage rate of $3m^3/m/hr$ @ 25 Pa unless there is test evidence in accordance with BS476-31.1 which shows compliance. If the smoke seal is not combined with an intumescent seal, it can be set away from the leaf centre line thereby avoiding hardware.

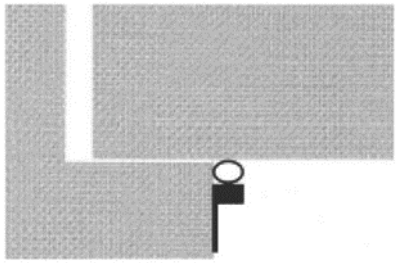
	Type A1: Pile (or brush) seal Fitting into a groove in the door edge or frame gives positive fixing, Tight gaps can cause accelerated wear and hamper closing. Pile can become compressed or distorted after prolonged use. Self-closing action of the door leaf may be hampered due to friction. Some pile/brush seals incorporate smoke fins to achieve the current maximum leakage rate of $3m^3/m/hr@25Pa$ which can lead to a 'wisping' noise when the door is open/shut and can also add to the closing force

	Type A2: Angled neoprene blade Closing force is low for correct gap width. Good resilience and recovery. Very tight gaps can cause this type of seal to tear especially if edge of frame is very square and the blade is thin. Can have high resistance to opening if gap is too wide because seal may be forced to flip over before leaf can be opened.
	Type A3: Offset straight elastomeric blade Offset blade makes it possible to bypass slim hinges or bolts and maintain smoke sealing. Thin, short flexible blade has less tolerance of gap width than the angled elastomeric blade but it is less affected by flip-flop effect during opening. It is more tolerant of gap width than pile seals. Short blade makes it less tolerant to increases in door gap width.
	Type A4: Straight elastomeric blade This type is available in single blade or twin versions. Double blades may improve the resistance to smoke leakage but may also introduce more friction and make self-closing harder

7.2 TYPE B: STOP MOUNTED SEALS FITTED TO OUTER VISIBLE FACE

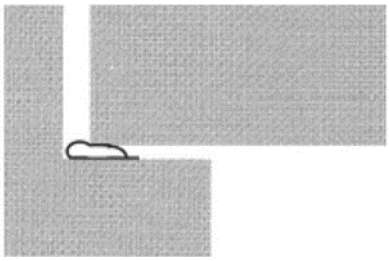
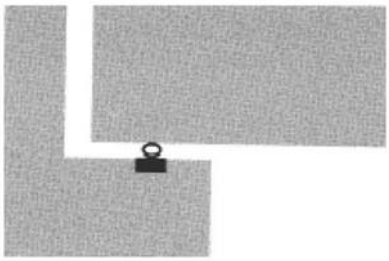
Ideal for fitting on existing doors because the door does not have to be removed but the product is normally visible. Can tolerate larger variations in gap width because of its surface position. Gaps between the door face and the stop can be accommodated during fitting. More prone to damage by trolleys or other traffic. Not very invasive when used on historical doors, but is normally conspicuous. The smoke seal is less prone to causing problems associated with self-closing of the door leaf. This type of smoke seal is rarely interrupted by items of hardware.

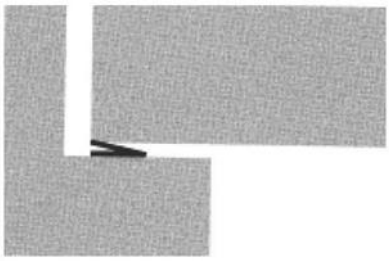
	Type B1: Angled neoprene blade The smoke seal, if well designed, has the lowest resistance to closing and is exposed to less frictional wear from the action of the door closing, making it more durable. Some smoke seals have the facility for adjusting the blade position to accommodate movement of the door leaf after the seals have been fitted. The seal can accommodate reasonable "in-service" distortion of the leaf and is generally better than pure compression seals in this position.

	Type B2: Compressible Resilient Bulb The smoke seal is exposed to less wear from the action of the door closing on the leading edge and is therefore more durable. When fitted to the closing stile, the seal is exposed to less wear than a wiping seal but it can suffer shear failure when fitted to the heel of the door (hinge edge). This type is more prone to causing problems associated with self-closing of the door leaf than the stop mounted blade seal because of the higher compression forces. Thin walled compression seals are more easily compressed and less likely to produce closing problems but are more likely to suffer from tearing or fatigue. Only limited ability to accept "in-service" distortion of the leaf depending upon the acceptable levels of compression.

7.3 TYPE C: STOP MOUNTED SEALS FITTED TO INNER NONVISIBLE FACE

The seal is not conspicuous and is suitable for historic or aesthetically sensitive doors. Can accommodate larger door edge to frame gaps but has limited ability to cope with door distortion. If the door is an existing good fit on the stops it will have to be re-hung or the stops refitted if planted. This type of seal is normally uninterrupted by items of hardware.

	Type C1: Surface mounted resilient bubble The durability of the seal is dependent on the performance of the bond between the seal and the frame, which in turn is influenced by the preparation of the surfaces. Depending upon the resistance to compression this seal is prone to causing some problems associated with self-closing.
	Type C2: Resilient bulb in recessed holder The positive nature of the fixing into the doorstop means that the seal is less likely to become detached than Type C1. This seal is invasive and less suitable for historic doors. Although the smoke seal can accommodate fairly large variations in door edge gap, the gap between the doorstop and the door leaf face is critical. The seal cannot accommodate warped door leaves unless the doorstop is adjusted or the balloon is very thin walled and easily compressed. Prone to shear failure caused by the heel of the door closing into the stop.

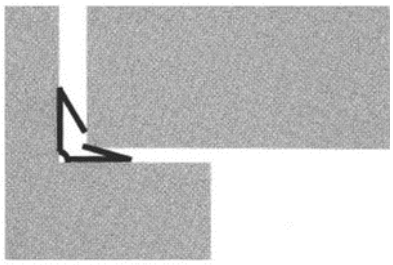
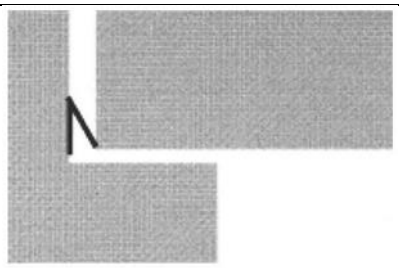
	Type C3: Surface mounted resilient blade The smoke seal is able to accommodate a wide variation in door edge gap sizes although an even gap between the door face and the doorstop is required. In retrofit situations this may often require adjustment of the hinges to improve the hanging. The smoke seal has limited ability to accommodate door leaf distortion. This seal is less prone than other Type C seals to causing problems associated with self-closing of the door leaf

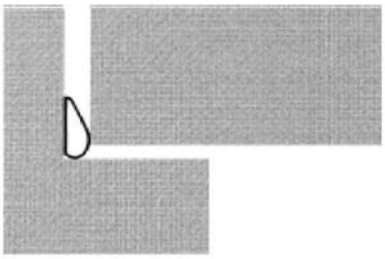
Notes:

1. Some designs of stop mounted seals combine Type C2 seals (described as resilient bulb) and Type C3 seals (described as resilient blade) within the same carrier

7.4 TYPE D: CORNER REVEAL MOUNTED SEALS FITTED TO INNER FACE

The durability of this seal type is dependent on the quality and performance of the bond between the seal and the frame. This can be influenced by preparation of the surfaces. Non-invasive and suitable for historic doors. Rarely interrupted by items of hardware. May not be possible to fit to a door with a tight door edge to frame gap without refitting door.

	Type D1: Surface mounted dual resilient blades The low resistance to deflection causes few frictional problems in respect of self-closing. May be difficult to fit if the comer is badly defined unless the seal is specifically designed to minimise this problem. The smoke seal has limited ability to accommodate door leaf distortion. In retrofit situations, may require adjustment of hinges or repositioning of the door stop to provide sufficient clearance for fit.
	Type D2: Surface mounted resilient blade Easy to fit into poorly defined comers. The low resistance to deflection causes few frictional problems in respect of self-closing. The smoke seal has limited ability to accommodate door leaf distortion. In retrofit situations, may require adjustment of hinges or repositioning of the door stop to provide sufficient clearance for fit.

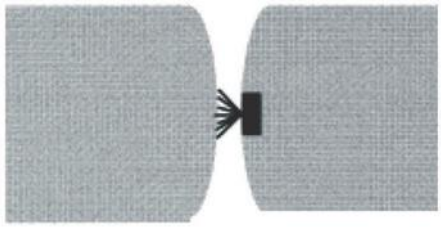
	Type D3: Surface mounted resilient bubble Easier than type D1 to fit into poorly defined corners. The slight wiping nature of this seal is prone to slightly increase the problems associated with resistance to self-closing. The smoke seal has limited ability to accommodate door leaf distortion. In retrofit situations, may require adjustment of hinges or repositioning of the door stop to provide sufficient clearance for fit.

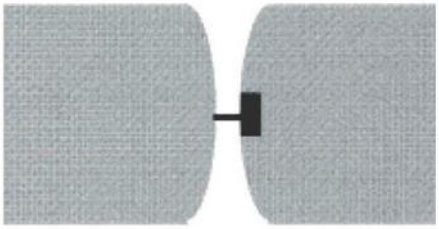
Notes:

1. Some designs of corner reveal mounted seals combine Type D2 seals (described as resilient blade) and Type D3 seals (described as resilient bubble) within the same carrier

8. SEALS FOR USE AT MEETING STILES

The seal fitted to the meeting stiles of a pair of doors has to be Type A (i.e. wiping) and, therefore, the other seals fitted to the head and the hanging or pivoting stiles have to be of the same type, unless test evidence in accordance with BS476-31.1 is available to prove the mixed seal types. Pairs of doors are difficult to seal satisfactorily, so it is essential to consult manufacturer's literature to ensure good performance. In particular, the seals are not very tolerant of variations in door edge to frame gaps. Where locks or flush bolts are fitted, the seal is likely to be interrupted making it difficult to achieve the required performance. It is not usually possible to mix stop mounted seals with wiping seals on these types of doors. Many pairs of doors have curved door edges to allow easy opening and special seals with curved faces have been developed for these applications. Note that blades or brushes should never be put into both edges simultaneously. The smoke seal may face an intumescent seal in the opposite door edge, dependent upon manufacturer's instructions.

	Type M1: Pile (or brush) seal Tight gaps can cause accelerated wear and hamper closing and pile can become compressed or distorted after prolonged use. Self-closing action of the door leaf may be hampered due to friction. It is recommended that a smoke fin is incorporated within the pile to meet the current maximum leakage rate of $3m^3/m/hr$ @25Pa.

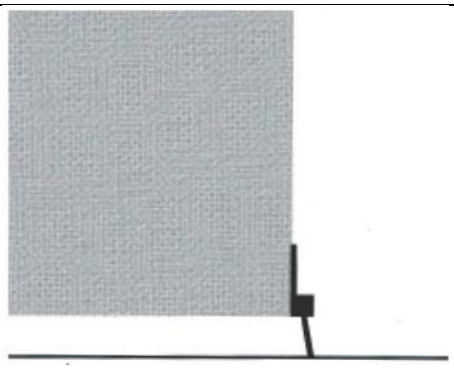
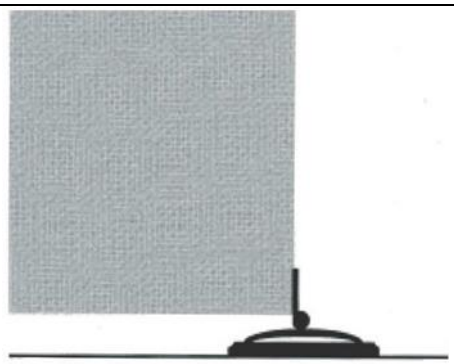
	Type M2: Straight elastomeric blade If the blade is too thick both closing and opening will be hampered. If blade is too thin it may tear in normal operation. Good recovery from deformed state.

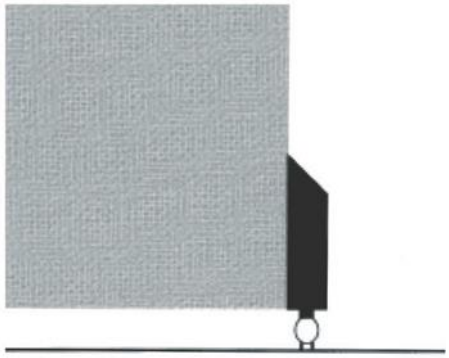
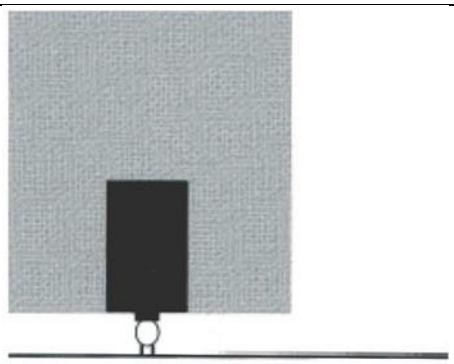
Notes:

1. For door assemblies with rebated meeting edges, typically it will only be necessary to fit a smoke seal in the bottom of one of the meeting edge rebates. Advice should be sought from the seal manufacturer to ensure the seal is suitable for rebated meeting edge applications.
2. There are many situations where single acting pairs can be effectively sealed by the use of an astragal incorporating a single or dual flexible blade element. Advice should be sought from the seal manufacturer to ensure the seal is suitable for unrebated meeting edge applications with astragals.

9. SEALS FOR USE AT THRESHOLDS

To be truly effective the line of the seal should line up with the seals fitted to door head and stiles. To achieve good performance, it is necessary to pay attention to the joint between the stile seal and the threshold seal.

	Type Tl: Fixed seal on level floor There can be a significant friction effect as the seal remains in contact with the floor when the door opens and closes. This effect is worse if floor rises on opening side but is eliminated if a suitable threshold strip is fitted to the floor. Low level of invasiveness makes it suitable for historic doors but visually can be fairly conspicuous depending upon design of holder Vulnerable to damage in use but able to tolerate changes in gap dimensions at the time of fitting.
	Type T2: Fixed seal with threshold bar The threshold strip allows carpet to be fitted up to it whilst the part fitted to the door swings dear of the carpet when the door opens. Low level of invasiveness but fairly conspicuous on historic doors.

	Type T3: Self-rising on level threshold Because seal rises as door opens friction is eliminated over most of the swing. More visually obtrusive especially in the context of historic doors, because of movement that needs to be accommodated. Self-levelling on sloping floors. Generally robust and larger units are available that can often be used to double-up as a kick-plate
	Type T4: Self-rising on level threshold Central location makes it compatible with most leaf edge mounted smoke seals. Not visually obtrusive but more invasive when considering historic doors. Less vulnerable to damage. Less able to accommodate varying gap across width of door at time of fitting but is self-levelling on sloping floors.

10. CONCLUSIONS

It can be seen that there is no universal smoke seal which is perfect for all applications. Seals which are good on the leading edge of the door are sometimes far less suitable at the heel of a door leaf where wiping seals are frequently used in compression. As a consequence, the specifier must consider what aspects are important for the intended use, but the guidance given in this Information Sheet should at least help in making the decision intelligently and in full knowledge of the issues.

11. BIBLIOGRAPHY

1. BS476: Part 31: Section 31.1: 1983 Fire tests on building materials and structures. Methods for measuring smoke penetration through doorsets and shutter assemblies. Method of measurement under ambient temperature conditions
2. BS EN 1634-3 Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware. Smoke control test for door and shutter assemblies
3. BS9999: 2017 Fire safety in the design, management and use of residential buildings. Code of practice
4. England & Wales Building Regulations: Approved Document B

12. INFORMATION ABOUT IFSA

The Intumescent Fire Seals Association (IFSA) is a trade association established in 1982 with the following objectives:

- To promote the life safety benefit associated with the use of intumescent and smoke seals
- To promote research and development into extending the areas where these benefits can be utilised
- To participate in the development of test procedures for fire protection products in BSI, CEN and ISO which are fair, repeatable and reproducible.

IFSA maintains close links with the fire community. The Secretariat is based at International Fire Consultants Ltd, from which the association receives technical advice and support.

At the time of its formation, IFSA recognised the need for a simple standard test to compare the performance of intumescent fire seals for use in fire door assemblies, which was free from the influence of other materials and constructional variations and yet subjected the intumescent material to the conditions which prevail in a full scale test.

It, therefore, sponsored the development of such a test and this is now embodied in BS476: Part 23: 1987. Whilst the results of the test have a limited field of application, only being usable on single leaf, single action, latched doors of limited size and distortion characteristics, it does allow the sealing capability of intumescent seals to be compared without any influence from the leaf.

There is now an ISO equivalent test, i.e. BS ISO 12472: 2003. Due to its repeatability the test method is being used successfully to evaluate the influence that real time ageing may have on the properties of intumescent fire seals produced by IFSA member companies. The programme is planned to investigate 25 years exposure to a variety of

controlled and uncontrolled environments. Early findings showed no detectable visual decline and tests are being undertaken soon to confirm these findings.

A test programme undertaken in conjunction initially with DOE/BRE to produce standardise conditions for evaluating penetration seals formed the basis of the standard configuration incorporated in the CEN test procedure EN 1366-3 for evaluating seals for use with metal pipes. This configuration has been refined and incorporated in ISO/TR 10295-3: 2012 where a method of extrapolating the results of penetration sealing tests, using simple solid conductors, can be used to establish the field of application of intumescent sealants.

Fire stopping, service penetration sealing, fire doors and fire glass are all critical aspects of fire safe premises and under the Regulatory Reform (Fire Safety) Order and the ongoing reliance on fire risk assessments, it is vital that risk assessors understand the role and function of these products.

The move away from brickwork, blockwork and cast concrete forms of construction, towards a greater use of studwork and joisted walls, floors and ceilings, has left many of our fire separating constructions compromised by the fitting of electrical services (switches, plug sockets, concealed lighting, extract fans). IFSA has cooperated with the Electrical Safety Council (ESC), in the preparation of their guide, 'Electrical installations and their impact on the fire performance of buildings; Part 1, Domestic Premises'.

Intumescent materials can seriously reduce the impact that such installations may produce. Correctly fitted sealing systems make a greater contribution to life safety in a fire than almost any other measure. If you do nothing else to enhance life safety- at least seal up the building with fire and smoke seals, preferably from an IFSA Member because they take fire safety seriously.

CURRENT IFSA MEMBERS AND CONTRIBUTORS TO THE INFORMATION SHEET

Technical Consultants to IFSA

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