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Information Sheet 03

Guide to the use of smoke seals in door assemblies

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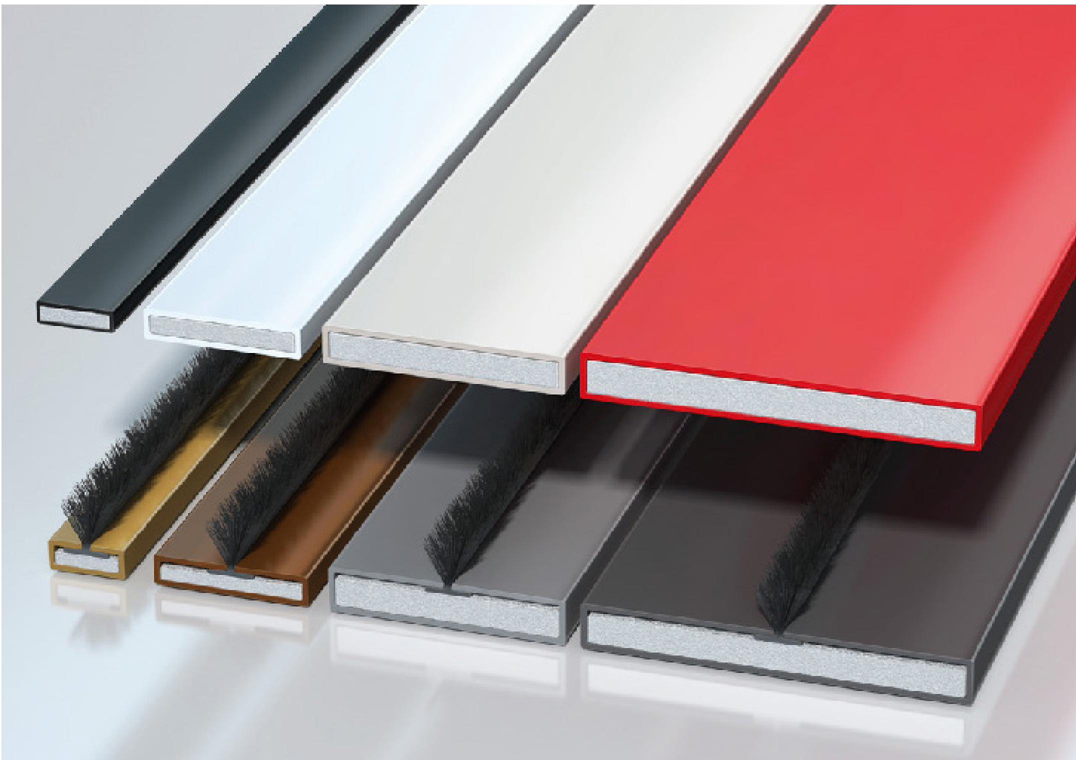
Intumescent Fire Seals Association
The home of reactive fire protection systems



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1.0 Introduction

With smoke spread being a major cause of death and injury and a large contributor to the cost of fire damage, the containment of smoke throughout the developing and developed fire phases is vital. Many of the fire resisting door assemblies used in buildings are also required to provide a smoke control function. This has been the case for many years, but it was the publication of BS476: Part 31.1 in 1983 that provided a standardised means of testing and quantifying the amount of smoke leakage through a door assembly. More recently a European standard for smoke control has been developed, for the purpose of classification and CE marking of smoke control doorsets, which broadly follows a similar test regime with similar leakage requirements but includes a method for testing smoke control at elevated temperatures. Elevated temperature smoke control is not typically called for in UK building regulations and for the purpose of clarity only ambient temperature smoke control is discussed herein.

BS476: Part 31.1 and BS EN 1634-3 are the test methods for evaluating the leakage rate of ambient temperature smoke which would occur through a door assembly during the early developing phase of a fire. This condition always exists at one of the doors in a building or complex at some stage during a fire. The door to the room of origin of the fire will initially be subjected to cooler, if not ambient temperature, smoke during the smouldering phase before flashover. After flash-over the door next in the chain is exposed for a period to the smoke egressing from the door to the room of origin and because the smoke is separated from the fully developed fire by the compartmentation, this smoke will have had time to mix with the surrounding air before it reaches the next door, and will have cooled down to an ambient temperature. This is why the test standard for smoke control is based on ambient temperature and is essentially a measurement of air leakage around the door perimeter.

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2.0 The role of the doorstop

If the doorstop could be fitted in perfect contact with the face of the leaf, it would restrict the flow of hot gases through the leaf to frame gap during exposure to the fully developed fire, and presumably during the developing phase. In practice even a 25mm deep stop (which was the industry norm for many years) will not provide significant restriction to leakage due to imperfections in fit and distortion during heating. When the fire resistance test first incorporated a positive pressure in the furnace chamber in 1972[1] the very limited contribution that the doorstop made to the fire performance was soon recognised. Intumescent seals were needed to prevent fire exploiting the gap between the leaf and frame and, once fitted, these rendered the stop redundant. The 25mm stop continued to be specified, however, presumably because it was felt to have a smoke control function. The introduction of BS476: Part 31.1 exposed the inadequacies of the doorstop in this respect, early tests showing that the ability of the stop to restrict smoke spread was negligible unless the fit was perfect. More recent tests show a 25mm stop to be only 12% more effective than a 12mm stop. As in the case of fire resistance, the function of the doorstop can be discounted as a means of significantly reducing smoke leakage.

3.0 Improved smoke control measures

When the early versions of BS5588 Codes of Practice for Offices and Shops[2] were published, the research work leading up to the publication of BS476: Part 31.1 had been performed. The inadequacy of the doorstop had, therefore, been recognised.

Unfortunately, no commercially available door assembly had been tested to the proposed procedure at this time, so a pragmatic decision was made to require all smoke control doors to be fitted with a 'flexible edge seal' as an interim measure. This recommendation was too general to remain in the Standard for long and so when these codes came up for revision[3] and as other codes were published, the requirement for the assemblies to meet a leakage rate of 3 metre^3/hour/metre (of leaf edge perimeter) at a pressure of 25Pa was introduced. This also could only be achieved by the use of flexible edge seals (for comparison a 25mm stop has been measured as allowing more than 35 metre^3/hour/metre of leaf edge perimeter). This requirement has been carried forward into national legislation, particularly as one of the methods given in the Approved Document B to the Building Regulations (England and Wales) as satisfying the functional requirement to produce adequate means of escape.

Because it was perceived to be difficult to achieve a seal at the threshold, the gap at the bottom of the door was exempted from the leakage criterion in B1. As the gap at the bottom of the door is straight through and is invariably wider than elsewhere in the assembly, then if the smoke is truly mixed and at an even pressure and temperature, a

(1, 2, 3) See FURTHER READING, Section 8.

greater proportion of the smoke is likely to be egressing from this gap than any of the others. The pragmatic decision to ignore the leakage from the bottom assumes that there will be some stratification of the gases and, therefore, less polluted air will be present nearer to the floor level. This cannot be guaranteed and so leakage through the threshold gap would lead to rapid smoke logging of the protected space. There are, therefore, real benefits to be achieved if the threshold is sealed to satisfy similar levels of performance. It is the recommendation of IFSA, where doorsets are required to restrict smoke leakage at ambient temperature, that they should have a leakage rate not exceeding $3m^3$/m/hour for all edges (head, jambs, base and where applicable, meeting edges) when tested at 25Pa under BS476-31.1.

4.0 Smoke seal designs

The fitting of edge seals to a door leaf has implications on many aspects of the design of a door assembly. There are two main types of edge seals capable of providing the specified smoke leakage rates:

1. Deflection/compression seals, normally fitted to the doorstop to produce a contact with the face of the door.

2. Wiping seals fitted in the leaf edge or in the frame opposite the edge.

Both of these types have advantages and disadvantages. In the case of double swing doors, where no stop is fitted, then the compression seal option is not available. If a seal is to be effective, it needs to be as near continuous as possible. Even in single swing, double leaf door assemblies where a compression seal may be suitable around the leaf to frame junction, the meeting stile will need to incorporate a wiping seal unless an astragal and the associated door selector mechanism is an acceptable solution. The change from a wiping seal in the meeting stile to a compression seal at the leaf edge compromises the quality of the seal because it leaves a gap where the seals change plane. Interruptions in the seal at ironmongery positions have a similar effect. It is not the role of this data sheet to recommend the best method; a specifier should establish the limitations or reductions in sealing efficiency resulting from the seal position, hardware etc., from the suppliers. Any type of wiping seal or compression seal will make it harder to close the door but well designed and carefully installed seals will have a minimum effect.

Nevertheless, the presence of the seal needs to be taken into account when selecting hinges, latches and closers. A door closer can only provide its designed closing force (moment). This has to overcome resistance in the hinges and in any latch fitted. If the resistance to closing of the smoke seal is greater than the residual force left after overcoming the ironmongery resistance, then the door will not close. It is possible to use a more powerful closer than the door weight would normally indicate, but such an increase in the power rating must not make the door difficult to use. Guideline figures on opening forces for access are given in Approved Document M[4] and BS8300: 2009 + A1: 2010. It is imperative that the resistance to closing is not reduced by opening up the leaf-to-frame gap and compromising the quality of the seals. Seals must make contact with the adjacent surfaces, whether wiping or in compression, if they are to be effective. Most overhead closers have a two stage closing action.

(4) See further reading, Section 8.

If the maximum smoke seal resistance does not coincide with the maximum latch resistance, advantage can be taken of the stronger closing action and the need for more powerful closers is obviated.

5.0 Durability and fixing

For smoke control to be effective throughout the reasonable life expectancy of a building, it is imperative that the seals fitted are able to withstand the expected normal operational conditions without any significant loss of performance. Doors in any building will have various operational frequencies depending upon the use of the room or space being closed off and the number of personnel likely to be present during the day. Doors in constant use must only be fitted with seals that are capable of withstanding damage. Seals that are able to demonstrate that they have withstood 100,000 cycles without visible damage, is a recommended minimum requirement for seals that are to be used with doors in high traffic environments, and seals which are able to demonstrate that they can still satisfy the $3m^3$/hr/m criteria after such an operational test are obviously highly recommended. Seals which are only capable of withstanding a lesser number of cycles without failure may still be suitable for use on doors where the normal use expectancy over a period is in line with the number of cycles which can be tolerated.

6.0 Design considerations resulting from the use of smoke sealed doors

Even when all of the above factors have been taken into account, difficulties may still be experienced in closing the door. In a typical commercial building with modern sealed windows, no fireplace and impermeable floors and ceilings, the action of closing a door will create a pressure difference between the inside and outside of the room. With no seals fitted, the pressure will equalise as a result of air egressing around the leaf edge. The slower the closing, the easier it is to achieve equilibrium pressure on both sides of the door. With wiping seals fitted to the door or frame, this method of equalising the pressure is not available and other gaps will have to be exploited if the door is to close.

In extreme cases and where the room or lobby is small the door may not close at all. Increased closing forces may help to overcome the problem but, as with frictional resistances, these must not cause the door to become too difficult to use by the normal users. Schools and sheltered accommodation may require different solutions to military establishments and sports halls, for example. If pressure build-up is a problem, then it is necessary to ventilate the space. If there are so few routes for air to egress, then the room is probably not 'healthy' for the user. However, any ventilator introduced must not allow the smoke to find another route out to the protected space, nor must it compromise the fire resistance of any fire wall. Most IFSA Members will be able to provide fire resistant air transfer grilles and some of these will incorporate smoke control sealing systems linked to the detection system.

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7.0 Specifying smoke sealed door assemblies

1. Select a set of seals which are proven by test or assessment to stay within the permitted maximum leakage rate, normally $3m^3$/hr/m@ 25Pa, on the door of the mode and type to which it is to be fitted (single, double leaf; single, double swing; latched, unlatched etc). Preferably this rate should also be achieved after 100,000 cycles.

2. Establish the tolerance to interruption by hardware etc., and select a hardware package that does not compromise the seal performance.

3. Check the selected seals and hardware do not reduce the fire resistance.

4. Check that the closer specified is able to overcome the total resistance to closing from the hinges, latches and smoke seals.

5. Check that the closing force selected is not rendering the door unusable by the building occupants, taking special note of the needs of the disabled (see both BS8300 and Approved Document M for guideline figures).

6. Specify the door assembly such that the door gaps are compatible with the seals selected.

7. Consider the ventilation of the space on either side of the door and introduce additional ventilation, if appropriate.

8. Ensure that any increased ventilation does not compromise the fire or smoke containment objectives. If so, specify fire/smoke protected ventilation.

8.0 Further reading

BS476: Part 8: 1972
Test methods and criteria for the fire resistance of elements of building construction. Superseded by BS476: Part 22: 1987

BS EN 1634-1: 2014 + A1: 2018
Fire resistance and smoke control tests for door, shutter and openable window assemblies and elements of building hardware.

BS476: Section 31.1: 1983
Methods for measuring smoke penetration through door sets and shutter assemblies under ambient conditions

England and Wales Building Regulations:
Approved Document B: 2019 Fire safety

BS9999: 2017 and BS9991: 2024
Fire safety in the design, management and use of buildings. Code of practice.

BS5588-11:1997
Fire precautions in the design and construction of buildings.

BS8300: 2009 +A1: 2010
Design of buildings and their approaches to meet the needs of disabled people. Code of practice.

England and Wales Building Regulations:
Approved Document M: 2016 Access to and use of buildings, Vol 1 and Vol 2.

Regulatory Reform (Fire Safety) Order: 2005

ASDMA The complexity of fire doors and the importance of door design

IFSA Fact Sheet No. 2
Smoke control in fire doors – 0422 V1

9.0 Information about IFSA

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

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

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 planned to investigate 25 years exposure to a variety of controlled and uncontrolled environments. Findings showed no detectable visual decline.

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 new 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. IFSA has produced a number of downloadable Good Practice Guides to help risk assessors know and understand when a particular intumescent application is right or wrong, or how a risk may be controlled by the use of the correctly specified sealing product.

Get in touch

Visit ifsa.org.uk for more information and expert technical guidance on fire door seals, smoke seals, glazing seals, and solutions for penetration and gap sealing.

Together, we're raising standards in fire safety - working to maximum safety and compliance across the fire protection industry.

Scan to meet our members

Visit the member showcase to discover how our community is shaping a fire-safe future.