Design guide

FPA DESIGN GUIDE:
THE FIRE PROTECTION OF BUILDINGS

Core document

PROTECTION OF OPENINGS AND SERVICE PENETRATIONS FROM FIRE

FPA
Fire Protection Association

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FPA Design Guide: Essential Principles

The objectives of the Design Guide are:

- to minimise the effect of fire on a business
- to limit the effects of business interruption
- to allow a business to be trading within 24 hours of a fire
- to protect the buildings within a business

by defining essential principles to be espoused in the design and construction of commercial and industrial premises, principles which will result in buildings which are safer from the risk of fire and better able to cope with the effect of fire in the event that it breaks out.

The essential principles are:

1. Use building materials which will not make a significant contribution to a fire at any stage of its growth;
2. Design a building's structure to have resistance to collapse or excessive deflection in the event of a fire;
3. Construct a building in such a way as to minimise the extent of fire and smoke damage in the event of fire;
4. Incorporate all necessary safeguards against the threat of arson;
5. Construct the building in such a way that fire cannot spread in from an adjoining building or other external fire source;
6. Install an appropriate automatic fire alarm system;
7. Ensure that fire protection systems are regularly inspected and maintained;
8. Initiate a comprehensive regime of fire safety management for the premises;
9. Give regard, at the design stage, to the potential damage from firefighting water and plan to minimise any undesired environmental effects that might relate thereto;
10. Specify only third-party certificated fire protection products;
11. Commission competent, specialist installers to fit fire protection products/systems;
12. Ensure that services and related components are designed/constructed/installed to guard against their becoming accidental sources of ignition.

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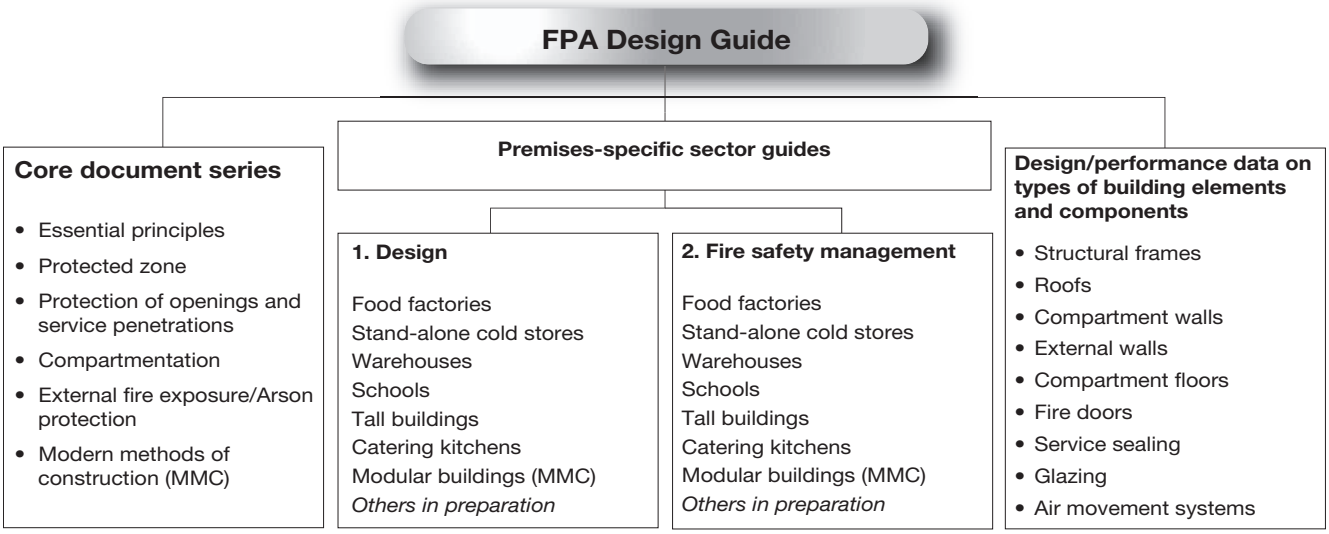
FPA DESIGN GUIDE:
THE FIRE PROTECTION
OF BUILDINGS

PROTECTION OF OPENINGS AND SERVICE PENETRATIONS FROM FIRE

FPA Design Guide: the Fire Protection of Buildings

The FPA Design Guide is a series of publications which (a) have been developed from predecessor documents and (b) also cover new ground. The Design Guide informs architects and designers about the business risk management issues which relate to the fire protection of buildings, issues which supplement in very important ways the life safety requirements contained in the principal legislative controls. It will give designers a more complete view about designing fire-safe buildings

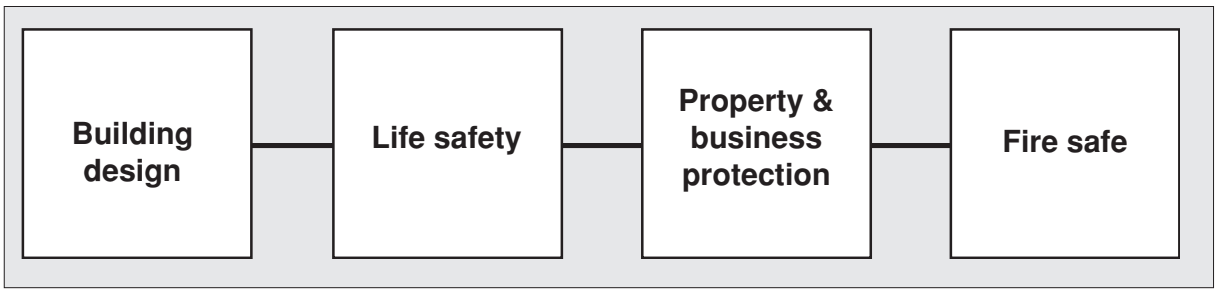
The Design Guide has been recast in three main parts.



- Core documents: a set of publications on fundamental design topics.
- Premises-specific sector guides: for each type there will be a design guide and a document concerning fire safety management.
- Design/performance data on building products: the datasheets are accessible on www.thefpa.co.uk/Resources/Design+Guide/.

It is also proposed to produce a document which concentrates on technical data, definitions of terms and details of sources of reference and information, as commonly used for insurance underwriting purposes, to support the suite of Design Guide publications.

Basic fire safety design framework



Emphasis is placed on the importance of early consultation among architects, those who manage risks in industry and commerce, and insurers, and on the value of risk assessment to use the Design Guide's recommendations to best effect.

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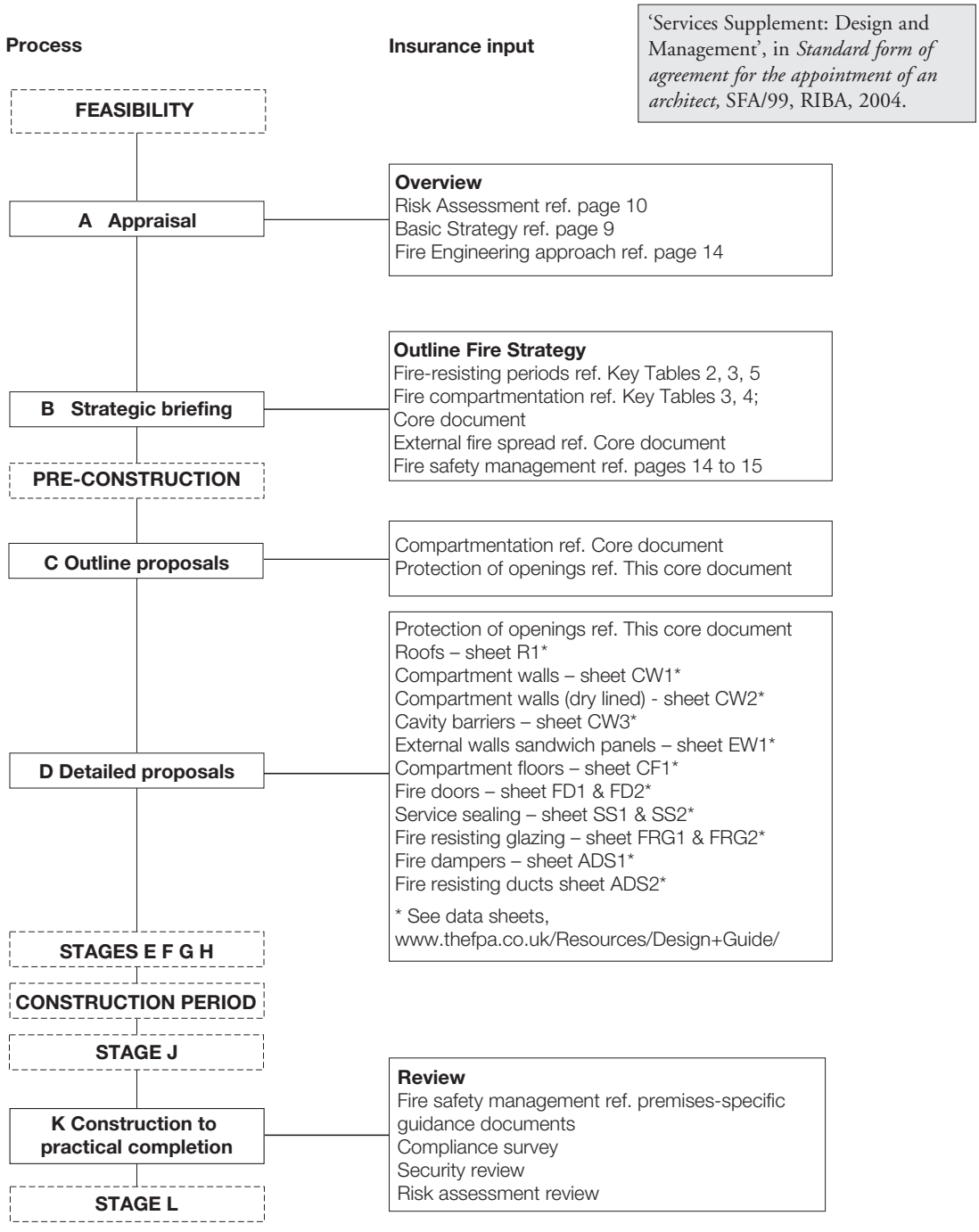
The Design Process

The fire safety design for a building will principally be driven by the necessity to meet the life safety goals of the Building Regulations. Codes and standards, including Approved Document B (and similar documents for Scotland and Northern Ireland), set down recommendations and guidance on how to meet the life safety objectives of the Building Regulations. Measures that specifically address fire damage and business interruption will generally not form part of the life safety guidance. It is therefore important that insurance property objectives are taken into account at the earliest opportunity in the design process. The flow chart below is the RIBA (Royal Institution of British Architects) Outline Plan of Work; guidance is given on the timing of *Design Guide* input into the process and where relevant, to section references. Data sheets on genetic types of building products and their fire protection attributes are accessible on www.thefpa.co.uk/Resources/Design+Guide/.



Contents

What the building designer should consider

The only way that the performance of a building in its entirety can be guaranteed is if each individual element is guaranteed to work in its environment. An understanding of this point is vital when considering the fire protection properties of a building which is being planned. Thus it is necessary to carry out a brief analysis of the part each element plays when considering its likely performance in a fire in relation to the elements bounding it.

Fire resistance

Often cited in terms of a length of time, fire resistance is the ability of a building material or an element of construction, in a fire:

- to continue to bear a certain load for that length of time without failure or deflection; or
- to prevent fire passing from one compartment to another for that duration; or
- both the above.

Various test criteria exist under the different Parts of BS 476 in relation to the fire resistances of different building materials/elements for varying applications.

Regardless of how well an individual element is designed and constructed and even, to some extent, how it is installed, if fire breaks out – and it should be assumed that fire will occur in the building under design – then, only if the building itself behaves in a predictable manner, can it act to reduce the spread of fire. The interaction between the elements should not cause elements to move and produce large gaps or to collapse prematurely. It is recommended that before a building is accepted as satisfying the requirements affecting and related to its principal properties – such as structural fire resistance, compartmentation, external resistance to fire - an analysis is made of the behaviour of the building as a whole.

A full appraisal of that kind would require all aspects of the building's behaviour to be considered together with all possible fire scenarios. Since it is not possible to take the full range of potential conditions into account, this guidance considers principally the behaviour of the individual elements when exposed to the test regimes of national and industry standards, subject to variations when such specifications are inappropriate.

Fire-resistance testing generally only considers single elements in isolation and evidence generated as a result of the test is therefore only of limited value in determining the ultimate behaviour of the building in which such an element is found. A detailed analysis of the behaviour of a building is beyond the scope of this document but an understanding of basic structural engineering, combined with an understanding of the behaviour in fire of the principal building materials, would allow a reasonable prediction to be made of the behaviour of the structure as a whole.

In the UK the design and construction of new buildings and alterations to existing buildings are controlled by legislation (the prime objective of which is life safety). The principal Regulations are:

- England and Wales: the Building Regulations
- Scotland: the Building (Scotland) Regulations
- Northern Ireland: the Building Regulations (Northern Ireland).

The FPA's Design Guide publications should be used by the building designer in conjunction with any official documents which give guidance about the appropriate Regulations.

The Fire Protection Association, in undertaking a revision of the *LPC Design Guide for the Fire Protection of Buildings 2000,* sought to start afresh by publishing its document *Essential Principles* (2003), a publication which surveys, in 12 principles, the basic measures necessary to achieve adequate levels of building fire protection for industrial and commercial buildings, their businesses and their contents. That document and the whole suite of related FPA Design Guide publications are intended for the designers and owners of such buildings, as well as for consultants working in the field, construction companies and insurers.

In the United Kingdom most legislative provisions which deal with buildings and fire are intended as life safety measures. In a number of instances the measures contained in the Design Guide series will set more onerous standards than the legislation and while it is generally the intention to reflect the approach contained in Approved Document B to the Building Regulations, different objectives do sometimes call for different requirements. The result will be buildings which will be safer for the workforce or visitors, better able to resist the effects of a fire should fire break out, and in any case better for protecting businesses, assets and jobs.

Risk assessment: the principle

Far too often it is the case that industrial and commercial buildings are designed and constructed with no considered thought given to an assessment of the hazards, including fire hazards, which may be introduced into the buildings by their occupiers. All too rarely do the designer, the occupier and the insurer manage to sit down together at an early stage to consider the matter, let alone proceed to carry out a risk assessment.

Risk assessment is, of course, an aspect of planning, and one which designers should be able to take in their stride. The importance of carrying out such an assessment cannot be overemphasised, since the establishment of property protection objectives and criteria will enable the achievement of cost effective fire protection of the assets of the business. What follows is intended to provide designers with a broad view of how they may contribute to a risk assessment for property protection purposes.

It is necessary to acknowledge that, as mentioned above, a property protection risk assessment is more wide ranging than one carried out to establish the life safety and means of escape requirements to satisfy national legislation. In addition to the direct financial losses arising from a fire, the effect on the profitability of the business needs to be assessed. (The FPA's book *Fire risk management in the workplace* is an excellent introduction to the topic.)

Adair Lewis and William Dailey, *Fire risk management in the workplace,* 2nd edition, 2000.

It follows therefore that higher standards of fire protection will often be necessary to achieve acceptable property protection criteria and objectives than would be required to satisfy national building regulations.

Fire hazard

A source or situation which has the potential to cause a fire.

Risk assessment: the aims

The purpose of risk assessment is: to identify, quantify, eliminate and/or reduce the hazards in a commercial building, thus reducing the overall risk; and then go on to determine the property protection objectives and criteria required to protect the residual risk to a level acceptable to the client and the client's insurers.

Fire risk

The product of the probability of fire occurring and the magnitude of the consequences of that fire.

Inherent hazards and risks

- The possibility of fire occurring due to the occupancy and/or processes intended for the building;
- the expected severity of a fire (fire load and fire development) due to the combustibility of the contents and any combustible elements of construction;
- the susceptibility of the building to fire spreading from adjacent buildings or external storage or plant;
- the susceptibility of the building to arson or malicious damage;
- the presence (or lack) of early warning systems;
- the insured values at risk;
- contribution of the premises to the profitability of the business.

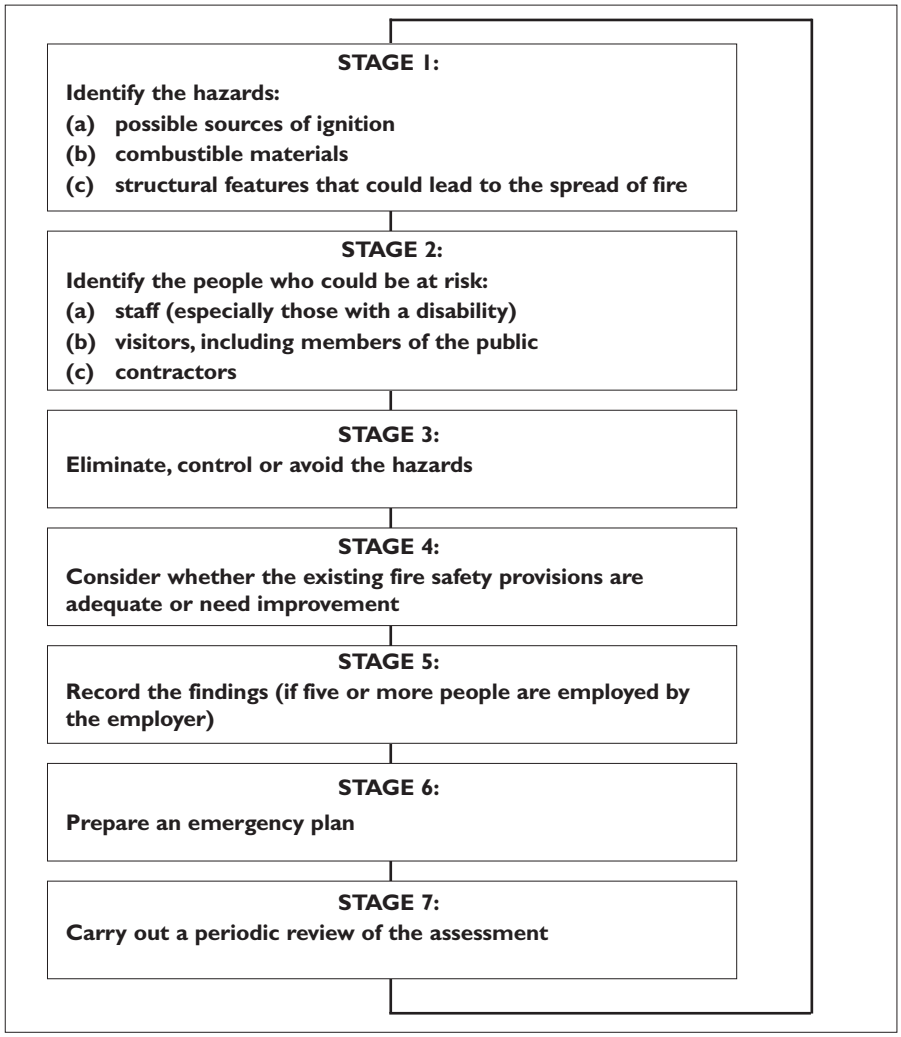
The property protection objectives and criteria

These should include consideration of the following:

- the overall fire resistance for the proposed structure;
- the sub-division of the building into fire-resisting compartments to limit the size of the direct monetary loss and the effect on the business;

- the protection of hazardous processes or critical business equipment;
- the availability of public fire brigade and water supplies;
- automatic fire detection and protection systems;
- lightning protection systems;
- security of the premises against intruders and any potential threats of arson and malicious ignition.

The risk assessment process



One way of carrying out a fire risk assessment (from Lewis and Dailey, *Fire risk management in the workplace*).

Insurers will identify with the client the component parts of the business operation and the effect that loss of each will have, not only in direct financial loss terms but also on the profitability of the business. The loss of a vital piece of machinery or plant, for example, effluent handling plant, may cause cessation of production, even though in itself, it may not constitute a fire hazard but will therefore require protection.

The following is a broad summary of the features of the business that will need consideration:

Occupancy

Usage and manufacturing processes involved;

Fire load arising from the occupancy, e.g. type of goods stored and storage heights proposed;

Premises' layout, e.g. proximity of production/storage;

Hazardous processes;

Critical business processes, equipment and/or components and stock, e.g. electronic equipment, high value components etc.

Estimated values at risk

Buildings;

Contents excluding stock;

Stock;

Business interruption exposure.

Surroundings

Exposure from other premises;

Type of area, e.g. residential/industrial.

Fire protection

Distance from the nearest public fire brigade;

Availability of adequate water supplies for fire fighting;

Fire detection/protection systems required to augment passive fire protection.

Security

Site security requirements.

Fire safety management and security

Fire safety management aims to ensure that the incidence of fire in a building is minimised and that, if a fire occurs, all of the passive, active and procedural fire safety systems are in place and operating properly.

Fire safety design should align with the normal use of the building, so design standards should reflect fire safety management objectives. The following issues should be considered at the design stage:

1. Passive fire safety systems must be maintained in an effective condition for the lifetime of the building.
2. Active fire safety systems must be properly maintained and tested.
3. Design assumptions regarding the use and management of the building are sound; for example, that they correctly anticipate the type of occupancy and the likely fire load.

Design guidance/recommendations should embrace three aspects of fire safety management as a positive linkage of design and building operation:

- consider where design measures can support on-going fire safety management;
- look at the connections with other considerations: arson, environment, security, disabled access and egress and sustainability;
- evaluate the options for verification of the fire safety management regime.

BS 5588: *Fire precautions in the design, construction and use of buildings:* Part 12: 2004: *Managing fire safety.*

Part 12 of BS 5588 gives recommendations for the management of fire safety over the lifetime of a building. It includes guidance for designers to ensure that the overall design of a building assists and can play a positive role in the management of fire safety. It also provides guidance on fire equipment and on the purpose and potential contents of a building's fire safety manual.

Fire safety engineering

The guidance provided in this series of publications follows the fire safety design solutions suggested in official publications such as the approved documents to building regulations. There is no obligation on the designer to adopt those solutions. But if alternative techniques of fire safety engineering are employed extensively in the design of a building – maybe one which is complex or novel in concept – then it is essential that insurers are consulted at the earliest opportunity and invited to participate in the Qualitative Design Review (QDR). For more information about fire safey engineering see BS 7974: 2001.

Fire safety engineering
The application of scientific and engineering concepts to the design and construction of a building so that the building will meet the fire safety demands placed on it in relation to its size, layout, use and location.

BS 7974: 2001: *Application of fire safety engineering principles to the design of buildings. Code of practice.*

Modern methods of construction

In recent times there has been increased use of modular and volumetric building systems that often employ off-site manufacture and introduce innovative materials and methods of construction. Buildings erected in that manner are not considered separately from those constructed using traditional methods. Just like traditional methods and materials, they should meet the performance criteria expressed in this design guidance and should be supported by suitable test data.

Qualitative Design Review
A process which establishes the fire safety objectives for a building under design, as part of a fire safety engineering analysis, and is normally carried out by a multi-disciplinary team.

A separate publication in the Design Guide series deals with modern methods of construction and includes definitions of terms like modules and volumetric systems.

Climate and location

Climate change may have potential impacts on the UK's building stock in the near or medium-term future. Among its forecast effects is an increase in the frequency and severity of storms, hence an increase in lightning strikes.

Lightning has long been recognised as a peril to be taken into account in building design and the designer should ensure that adequate provision is made with respect to lightning protection. The trend towards higher multi-storey buildings means that lightning protection assumes greater significance.

Just as some areas of the UK are more prone to lightning strikes than others, there are locations where flooding is a recognised peril. The informed designer will take it into account when considering the factors which could affect the building which is being planned.

Depicting passive fire protection measures

The illustration is used by kind permission of the Passive Fire Protection Federation.

The following descriptions of the features illustrated make reference to products and/or systems. It is not the purpose of this design guidance to recommend proprietary products but in the main text there are references to the need to select products which are approved via appropriate third-party testing and certification. On the FPA's website are data sheets which provide more information about broad types of products or systems (www.thefpa.co.uk/Resources/Design+Guide/).

A Structural framework

Usually steel (but can be reinforced concrete or timber). As well as providing a robust framework to support all the loads presented by or imposed upon a building it needs to maintain its load-bearing capacity in a fire for an appropriate duration (see Key Tables 2 and 3). Structural steel may require protection against the effects of fire by the application of a suitable protection material or coating.

B Roofs

Very often the roofs of industrial/commercial buildings are made of composite panels with fire resistance performance appropriate to their purpose. Where portions of a roof fall within the protected zone (see Glossary of terms), then additionally they shall have the ability to resist the spread of fire inside to outside.

C Compartment walls

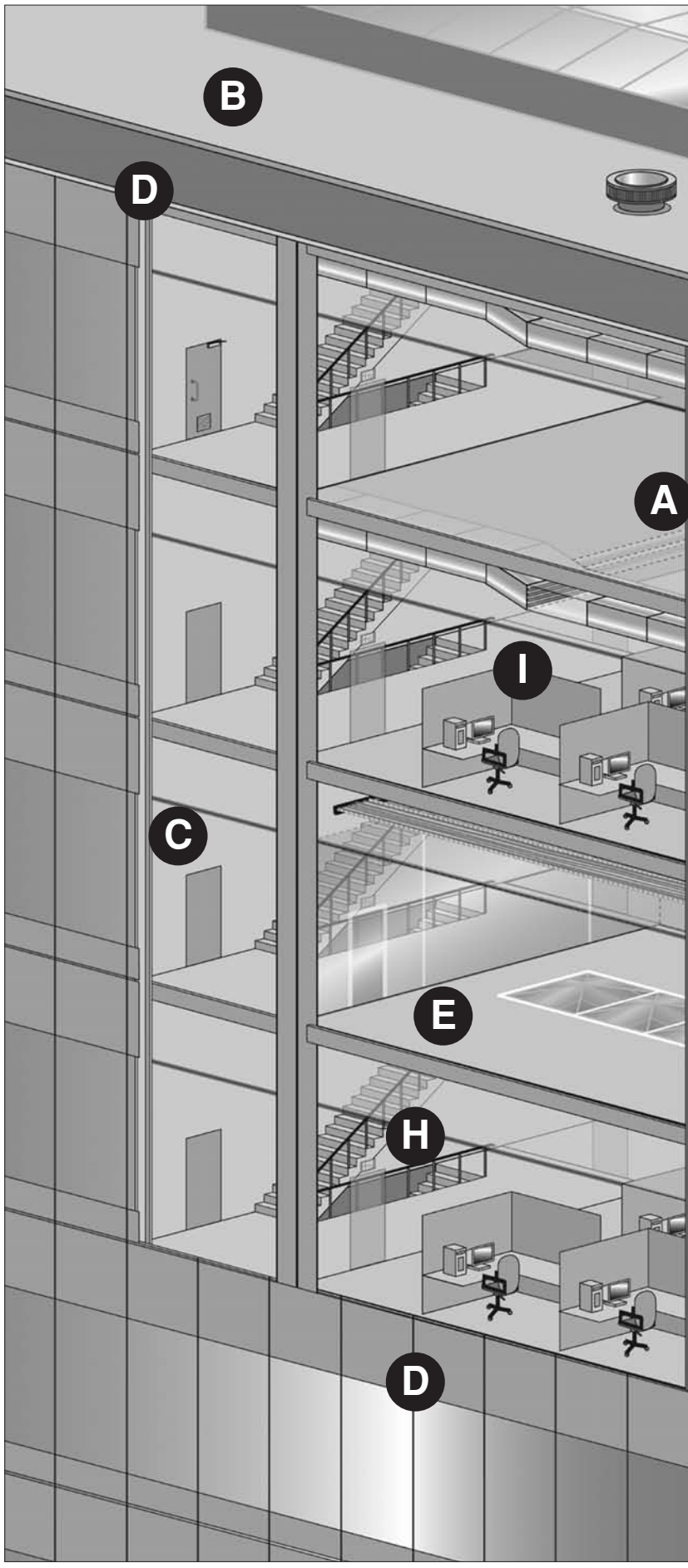
These provide vertical barriers to prevent fire spreading horizontally between compartments within a building (see Key Table 3). A compartment wall shall be designed to maintain its integrity for a specified duration and to restrict the rise of temperature on its face not exposed to the fire to the level required to prevent the spread of fire by the conduction of heat (Key Table 3).

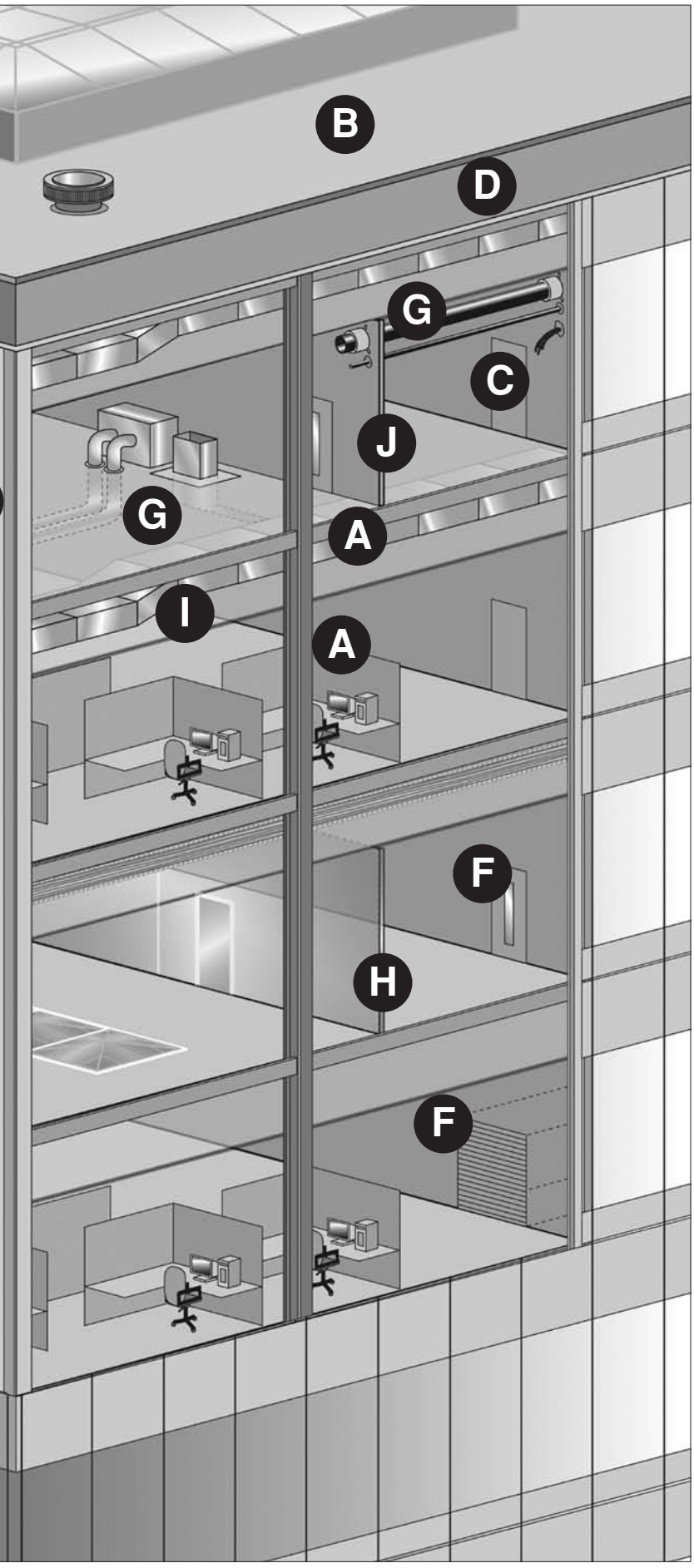
D External walls

External walls shall make no significant contribution to a developing fire but shall meet any requirements specified for thermal insulation. An external wall shall prevent fire spread around a compartment wall, where the two adjoin, by meeting the fire resistance requirements appropriate to the protected zone. It is necessary to specify a product that can resist fire spread from both inside and outside. See Key Table 2.

E Compartment floors

These provide horizontal barriers to prevent the vertical spread of fire between compartments within a building as required by Key Table 3. A compartment





floor shall be designed to maintain its load-bearing capacity in a fire, to contribute appropriately to the stability of a building and to ensure that means-of-escape routes remain accessible. It shall also restrict an increase in temperature on the surface of the floor not exposed to the fire (thus preventing fire spread by heat conduction) for the period specified in Key Table 3.

F Fire doors and shutters

The function of fire-resisting doors and shutters is to maintain the fire and smoke separation performance of a compartment wall (or large cavity barrier) when such openings need to be provided to permit the passage of persons or objects. Thus that function extends to restricting the passage of both heat and smoke. It is essential to specify a product for which there exists test evidence of suitability for its location and design purpose.

G Service sealing

The stopping of gaps around service pipes, at penetrations through compartment walls and floors, is essential to maintain the fire resistance performance of those walls/floors. There is a multiplicity of sealing products and systems and it is vital to acknowledge the need to repair imperfect fits and to choose a product/system that is suitable for their location and design purpose.

H Fire-resistant glazing systems and framing

The principal function of fire-resistant glass is to maintain the integrity of a compartment wall for the duration specified in Key Table 3. It is essential to specify a system (glass and framing) that delivers the complete range of fire-resisting features appropriate to the intended location and use.

I Air distribution systems

Where air distribution ductwork is fitted, then if it passes through compartment walls/floors it shall maintain fire compartmentation. This will require the specification of steel ductwork (which may be protected by fire protection systems – such as detection devices linked to fire dampers) or of duct systems constructed from fire protection boards. The appropriate service sealing product or system should be employed where such distribution systems penetrate compartment walls/floors.

J Fire-rated partitions

Lightweight internal partition walls shall be constructed of materials which do not contribute to the overall fire loading of the building. They are not compartment walls (see item C).

Structural requirements

Essential Principles numbers 1 and 2 of the *FPA Design Guide* call for buildings that will:

- use materials that do not contribute to fire growth at any stage; and
- have resistance to structural collapse or excessive deflection in the event of a fire.

Contribution to fire growth

Potential fire spread and rate of growth should be reduced as far as possible by the use of materials that are:

- non-combustible or of limited combustibility or, if timber, that comply with the fire resistance requirements given in Key Tables 2 and 3; or
- products (which may include combustible materials) which have been tested by a nationally accredited, independent third-party certification body and shown not to make a significant contribution to fire growth; or
- products which incorporate finishes conforming to Class 0 (as defined in the supporting documents to building regulations) on non-combustible cores/substrates.

NB. This third requirement does not apply to columns and beams or to steel portal frames.

Fire resistance – structure

All building design must incorporate the correct level of fire resistance for all elements of construction, to be determined by an appropriate risk assessment.

Unless otherwise stated, fire resistance requirements are related to integrity, insulation and – for loadbearing elements – loadbearing capacity also.

Minimum recommended fire resistance periods are as follows:

Single storey buildings

- the recommendations relating to fire resistance for compartmentation in Key Table 5;
- there are no other minimum recommendations concerning the fire resistance of single storey buildings. Decisions on protection should be based entirely on the outcome of a risk assessment.

Multi storey buildings

- the minimum fire resistance times for elements of construction in Key Table 2.

In all cases, consideration should also be given to the recommendations contained in another core document in this design guidance, External exposure to fire.

For basements, unless otherwise specified in this design guidance, the guidance in the appropriate supporting documents to building regulations should be followed.

Non-combustible

A material may be considered to be non-combustible if it satisfies the requirements for non-combustibility when tested in accordance with BS 476: Part 4 or Part 11, that is, it does not flame and there is no rise in temperature on certain specified test thermocouples.

Material of limited combustibility

For the purposes of this Design Guide, a material of limited combustibility is:

- any non-combustible material;
- any material of density 300kg/m^3 or more which, when tested to BS 476: Part 11, does not flame and for which the rise in temperature on the furnace thermocouple is not more than 20°C;
- any material with a non-combustible core at least 8mm thick having combustible facings (on one or both sides) not more than 0.5mm thick (where a flame spread rating is specified, these materials should also meet the appropriate test requirements);
- any material of density less than 300kg/m^3 which, when tested to BS 476: Part 11, does not flame for more than 10s and for which the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and on the furnace thermocouple is not more than 25°C.

BS 476: Part 11: 1982: *Method for assessing the heat emission from building materials.*

Introduction

Scope

This book in the FPA's series of Design Guide publications deals with the protection of openings or gaps in compartment walls and compartment floors (Part 1) and the protection of services penetrations (Part 2). (The principles of compartmenting buildings to resist the spread of fire are dealt with in a separate book in the series, *FPA Design Guide: Fire compartmentation.*) The following are covered in this publication:

- Fire-resisting and/or smoke control doorsets and shutter assemblies including hinged or pivoted doorsets, vertical rolling shutters, laterally operating rolling shutters, folding shutters, lift landing doors, escalator/horizontal rolling shutters, closures for conveyors and active smoke barriers.
- Fire-resisting windows and glazed screens.
- Ducts and other building services.
- Cavity barriers.
- Fire stopping and linear gap sealing.

Design principles

- Openings shall not permit the spread of fire and/or smoke through compartment walls and/or floors.
- All openings shall be provided with a closure that at least maintains the required integrity of the compartment wall or floor.
- Any requirement for insulation classification of the closure shall follow from risk assessment.
- Insulation shall be provided where there is any possibility that, when the building is in use, materials will be in direct contact with or in close proximity to the surface.
- Closures must be suitable for their intended use in terms of robustness and durability and fitted with hardware of appropriate quality and purpose.
- All fire protection products falling within the scope of this document shall be certified by a nationally accredited, independent, third-party certification body and such products shall be installed and maintained by an appropriately assessed and qualified, competent contractor.

In the United Kingdom, the national accreditation body is the United Kingdom Accreditation Service (UKAS); the Loss Prevention Certification Board (LPCB) is an example of a third-party certification body.

BS 476: Part 20: 1987: *Method for determination of the fire resistance of elements of construction (general principles).*

BS EN 1363: *Fire resistance tests:* Part 1: 1999: *General requirements.*

BS EN 13501: Part 2: 2003. *Classification using test data from reaction to fire tests excluding ventilation services.*

Means of escape in the event of fire

While the FPA Design Guide does not specifically deal with means of escape, that issue must always be at the forefront of any designer's approach. For example, the Design Guide allows some relaxations for uninsulated constructions such as doors and glazing which may not be appropriate where an escape route runs alongside a compartment wall incorporating uninsulated constructions. Reference to integrity and insulation made in this part of the Design Guide relates to the performance criteria of BS 476: Part 20:1987 or BS EN 1363: Part 1 and appropriate classification from BS EN 13501: Part 2.

Passive fire protection products and installation standards

Products and their installation are mentioned above. They are covered by three of the Design Guide's Essential Principles between which there is a particularly critical link:

- use building materials which will not make a significant contribution to a fire at any stage of its growth (Principle 1);
- specify only third-party certificated fire protection products (Principle 10); and
- commission competent, specialist installers to fit fire protection products/systems (Principle 11). (Which means a third-party accredited installation company, for preference.)

Even the best and safest of designs will be undermined if inappropriate or substandard products are used, or if the products and systems are properly specified but the standard of installation and workmanship is inadequate or unsupervised.

The Design Guide's associated construction design and product performance data sheets – which give generic information about the performance of types of passive fire protection products and systems – are available via the FPA web site, www.thefpa.co.uk/Resources/Design+Guide/. Some trade associations publish advice about such products and installation standards and reference could be made to documents produced by the Passive Fire Protection Federation and the Association for Specialist Fire Protection, as well as those of other organisations which are listed in the References (see page 76).

Guide to demonstrating the performance of passive fire protection products, 2004.

Guide to undertaking assessments in lieu of fire tests, 2000.

Both published by the Passive Fire Protection Federation.

Ensuring best practice for passive fire protection in buildings, 2003, Association for Specialist Fire Protection.

It is important that the designer has confidence in those products which are specified for the building under design and it is also vital that the standard of installation matches the quality and purpose of the products.

Appendix information

The appendix to this document gives valuable and more detailed information on a number of important aspects of the protection of openings that can be taken into account by building designers and other professionals who consult this guidance.

References to publications

The reader will find frequent references in the text to technical publications. At the first occurrence of a reference to a particular document, for example, BS 476: Part 20, there will be a marginal note which gives more information about the reference. A complete list of references is provided towards the end of the book.

Explanations of terms

It has been felt necessary to explain some of the terms used in this book. Such explanations are provided in the form of marginal notes at or near the time of first use of a term. These explanations are not intended to take the place of more precise definitions which may be found in legislation, official documents or other publications, but serve as basic descriptions to clarify the matters being described. The terms are contained in a glossary at the end of the book.

It is intended to publish a document in this series which will concentrate on technical data, definitions of terms and details of sources of reference and information, as commonly used for insurance underwriting purposes, to support the suite of Design Guide publications.

Key Tables

These Key Tables present the most frequently used design criteria in forms similar to those used in Approved Document B to the Building Regulations. The periods of fire resistance and compartment sizes which are given differ, however, in some cases from those cited in the official documents in order to reflect the part which this guidance plays in relation to the protection of property.

This design guidance is applicable to:

- all new buildings, excluding dwelling houses, maisonettes, and stand-alone car parks for light vehicles – for all these the provisions of the supporting documents to Building Regulations are considered to provide adequate property protection;
- major extensions and the refurbishment and upgrading of existing buildings within the purpose groups covered.

Elements of construction

This term covers: structural framework, walls (internal and external), floors, roofs, stairs and enclosures to floor openings.

In this design guidance it is given a slightly broader meaning than in some official guidance. It includes, for example, the roof of a building, a feature not covered by the definition of the similar term 'element of structure' in Approved Document B to the Building Regulations.

Compartmentation

The division of a building into fire-resisting compartments, comprising one or more rooms, spaces or storeys, by elements of construction designed to contain a fire for a predetermined duration.

Single-storey and multi-storey buildings

This design guidance does not apply to single-storey buildings except for the following:

- requirements for compartment size (Key Table 4);
- recommended fire resistance levels for compartment walls and floors (Key Table 5).

Single-storey buildings shall be designed to meet the overriding requirements of the Essential Principles (see inside front cover). Decisions concerning fire resistance and fire protection should be based entirely on the outcome of a risk assessment.

Multi-storey buildings shall comply with the requirements contained in Key Tables 3 to 5.

Mezzanines: the addition of any mezzanine floor in excess of 10% of the plan area of a building may compromise the design criteria of the compartment. Insurers must be consulted at the earliest possible opportunity.

Separation

Regardless of the size of a compartment, separation in accordance with the recommendations of Key Table 3 shall always be considered between:

- manufacturing areas and warehousing facilities;
- retail areas and storage/goods delivery accommodation;
- in some circumstances, for example, to separate different occupancies within a building or to separate two buildings, it may be necessary to provide an imperforate compartment wall with at least 240 minutes fire resistance. (Insurers formerly called this a 'fire-break' wall.)

Adjacent buildings

It is inevitable that this design guidance deals principally with a building as it will be individually constructed, standing on its own. There may be other fire resistance considerations, however, which relate to adjacent but separate buildings. For guidance on that matter see *FPA Design Guide: External fire exposure and arson.*

Modern methods of construction

See page 14. The information in the Key Tables makes no concessions to the construction methods and materials broadly termed 'modern'.

KEY TABLE 1. Purpose groups specified in Approved Document B, The Building Regulations 2000

Title	Group	Purpose for which building or compartment of building is intended to be used*
Residential[1] (dwelling)	1(a)	Apartment.
	1(b)	Dwelling house which contains a habitable storey with a floor level which is more than 4.5m above ground level.
	1(c)	Dwelling house which does not contain a habitable storey with a floor level which is more than 4.5m above ground level.
Residential (institutional)	2(a)	Hospital, nursing home, home for old people or for children, school or other similar establishment used as living accommodation or for the treatment, care or maintenance of people suffering from illness or mental or physical disability or handicap, place of detention where such people sleep on the premises.
(Other)	2(b)	Hotel, boarding house, residential college, hall of residence, hostel, and any other residential purpose not described above.
Office	3	Offices or premises used for the purpose of administration, clerical work (including writing, book keeping, sorting papers, filing, typing, duplication, machine calculating, drawing and the editorial preparation of matter for publication, police and fire service work), handling money (including banking and building society work), and communications (including postal, telegraph and radio communications) or radio, television, film, audio or video recording, orperformance (not open to the public) and their control.
Shop and Commercial	4	Shops or premises used for a retail trade or business (including the sale to members of the public of food or drink for immediate consumption and retail by auction, self-selection and over-the-counter wholesale trading, the business of lending books or periodicals for gain and the business of a barber or hairdresser) and premises to which the public is invited to deliver or collect goods in connection with their hire, repair or other treatment, or (except in the case of repair of motor vehicles) where they themselves may carry out such repairs or other treatments.
Assembly and Recreation	5	Place of assembly, entertainment or recreation; including bingo halls, broadcasting, recording and film studios open to the public, casinos, dance halls; entertainment, conference, exhibition and leisure centres; funfairs and amusement arcades; museums and art galleries; non-residential clubs, theatres, cinemas and concert halls; educational establishments, dancing schools, gymnasia, swimming pool buildings, riding schools, skating rinks, sports pavilions, sports stadia; law courts; churches and other buildings of worship, crematoria; libraries open to the public, non-residential day centres, clinics, health centres and surgeries; passenger stations and termini for air, rail, road or sea travel; public toilets; zoos and menageries
Industrial	6	Factories and other premises used for the manufacturing, altering, repairing, cleaning, washing, breaking-up, adapting or processing any article; generating power or slaughtering livestock.
Storage and other non-residential[2]	7(a)	Place for the storage or deposit of goods or materials (other than described under 7(b)) and any building not within any of the purpose groups 1 to 6.
	7(b)	Car parks designed to admit and accommodate only cars, motorcycles and passenger or light goods vehicles weighing no more than 2500kg gross.

* Key Table 1 replicates the purpose groups of Table D1 of Approved Document B to the Building Regulations.

[1] Includes any surgeries, consulting rooms, offices or other accommodation, not exceeding 50m^2 in total, forming part of a dwelling and used by an occupant of the dwelling in a professional or business capacity.

[2] A detached garage not more than 40m^2 in area is included in purpose group 1(c); as is a detached open carport if not more than 40m^2, or a detached building which consists of a garage and open carport where neither the garage nor open carport exceeds 40m^2 in area.

KEY TABLE 2. Minimum fire resistance (in minutes) for elements of construction (based on Table A2 of Building Regulations Approved Document B).

Purpose group	Height of building Not more than 5m high	Not more than 18m high	Not more than 30m high	More than 30m high
1a Residential (domestic) Apartment	Not covered in this design guidance	Not covered in this design guidance	Not covered in this design guidance	Not covered in this design guidance
1b/1c Residential Dwelling house	Not covered in this design guidance	Not covered in this design guidance	Not covered in this design guidance	Not covered in this design guidance
2a/2b Residential Institutional and other residential including hotels	30[1]	60	90	120[2]
3 Office				
not sprinklered	30[1]	60	Not recommended[3]	Not permitted
sprinklered	30[1]	30	60	120[2]
4 Shop and commercial				
not sprinklered	60	90	Not recommended[3]	Not permitted
sprinklered	30[1]	60	60	120[2]
5 Assembly and recreation				
not sprinklered	60	60	90	Not permitted
sprinklered	30[1]	60	60	120[2]
6 Industrial - all hazard groups				
not sprinklered	60	90	Not recommended[3]	Not permitted
sprinklered	30[1]	60	90	120[2]
7a Storage and other non-residential[4]				
not sprinklered	60	90	Not recommended[3]	Not permitted
sprinklered	30[1]	60	90	120[2]
7b Integral car park for light vehicles[5]				
not sprinklered	Not recommended[3]	Not recommended[3]	Not recommended[3]	Not recommended[3]
sprinklered	60	60	60	60

1 Increased to a minimum of 60min for compartment walls separating buildings.

2 Reduced to 90min for elements not forming part of the structural frame.

3 In individual circumstances consideration may be given by insurers to increased fire resistance in place of sprinkler protection. Assessment of risk should be carried out in consultation with the insurer.

4 Extends to other occupancies where the risk assessment reveals a high fire load arising from storage incidental to the main purpose group but not retail warehouses.

5. Refers to car park which forms part of a building falling within another purpose group. No recommendations are made here in respect of stand-alone car parks.

Height of building
Depends on the type of building and the roof configuration. For guidance see Diagram C3 of Appendix C to Approved Document B to the Building Regulations (accessible via www.odpm.gov.uk and follow links to 'Building Regulations – Documents and publications').

KEY TABLE 3. Compartmentation - recommended fire resistance of compartment wall or compartment floor.

Purpose group	Minimum fire resistance (min)	
	Sprinklered	Not sprinklered (or sprinklered on one side only).
	This level of fire resistance is permitted where sprinkler protection is installed on both sides of the compartment wall or floor. This must be designed and installed in accordance with the *LPC Rules for Automatic Sprinkler Installations incorporating BS EN 12845.*	Premises where control of the sprinkler protection either side of a compartment wall is in different ownership or rests with different occupiers must be treated as not sprinklered.
1a Residential (domestic) Apartment	Not covered in this design guidance	Not covered in this design guidance
1b/1c Residential Dwelling house	Not covered in this design guidance	Not covered in this design guidance
2a/2b Residential Institutional and other residential including hotels[4]	90	120
3 Office[4]	90	120
4a Shop and commercial	90	120
4b Retail warehouse and superstore[1, 3]	120	240
5 Assembly and recreation[4]	90	120
6 Industrial Ordinary hazard groups OH1 and OH2[2, 3, 5]	90	120
Ordinary hazard groups OH3 and OH4 and High hazard process[2, 3, 5]	120	240
7a Storage and other non-residential	120	240
7b Integral car park for light vehicles	120	Not recommended

1 'Retail warehouse and superstore' refers to retail buildings containing storage arrangements similar to those encountered in storage occupancies.

2 For details of hazard groups see the tables in Appendix A of BS EN 12845: 2003, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance.*

3 These additional subdivisions in purpose groups depart from those given in Key Table 1. They relate to potential fire size and are considered necessary for property and business protection.

4 With respect to purpose groups 2, 3, and 5, buildings less than 20m high: when compartment walls are provided to limit compartment to a size specified in Key Table 4 they need only have fire resistance specified for elements of construction in Key Table 2.

5 The two levels of fire resistance given for factory buildings for both sprinklered and unsprinklered situations is in recognition of the considerable range of fire loads that exists in different factories.

LPC Rules for Automatic Sprinkler Installations incorporating BS EN 12845, Fire Protection Association, 2003.

KEY TABLE 4. Guide to maximum recommended compartment floor areas in single and multi-storey buildings. These maximum recommended compartment floor areas are intended for general guidance only and may be varied dependent upon more precise information on occupancy, trade and processes, leading to a risk assessment. More specific advice is provided in premises-specific sector guides which form part of this design guidance. Insurers must be consulted at the earliest possible opportunity.

Purpose group	**Floor area of any one compartment (m^2)**	
	Not sprinklered	Sprinklered
1a Residential (domestic) Apartment	Not covered in this design guidance	Not covered in this design guidance
1b/1c Residential Dwelling house	Not covered in this design guidance	Not covered in this design guidance
2a/2b Residential Institutional and other residential including hotels	No recommendation other than hotels should be limited to 4000	No recommendation other than hotels should be limited to 8000
3 Office	4000	No recommendation
4 Shop and commercial	2000 2000 (multi-storey limit)	8000 4000 (multi-storey limit)
5 Assembly and recreation	4000 2000 (multi-storey limit)	8000 4000 (multi-storey limit)
6 Industrial - all hazard groups[1]	5000	10000
7a Storage and other non-residential[1, 2]	4000	8000
7b Integral car park for light vehicles	Not recommended	8000 4000 (multi-storey limit)

1 There may be specific limitations on floor area under other legislation, for example in respect of storage of LPG and certain chemicals.

2 Extends to other occupancies where the risk assessment reveals a high fire load arising from storage incidental to the main purpose group.

KEY TABLE 5. Compartment walls and floors - recommended fire resistance levels (References are to Key Table 2 (KT2) or Key Table 3 (KT3).)

Wall/floor	Appropriate table for specified fire resistance		Walls/floor openings – fire resistance (% of value given in Key Table 2 or 3)	
	Structural frame	Walls/floor[3]	Integrity	Insulation
COMPARTMENT WALLS				
Between different occupancies and/or ownership	KT3	KT3	No openings allowed except insulating security doors fitted with an emergency egress device for means of escape. Such doors should provide 100% integrity and insulation.	
Between different purpose groups	KT3	KT3	100%	100%
To restrict compartment sizes	KT3	KT3	100%	100%
Between high hazard or high value at risk[1]	KT2 or KT3[2]	60min minimum	100%	100%
COMPARTMENT FLOORS				
Between different occupancies or purpose groups	KT3	KT3	100%	100%
Between floors in same purpose group	KT2	KT2	100%[4]	100%[4]
Separating high hazards or values[1]	KT2or KT3[2]	60min or KT2 whichever is greater	100%[4]	100%[4]

1 See Appendix to *FPA Design Guide: Fire compartmentation.*

2 Where the high hazard or value is on an upper floor, the fire resistance of the wall or floor and its structural frame should not be less than 60min. If Key Tables 2 or 3 specify higher levels of resistance the values in the tables will apply. It will not be permissible to reduce the level of resistance to less than 60min even in buildings which are sprinkler protected. The floor areas given in Key Table 4 are not applicable to this type of subdivision and advice should be obtained from the insurer.

3 Loadbearing walls and floors should satisfy the loadbearing capacity, integrity and insulation criteria for a period equal to the fire resistance specified in the appropriate table. For non-loadbearing compartment walls, they should satisfy the integrity and insulation requirements for the required period.

4 For doors installed in vertical shafts (lift-shafts, stairwells etc), only 50% of the fire resistance specified in this table for floors is required (but see Fig. 3(b) for further discussion). The walls making up the shaft shall maintain their loadbearing capacity for the same duration as the floor, but may have levels of integrity similar to those of the doors.

PART 1: THE PROTECTION OF OPENINGS

Fire-resisting doorset or shutter assembly

A doorset or shutter assembly, of any design and construction which, when tested to methods 6, 7 or 8 given in BS 476: Part 22:1987 or when tested to BS EN 1634: Part 1, provides the specified level of fire resistance and any other requirements of this book, as appropriate to its design and use. The doorset or shutter may be insulated or uninsulated.

BS 8110: *Structural use of concrete:* Part 1: 1997: *Code of practice for design and construction.*

Doorset

A complete, factory-produced door unit, comprising its frame, the door itself, stops, architrave and hardware.

Compartment wall

A loadbearing or non-loadbearing vertical fire-resisting wall designed to contain a fire within an area for a predetermined duration in order to minimise the risk of fire spread.

Compartment floor

A horizontal, fire-resisting floor designed to contain fire within an area for a predetermined duration in order to minimise the risk of fire spread.

In the United Kingdom, the national accreditation body is the United Kingdom Accreditation Service (UKAS); the Loss Prevention Certification Board (LPCB) is an example of a third-party certification body.

1. General construction, design and use considerations

- It is an insurance and legal requirement that doors in compartment walls or floors be maintained in efficient working order.
- It is preferred that fire-resisting doorsets be fitted with automatic self-closing capabilities to return them to the closed position after each operation, except for cases such as plant room or cupboard doors which are maintained permanently closed and locked.
- It is also important that the travel paths of doorsets and shutter assemblies are kept free of goods that might obstruct their operation and that their operation (including that of any automatic release and self-closing devices fitted) is regularly checked.
- Door openings used for the passage of fork lift trucks and similar traffic should be designed with adequate protection, for example, bollards or recessed guides, to prevent mechanical damage to the doorset/shutter assembly, frame and wall opening.
- Where there is a potential risk from flowing hazardous liquids, the floor of the compartment should be dished or all door openings should be provided with ramped raised sills to contain such liquids in the building on fire.
- Products shall be carefully selected to reflect the intended activity and frequency of use expected in the building.

2. Fire-resisting and/or smoke control doorset and shutter assemblies

(The following sections deal principally with design considerations. For additional, technical information about doorsets and shutter assemblies, see Appendix A.)

2.1 Construction of the opening

It is assumed in setting these sizes for doors or shutters that the opening into which the assembly is fitted is formed by the use of a lintel that complies with BS 8110 for the appropriate fire resistance duration. If an alternative form of construction is used the lintel, together with any applied fire protection, shall have a proven level of fire resistance at the intended span when taking into account the attachment of the door or shutter assembly, and any loads applied under normal conditions.

2.2 Doorsets and shutter assemblies

This section describes the performance requirements of doorsets and shutter assemblies that may be installed in compartment walls, shafts or enclosures around openings in compartment floors. The designer seeking more information about the principles of fire compartmentation should refer to the companion volume in this series, *FPA Design Guide: Fire compartmentation.*

Examples of types of fire-resisting doorset and shutter assemblies covered by this Design Guide are shown in Table 1, which also gives typical applications.

The functional requirements for such doorsets and shutters are expressed in terms of performances in respect of the criteria, where given, in BS 476: Part 22 or BS EN 1634: Part 1 and BS EN ISO 13501: Part 2 for fire resistance, and BS 476: Part 31.1 or BS EN 1634: Part 3 for smoke leakage control, together with any additional requirements which may be specified in this guidance.

This section also deals with:

- requirements for escalator roller shutter doors installed in enclosures surrounding openings in compartment walls and floors;
- closures for conveyors, used for the protection of openings in compartment walls or floors where mechanical transport systems pass through;
- lateral shutters, which meet the requirements for uninsulated doors given in section 3.

BS 476: Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction;* Part 31.1: 1983: *Methods for measuring smoke penetration through doorsets and shutter assemblies. Method of measurement under ambient temperature conditions.*

BS EN 1364: *Fire resistance tests for non-load bearing elements,* Part 1: 1999: *Walls;* Part 3: 2000: *Smoke control doors and shutters.*

BS EN ISO 13501: *Fire classification of construction products and building elements.* Part 2: 2003: *Classification using test data from reaction to fire tests excluding ventilation services.*

Table 1. Typical applications for various types of fire-resisting doorsets and shutter assemblies. For more information about types and applications of doors, see Appendix A.

Door type	Typical application	Purpose groups
Hinged or pivoted timber and mineral cored, timber faced doors	Means of escape, access compartment walls and shafts	All purpose groups covered in this design guidance
Hinged steel doors	Means of escape, access compartment walls and shafts	All purpose groups covered in this design guidance
Roller shutter doors[3] and lateral shutters	Access only, not means of escape[1, 2]	Shop and commercial; retail warehouses and superstores; industrial; storage
Folding shutter doors	Access only, not means of escape[1]	Industrial; storage; commercial; retail
Sliding doors	Access only, not means of escape[1]	Industrial; storage; commercial; retail
Lift landing doors	Access to lift cabin (outer door)	All multi-storey buildings
Escalator shutters	Floor openings	Floors in same purpose group only
Conveyor closures	Conveyor and other mechanical transfer systems	Industrial; storage

1 As the recommendations in this guidance are for all doors to be fitted with automatic door closers (8.3) (other than those which are kept in a closed and locked position), this type of door may be considered suitable for access through compartment walls but may be unsuitable for protecting means of escape.

2 Power operated vertically moving products, such as rolling shutters, may be used to provide a dual role of smoke barrier and fire resistance on means of escape routes. For the purpose of smoke control they initially close only to a height of not less than 2.0m, following which they fully close to effect fire resistance only after local heat detection, for example by a fusible link.

3 It is assumed that, as appropriate, shutter operation is fully integrated with automatic smoke and heat detection systems.

Conveyor closure

A device or system that in the event of a fire will close automatically and seal the openings in compartment walls or floors provided for the passage of goods on conveyor systems that when tested to BS 476: Part 22: 1987 or to BS EN 1366: Part 7 satisfies the appropriate fire resistance and other requirements of this design guidance.

BS EN 1366: Part 7: 2004: *Conveyor systems and their closures.*

Lateral shutter

A door comprising a horizontally moving curtain primarily used for closing off large openings such as occur at the entrance to individual shops or for atrium protection normally in shopping centres.

2.3 Sizes of doors and shutters (see also Appendix, A1)

- It is quite rare for the sizes of doors and shutters required in practice to be identical to the sizes of the specimens used for fire resistance testing.
- Consideration must be given to the proof of conformity requirements for fire-resisting doorsets and shutter assemblies when detailing products for use on openings in compartment walls which differ from the tested specimen size.

The influence of size on the fire resistance of doorsets and shutter assemblies

Field of direct application

Specific rules given in BS EN 1634: Part 1 which permit the variation of sizes, details and/or material contents away from the tested specimen.

- Test results alone are not to be accepted as proof of conformity for doorsets and shutter assemblies which differ from the tested specimen size unless covered by the field of direct application of BS EN 1634: Part 1.
- Where the required sizes are beyond the field of direct application, an expert qualified assessment is required.
- The fire resistance classification of a fire door can be greatly influenced by its size. The degree of influence will generally be related to the levels of restraint applied to the leaf edges by the building hardware. The larger the leaf, or opening element, the greater is the potential distortion and, hence, the size of any through-gap that develops as a result. This can directly influence the integrity rating.

Maximum opening size

Field of extended application

Extent of approved variations in the construction based on calculation or best available knowledge and experience (expert judgement) which may in turn be supported by additional indicative testing. Variations covered are principally for larger sizes or arrangements/materials other than those incorporated in standard fire test specimens.

No door shall be installed in a size greater than tested unless a recognised, independent body has carried out an appropriate, extended field of application assessment.

Table 2 gives some indication of maximum recommended opening sizes for different types of door assemblies. These sizes are based on what has been deemed to be acceptable historically and by expert judgement. It is important to note that variations can be expected depending on the types of constructions into which the door is built. The figures given in Table 2 assume that the door is installed in a masonry or normal weight concrete construction. They may not be appropriate for other types of constructions, including aerated concrete block walls of mass less than 650kg/m^3. (Further information is given in section 9, 'Interaction with supporting construction'.)

2.4 Durability of doors and shutters

prEN 13916: *Fire resisting doorsets. Requirements and classification.*

BS EN 14013: *Smoke control doorsets. Requirements and classification.*

A door installed in a compartment wall in purpose groups 4(b), 6 or 7(a), shown in Key Table 3 should be retained in a permanently closed and locked position (that is, cupboard type doors) or shall be provided with an automatic closing mechanism capable of maintaining its performance for the life of the door. Durability of self closing shall be applicable to the type of use as defined in prEN 13916 and/or BS EN 14013.

Table 2. Recommended maximum allowable opening size of any single doorset or shutter assembly[3].

Door type[1]	Height (m)[3]	Width (m)[3]
Hinged/pivoted timber doors (single leaf)	2.8	1.1
Hinged/pivoted timber doors (double leaf)	2.8	2.2
Hinged/pivoted steel doors (single leaf)[2]	3	1.5
Hinged/pivoted steel doors (double leaf)[2]	3	3
Roller shutter doors[2]	7	10
Lateral-operated shutters[4]	5	30
Folding shutter and industrial lift doors[2]	7	7
Sliding doors[2]	4	4
Lift landing doors (non-industrial)	3	3
Closures for conveyors	1.5	3
Escalator shutters	Max width 5m	Max length 15m

1 For specific requirements see Appendix A.

2 For uninsulated doors where there is no sprinkler protection, the safe distances are given in Fig. 1.

3 These limits are for guidance. It is essential to establish by assessment the integrity, insulation or radiation performance of the specific assembly when installed in a particular form of compartment wall construction. The limits may be exceeded where manufacturers have obtained certification for larger dimensions. This will require also consideration of the following circumstances:

- for insulated doorsets, any increase in dimensions shall be substantiated by an independent assessment, undertaken to confirm that the integrity requirements will still be satisfied and that the door continues to satisfy the insulation requirements in full.
- for uninsulated doorsets, some increase in dimensions may be acceptable based on product certification and also when double doors are installed. This is subject to an independent assessment being undertaken to confirm that the integrity requirements will still be satisfied and that the distance from combustible materials is not less than given in Fig. 8.

4 Recommended maximum size subject to risk assessment by insurer on an individual case for case basis.

Effects of door type on maximum size

- Door leaves forming part of hinged or pivoted side-hung doorsets, distort under heating either as a result of differential shrinkage or expansion. The degree of such distortion is normally a function of leaf size, construction and the restraint at the perimeter of the leaf.

2.5 Types of doors, proposed uses and approved sizes

- Some guidance on the applicable field of direct application for different door types is given in BS EN 1634: Part 1, on which the following advice has been based.

Hinged or pivoted timber doorsets (see also Appendix, A2)

- The performance of timber doors is inter-related to the height and width ratio of the door leaf for any particular mode, configuration, hardware/ironmongery and seal combination and this relationship is frequently expressed in the form of an 'envelope' of approved sizes.
- Such an 'envelope' is given in section B8 of the Appendix and when checking whether a particular size of door is approved it is important that it lies within the envelope of approved size.
- These envelopes are generated taking into account both the direct field of application and, when appropriate, also the extended field of application which may be based on the results of additional testing.

Insulated door

Insulated doors can typically be either of timber construction, generally up to 60 minutes fire resistance, or of a timber faced, and possibly lipped, mineral cored and/or framed construction, or be of an insulated steel faced flush door or a metal framed stile and rail construction incorporating insulating glass. In all cases the cotton pad integrity test shall always be used to establish the integrity of the construction regardless of the method of manufacture.

Hinged or pivoted metal doorsets

- For uninsulated steel doorsets the increases which may be permissible for height and width dimensions will generally be larger than those for insulated steel doorsets, since in the latter case there is a greater risk of reducing the integrity rating as a result of differential distortion.
- It is not normal to express the size limits for steel doors by means of an envelope of approved size.
- Additional door hardware may be required to control distortion in larger door assemblies.
- It is therefore more important for the largest possible practical size of door to be used for testing purposes, than it is for timber doors.

Hinged and pivoted glass doors (fully glazed fire doors)
(further guidance is given in the Appendix, A4)

- The tendency to use greater areas of fire-resisting glass in buildings means that fire-resisting doors are also having to respond to this need.
- In most cases the use of such doors will be restricted to the construction of protected stairways and corridors as part of the means of escape provision.
- There is a potential in medium to high rise, multi-occupancy buildings, however, to use them as access doors between the protected shaft and the business in question.

Industrial type door/shutter assemblies

- Industrial type door/shutter assemblies are normally for larger openings which cater for vehicular and/or pedestrian traffic.
- Within the overall range, the selection of uninsulated or insulated products is dependent upon individual site risk analysis establishing the safe distance requirements for each opening.
- If compartments on the fire risk sides of openings are protected by sprinklers there is no requirement for safe distance protection, and on the protected sides of such locations uninsulated products are acceptable without the application of safe distance control. See Appendix B2.
- The maximum sizes for uninsulated doors are based on extrapolation rules for lateral expansion and deformation of homogeneous materials.
- Calculating extended field of application suitability for radiation control products requires safe distance evaluations for the full range of applicable sizes.
- Extended application for insulated doors is normally based on results of more than one test on model specimens.

Uninsulated doorset

An insulated door does not possess the ability to rstrict the rise of temperatures on the non-fire side of the door which would result in fire being transmitted only when integrity fails. that is, it does not restrict the passage of conducted and radiated heat in the manner of an *Insulated door.*

3. Fire resistance performance of uninsulated doors

3.1 General

Uninsulated doors or shutter assemblies, that is, those evaluated by means of the procedures given in clause 8 of BS 476: Part 22 or to BS EN 1634: Part 1, can reduce the effectiveness of a fire-resisting wall as a result of:

- loss of integrity
- heat transfer by means of conduction

BS 476: Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction*

BS EN 1364: *Fire resistance tests for non-load bearing elements,* Part 1: 1999: *Walls.*

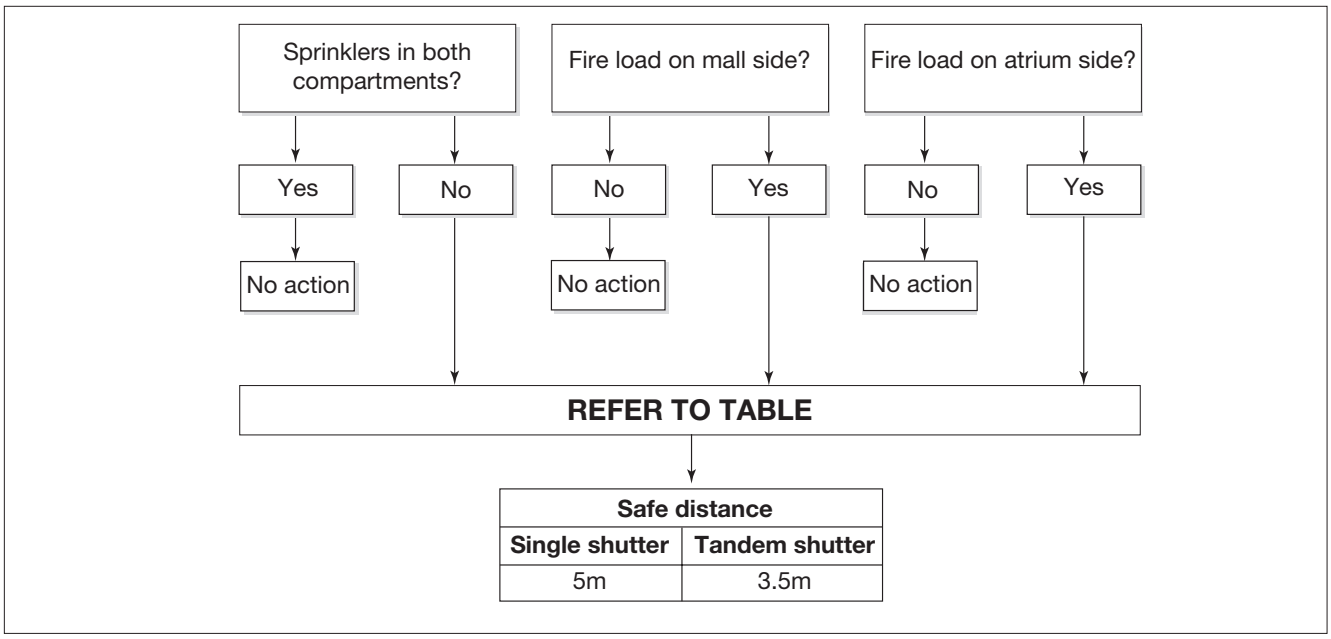


Fig. 1. Gauging safe distance from an uninsulated door which separates two compartments in which combustible materials are stored. (Notes: (a) assume the area of the door is 49m^2; (b) as an alternative to this guidance a fire engineering analysis can be adopted.) Reference should be made to Appendix B2, where advice is given on the calculation of safe distances.

- heat transfer by means of radiation.

Since door assemblies are moving elements the likelihood of fire spread as a result of conduction is effectively ignored in the FPA *Design Guide,* as it is in UK fire legislation, since combustible materials should not be in contact with them.

Uninsulated doors are only permitted when there is no risk of combustion on the non-fire side of the particular site installation. Consider the following examples by reference to Fig. 1, where a door may:

- separate a mall from a department store where there is no fire load on the mall side;
- separate a particular floor from an atrium where there is no fire load on the atrium side;
- separate two compartments each with a fire load that is protected by sprinklers.

Note: Redundant uninsulating door assemblies must not be allowed to be treated as other parts of the structure which should meet the insulation requirement, for example, as compartment walls. No combustible goods shall be permitted to be stored in contact with such doors after they have become redundant and safe storage distances shall continue to be observed. It is always preferable that such redundant door openings be infilled to provide fire resistance similar to the surrounding construction.

3.2 Requirements: integrity

The door or shutter assembly shall provide the integrity rating appropriate for its intended position and use (see Key Tables 3 and 5), and as determined by the methods described in clause 8 of BS 476: Part 22 or BS EN 1634: Part 1.

4. Fire resistant performance of insulated doors

4.1 General

Insulated doorsets or shutter assemblies, that is, those evaluated by means of the procedures given in clause 6 of BS 476: Part 22 or in BS EN 1634: Part 1, provide higher levels of effective fire separation than uninsulated doors for the period of classification through to when they fail the integrity criteria.

4.2 Requirements: integrity and insulation

- The door assembly shall provide the integrity and insulation rating appropriate for its intended position and use when evaluated in respect of clause 6, of BS 476: Part 22 or BS EN 1634: Part 1.
- Where glazing is required to be greater than 10% then the glazing panel must be tested as part of the specimen and allowable sizes must be within those permitted by the field of direct application from BS EN 1634: Part 1.

5. Smoke control doorsets and shutter assemblies

5.1 General

Smoke control can be an additional classification feature for fire-resisting doors or can be a stand-alone feature for certain doors, which do not need to possess fire resistance. Smoke control is a property of the door assembly and not just of the seal since there are many routes for smoke leakage in a door assembly.

5.2 Requirements: smoke leakage control

- All timber and mineral cored and steel single and double leaf hinged or pivoted doors that enclose areas of special risk or high value, as identified in the Appendix of *FPA Design Guide: Fire compartmentation,* should be able to restrict passage of cold smoke. As far as is practical these shall not exceed the specified level of leakage for smoke at ambient temperature of $3m^3/h.m$ at a pressure of 25Pa when tested in accordance with BS 476: Part 31.1 or BS EN 1634: Part 3.
- In order to achieve the specified level of leakage (see above) all leaf frame perimeter seals need to be fitted almost continuously and all apertures in the leaf/shutter (for example, glazed openings) need to be sealed with a suitable sealant.
- A threshold seal should be fitted to assemblies bordering large spaces since smoke cooling and falling will take place and smoke may penetrate the gap at the base.
- Information on the selection and installation of smoke seals is given in the Intumescent Fire Seals Association (IFSA) Information Sheet No 3, *Guide to the Use of Smoke Seals in Doorsets.*

Smoke leakage control door

A doorset or shutter assembly to meet the requirements of BS EN 1634: Part 3, which may or may not be fire resisting, which is provided to reduce smoke leakage from the room of origin. (The ambient temperature smoke door is designed as a back-up provision.)

Intumescent Fire Seals Association, IFSA Information, Sheet No 3, *Guide to the Use of Smoke Seals in Doorsets.*

6. Additional requirements for specific door types

All doorsets installed in compartment walls for the purposes of providing fire resistance and/or smoke control in accordance with this guidance shall satisfy the relevant requirements given in the preceding sections. Further explanation or technical guidance may be found in Appendix A for:

- hinged/pivoted timber doorsets;
- hinged/pivoted metal doorsets;
- hinged/pivoted glass doorsets (fully glazed fire doors);
- vertical roller shutters/laterally opening shutters;
- folding shutters;
- sliding doors.

Additional specific requirements for each particular type of door are given in the following subsections.

6.1 Doors installed in vertical shafts

Doors installed in vertical shafts (lift shafts or stairways) should have fire resistance in terms of integrity of not less than 50% of the values given in Key Tables 2 or 3 for compartment floors (subject to a minimum fire resistance of 60min). This 50% value is based on the fact that the aggregate of fire resistance into the shaft and fire resistance out again from the shaft into the compartment above equals the fire resistance required for the compartment floor. It is important that the door has been tested separately from each side to ensure compliance with the recommendations of this guidance, unless an obvious weaker side is identifiable.

6.2 Lift landing doors

The door should have a fire resistance of not less than 50% of the values given in Key Tables 2 or 3 and should meet the requirements of LPS 1056 (or an equivalent standard).

LPS 1056, *Requirements and tests for fire doors, lift landing doors and shutters.*

6.3 Escalator shutters

Where escalator wells are to be protected by escalator shutters (see Fig. 2) such shutters shall meet the requirements of LPS 1056 (or equivalent). The safe distance for combustible materials is dependent on the height, width and construction of the balustrades. Serious consideration should be given to the use of insulated balustrade constructions if combustible materials are likely to be placed alongside the balustrade of the escalator shutter.

The uninsulated lath will radiate heat towards the ceiling and combustible items must be excluded from the area above the protected opening. The end of the uninsulated shutter curtain passes down to the floor, normally across the walkway, and no storage is envisaged to be in close proximity to this part of the door.

An example is given in Fig. 2.

Conveyor closure

A device or system that in the event of a fire will close automatically and seal the openings in compartment walls or floors provided for the passage of goods on conveyor systems that when tested to BS 476: Part 22: 1987 or to BS EN 1366: Part 7 satisfies the appropriate fire resistance and other requirements of this design guidance.

6.4 Conveyor closures

- It is important to ensure that if a fire occurs, combustible goods which may be on a conveyor that passes through a compartment wall cannot be ignited or cause an ignition on the non-fire side by

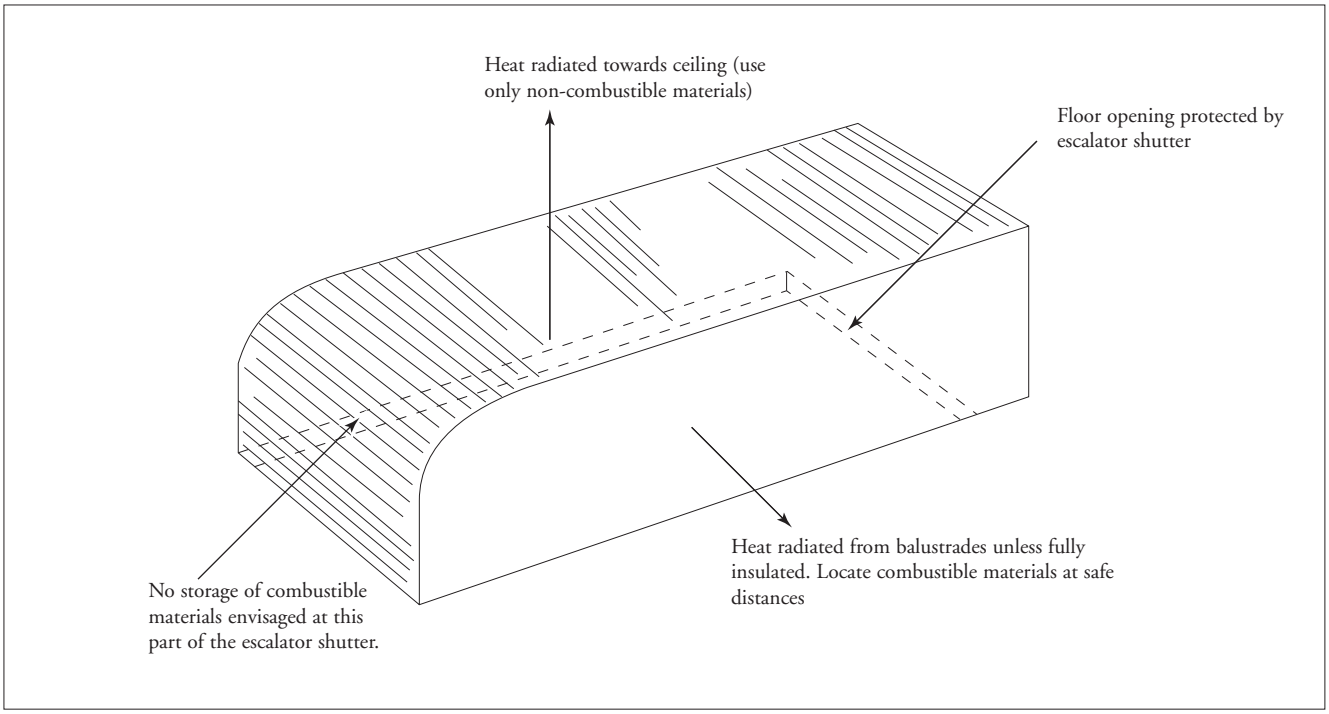


Fig. 2. Escalator shutter.

allowing fire spread along a belt, for example. It is strongly recommended that any closure equipment should include a method to ensure that the opening in the wall or floor is not closed until the aperture is clear of goods. Closures that operate from a fusible link system are unable to meet this requirement. Closures shall satisfy the integrity requirements specified in Key Table 3 and insulation for not less than 60 minutes with respect to BS 476: Part 22 or BS EN 1634: Part 1 and BS EN 1366: Part 7. If this preferred option is not possible, the following options should be considered:

1. Two uninsulated closures may be used, arranged not less that 1.5m apart in a fire-resisting enclosure. This enclosure should be constructed from non-combustible materials and have a fire resistance in terms of integrity or insulation of not less than 50% of the compartment wall or floor.
2. A mechanical device to ensure that items on the conveyor on the non-fire side shall be kept away from the immediate area of the opening in the event of a fire being detected.

BS EN 1366: Part 7: 2004: *Conveyors systems and their closures.*

Non-combustible

A material may be considered to be non-combustible if it satisfies the requirements for non-combustibility when tested in accordance with BS 476: Part 4 or Part 11, that is, it does not flame and there is no rise in temperature on certain specified test thermocouples.

Smoke barrier

A doorset or vertical dropping shutter assembly with a two-stage operation, to meet the requirements of prEN12101: Part 1, which may or may not be fire resisting, which prevents the free uncontrolled spread of buoyant smoke.

LPS 1182: Issue 2: 1994: *Requirement and tests for LPCB approval of fixed fabric smoke curtains, fixed metal smoke curtains and powered smoke curtains.*

7. Smoke control barriers

- Industrial doors that are required to enclose areas of special risk or high value (as defined in the companion document *Fire compartmentation*) but are too large to test, should be constructed in such a way to restrict the passage of smoke. Such door/shutter assemblies should be tested to prEN 12101: Part 1 to meet the requirements of LPS 1182 (or an equivalent standard).
- Power-operated fire-resisting rolling shutters may be utilised to perform a dual role, (1) as smoke barriers (when closed from receipt of a smoke signal down to a clear height of say 2.0m, thereby allowing pedestrian exit), and (2) additionally to provide fire resistance when eventually closed fully following release after local heat detection.

8 Door hardware

8.1 General

The selection of door hardware should not be ruled by cost alone. For most of its life door hardware is required to perform the simple function of allowing passage through an aperture in a wall or partition. But it should also perform a key role in ensuring the reliable closure of the opening in the event of fire.

Hardware fitted to fire-resisting doorsets and shutter assemblies falls into two categories:

Essential hardware

Hardware that ensures that the leaf/leaves or curtains are retained in position during the fire and is essential to the achievement of the fire resistance classification; and

Non-essential hardware

Hardware that is fitted to an assembly in order for it to provide its normal use function but which makes no contribution to its fire resistance, for example, an overhead closing device fitted to a latched door. Non-essential hardware may have a negative influence on the fire resistance and must be evaluated for such before fitting.

Any change in the selection of hardware, whether 'essential' or 'non-essential', can have a serious effect on the performance of the assembly. In the case of hinged or pivoted doors, for example, the type, design, number and location of latches, hinges, restraints or pivots can drastically influence the performance.

8.2 Selection of hardware

When establishing the suitability of an item of hardware which is different from that tested it is important that any item of 'essential' hardware is able to make an equivalent level of contribution and that any 'non-essential' item will not negate the fire resistance by failing prematurely. Latches and/or lock units which contain low-melting-point or even flammable components are likely to ignite; closing devices which incorporate flammable damping fluids and are fitted fitted to the protected faces of non-insulating doors can also 'burst', resulting in ignition of the fluid. It is important that such matters are considered at the time of specification so that only alternatives with tested or assessed performance are used.

All door furniture for timber and mineral cored doors, including edge seals, should be subjected to third-party appraisal to determine its suitability for the intended application (for example, by a competent, nationally accredited organisation in accordance with their current technical schedules or equivalent).

Door furniture for industrial doors and all steel doors shall be restricted to that used in the fire test, or equally certificated under an approved scheme.

As a consequence, any substitution of hardware or modification of its position on the door should be verified by alternative test evidence on an identical type of assembly. Alternatively, a qualified assessment, based on fire engineering principles which evaluates that the fire resistance of the door will still be maintained, is acceptable.

Additionally, it is important that test data is available to show that the hardware is able to meet the cyclic requirements given in Table 8 (see Appendix, A2). All items should satisfy the appropriate British Standard (BS) or prEN equivalent, which invariably specifies the cycling test requirements. The category appropriate to the intended use given for the assembly in Table 8 should be used when specifying. The mechanical strength of critical items of door hardware such as latches should not be less than that of those items installed in the fire test specimen. This is particularly critical for hinged steel doors.

Door closer

A type of self-closing device fitted to the face or edge of a hinged doorset and its frame to ensure that the door automatically returns to its closed position each time it is used.

BS EN 1154: 1997: *Building hardware. Controlled door closing devices. Requirements and test methods.*

8.3 Door closers

All hinged or pivoted doors which are installed in compartment walls but are not permanently retained in a closed and locked position, should be fitted with a controlled self-closing device, which incorporates a latching action, whether or not the door is on an escape route. All overhead self-closing devices shall meet the requirements of BS EN 1154: 1997, plus amendments A1: 2001.

Release mechanism

A series of links or control devices capable of holding open and releasing a fire-resisting or smoke control doorset so as to close automatically on receipt of a signal of a fire.

BS EN 1155: 1997: *Building hardware. Electrically powered hold-open devices for swing doors. Requirements and test methods.*

8.4 Electromagnetic hold open and release mechanisms

Any door installed in a compartment wall which, for convenience, needs to be held open during normal use shall be fitted with an automatic release mechanism, which is connected directly to a detector belonging to an automatic fire detection and alarm system. (Such a system will comply with BS 5839: Part 1: 2002.) The mechanism should comply with the requirements of BS EN 1155:1997 plus amendments A1: 2001. All such mechanisms shall be capable of release during the absence of mains power supplies. Hold-open devices, which require manual release, shall not be fitted.

Release mechanisms based solely on heat detection (such as fusible links or quartzoid bulbs) are permitted providing the sensing device is installed in an appropriate position adjacent to the door opening.

8.5 Power operated doors or shutters

Where the fire resistance testing of a product is completed on a specimen without any drive unit fitted, or with an externally mounted drive unit fitted, then only externally mounted drive units can be applied. The incorporation of tubular motors for rolling shutters is not permitted unless specifically tested as part of the original specimen or in an additional test. Each alternative tubular drive will need to have supporting test evidence.

prEN 13916: *Fire resisting doorsets. Requirements and classification.*

BS EN 14013: *Smoke control doorsets. Requirements and classification.*

These shall meet the requirements of the Workplace (Health, Safety and Welfare) Regulations 1992 and prEN 13916 or BS EN 14013.

8.6 Air transfer grilles

Air transfer grille

Non-ducted grille installed in doors or partitions to allow air to transfer naturally from one room or zone to another without connection to a mechanical ventilation system.

Where a fire-resisting door assembly needs to incorporate an air exchange grille this shall not compromise the fire resistance of the assembly. This type of product shall be approved to LPS 1256 (or an equivalent standard). The grille, normally consisting of a matrix of intumescent materials, shall have evidence of performance to demonstrate that it satisfies the relevant criteria in the position in which it is to be installed and in a door of similar, or even, identical construction. The grilles may not adequately prevent the flow of cold smoke and therefore should not be used in doors protecting areas of special risk or high value as defined in the companion publication *Fire compartmentation.*

8.7 Other recommendations

All industrial doors shall, as a minimum, be fitted with a release mechanism, see 8.4. As far as possible, it is recommended that such doors are additionally fitted with an automatic self-closing device, connected to a smoke detector. In such cases the operation of the released door must be safe in accordance with prEN 13916 or BS EN 14013.

- Whenever possible, double doors (fitted in tandem), and having automatic self-closing devices, should be arranged to close simultaneously.
- All hinged, rebated double leaf doors fitted with any type of self-closing mechanism must close in the correct sequence, and the control device shall not reduce the integrity of the assemblies.
- Automatic closing devices or systems should not interfere with the normal opening and closing of the door(s) or shutter(s)

Self-closing device

A device or mechanism to be attached to or be part of a fire-resisting doorset or shutter assembly which provides a return to the closed position. Rising butt hinges are not permitted.

9. Interaction with supporting construction

The performance of a fire door assembly can be substantially affected by the type of supporting construction into which it is installed and by the method of fixing the door to the wall, since this will influence the restraint available to resist deflection/distortion. Any deviations from the fixing specification tested shall be the subject of a qualified assessment based on an extended-field-of-application analysis or an additional fire test.

With respect to masonry or concrete walls, it is generally accepted that the following rules apply:

- A test result obtained for a non-insulating fire-resisting doorset or shutter assembly tested in a wall made of masonry or concrete (without any cavity) is applicable to the same type of supporting construction with a thickness and density equal to or greater than that of the supporting construction used for the test. However, this rule is only applicable if the method of fixing provides the same degree of fixing used in the test. This may not always be the case, as a fixing suitable for clay bricks may be unsuitable when used for aerated concrete. Any deviations from the fixing specification tested shall be the subject of a qualified assessment based on an extended-field-of-application analysis, which may require that an additional fire resistance test shall be undertaken.
- Decreasing the density of masonry or concrete from that which was tested can reduce the insulating character of an insulated door assembly or affect the rigidity of the fixing technique and should only be permitted following an analysis of the influence such a change will make.
- Doorsets or shutter assemblies tested in masonry or concrete walls shall not be installed in dry lined, stud construction walls (since they do not have the same strength or thermal characteristics), unless additional tests have been completed with the door installed in such systems. Similarly, if a fire door has only been tested in a dry lining system, it cannot be assumed that a similar result will be achieved if it is installed in a masonry or concrete wall. When installing insulating metal doors the influence that the supporting construction

Supporting construction

Any rigid or flexible type of wall construction which is capable of supporting a fire-resisting doorset or shutter assembly.

Qualified assessment

An assessment based on fire engineering principles and/or guidance, which has been prepared by a nationally accredited, competent body.

will have is more complex and in all cases the influence of a significant change in the wall type will need to be covered by a qualified assessment. Timber frames are less likely to be affected by such changes.

- In the case of doorsets or shutter assemblies tested in dry lining systems, a qualified assessment will be required when any deviations from the system tested are undertaken except when the deviation consists only of adding additional linings.
- Industrial type doors may be fixed directly to protected steelwork constructions provided:

  - any expansion provisions required for the door assembly are still incorporated; and

  - the steelwork is protected to at least the same fire resistance as that required for the door and compartment wall. The fixing of fire-resisting industrial doors to unprotected steel is not permitted.

Unless all the above requirements are implemented a premature loss of integrity may occur and the appropriate level of fire resistance may not be achieved.

10. Installation, marking and labelling

- All products shall be installed by a competent installer who is certificated under a recognised third-party installer scheme;
- all fire-resisting and smoke control doorsets and shutter assemblies shall be marked to signify conformity with a recognised third-party product certification scheme and a third-party installation certification scheme.

11. Operation, inspection and maintenance of door and shutter assemblies

- All fire-resisting and smoke control doorsets and shutter assemblies should close immediately after use;
- where such doors are required to be left open during times of occupancy they shall be fitted with an automatic closing device to close them in case of fire and preferably should be closed during periods of non-occupation. (See sections 8.3, 8.4.)
- doors, shutters and other forms of closures, together with their frames, shall be regularly inspected and serviced in accordance with the manufacturer's recommendations and with any conditions imposed in respect of the product by the certification authority;
- non-metallic hinged doorsets should be maintained in accordance with the recommendations given in BS 8214.

BS 8214: 1990: *Code of practice for fire door assemblies with non-metallic leaves.*

12. Fire-resisting glazing and glazed screens

- All fire-resisting glazing incorporated in compartment walls should be independently certified to meet the requirements of a recognised third-party certification scheme.
- Part C of the Appendix contains detailed information on the various types of glasses and the factors that can influence the performance of glazing under fire conditions.

12.1 Types of glasses, frames and glazing systems

- Fire-resisting glazed screens and windows are permitted in compartment walls subject to compliance with the fire resistance requirements specified in Key Tables 2, 3 and 5 as appropriate;
- insulated glazing should be used when the recommended safe distances cannot be complied with;
- there are limitations on the sizes of glazed screens and windows and in every case this must be confirmed by the field of application derived from LPS 1158 (or an equivalent) for the system to be used or by reference to the test evidence for the type of glass, framing and glazing system to be used. (In the absence of such evidence, expert independent analysis must be sought to establish the maximum pane and screen size acceptable.);
- framing materials will normally be restricted to the use of timber and steel but other materials may be acceptable subject to compliance with LPS 1158 (or an equivalent standard) and satisfactory test evidence.

Fire-resisting glazed screen assembly

An assembly of glass panes, mounted in a steel or timber frame, which when installed forms part of a fire compartment wall, that when tested to method 10 of BS 476: Part 22, provides the required fire resistance and meets the requirements of LPS 1158 (or equivalent) and in addition any other requirements of this design guidance.

BS 476: Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction.*

LPS 1158, issue 2, *Requirements and tests for fire-resisting glazing systems.*

There are two major categories of fire-resisting glass:

Non-insulating glass

Where the glass (both wired and non-wired types) is inherently conductive and monolithic in form and is able both to transmit and emit radiation from the unexposed face in significant quantities during fire exposure.

Insulating glass

Where a multi-layer glass incorporates transparent materials that, in the event of a fire, become active and significantly reduce the conduction and the ability of the glass to either transmit or emit radiant heat (some resin bonded laminated glass products may produce excessive smoke).

Each of these glass types can then be further categorised and further information is given in part C of the Appendix.

12.2 General design and use considerations

- It is essential that the use of glazed assemblies in compartment walls is supported by test certification or expert independent assessment against LPS 1158 (or equivalent) of the glass, framing and glazing system as a complete unit.
- No substitution of components is acceptable unless supported by appropriate test evidence or an independent expert assessment against LPS 1158 (or equivalent) of such components in a complete assembly.
- The type, thickness and maximum size of the glass, together with the type and dimensions of the framing and the bead profile of the glazing system used, are all critical factors. No changes to any of these features or to the shape or orientation of any glass from that contained in the tested sample, for example, horizontal to vertical, can only be made unless they are the subject of a new test or independent assessment of the complete glazed element to confirm that the fire resistance and, where applicable, insulation levels are maintained.

- Slumping of the glass due to high temperatures constitutes an integrity failure and must be avoided except to the extent permitted by the test or extrapolation given in the field of application. Reference should be made to part D of the Appendix to establish the important design parameters, such as the maintenance of a cool edge and/or clamping of the glazing in the frame.
- Attention should be given to the qualitative smoke tightness of the elements and methods of jointing of glazed screens in order to restrict or prevent the spread of smoke.
- Screens and windows should not be sited in positions where they may be susceptible to accidental damage unless appropriate precautions are taken.

See part D of the Appendix for further guidance.

12.3 Limits on opening sizes and fire resistance of glazed screen assemblies

Maximum size of individual glass panes/blocks

- The maximum size of any individual pane for any specific installation or requirement should be established by test, and information should be sought from the individual glazing manufacturer.
- Glass blocks may be used in walls up to the areas approved by the field of application given in the test standard or test report.

Maximum fire resistance of glazed screen assemblies

Table 3. Maximum fire resistance

GLASS TYPE	Fire resistance - integrity (min)	
	Timber framing	Steel framing
Georgian wired polished plate (GWPP) (integral wires)	60	60[1]
Laminated wired glass (non-integral wire)	30	30
Modified toughened soda-lime glass	30[1]	30[1]
Laminated clear glass	30	30
Borosilicate glass	60	120
Clear ceramic	60	240
Insulated laminated glass	60	60[2, 3]
Insulated gel glass	30	90[3]

1 These durations may be exceeded by gluing or pressure glazing the panes in position but these will require permanent marking in use as required in part D2 of the Appendix.

2 Although only stated as the maximum integrity rating, this may require an insulating frame to control deflection and prevent exhaustion of the active inter-layer near the edges.

3 Multiple panes in separate frames can be used to extend duration. At 90min, weight is an important consideration.

The recommendations given in Table 3 have been based on available information and the designer should establish with the specific manufacturer the appropriate fire resistance levels. Requirements for fire resistance levels are given in Key Table 5 which refers, as appropriate, to Key Tables 2 and 3. Fire resistance levels below 90 minutes have limited application in this guidance. The ratings are given for pane sizes not less than 1.2m^2 in area and these may increase significantly when used in small pane sizes. Restrictions imposed by the field of application of of test evidence given in LPS 1158, for example, shall be noted.

These durations are given in relation to single panes, individually glazed, and do not necessarily apply to all manufacturers' products. If the pane is sharing a framing member with an adjacent pane, or panes, then the duration may need to be reduced or a smaller pane size be used. For all durations over 30min there will inevitably be a maximum size allowed and a restriction on the aspect ratio except for clear ceramic glass. As the duration increases towards the 90min levels the pane size may be severely restricted and manufacturers' evidence of performance needs to be obtained and examined carefully. In timber framing the glazing system is critical for all 60min applications (see part D of the Appendix).

Maximum area (based on safe distances to combustible materials)

Subject to meeting any other requirements laid down in this guidance, there is no restriction on the use of glazed screens consisting of insulating glass fixed into insulated frames. Where the glass and the frame is uninsulated then the heat transfer to the protected area as a result of radiation can present a risk and needs to be restricted. Figure 3 (in Appendix, A4) gives guidance on the safe storage distance for various areas of non-insulated fire-resisting glazing.

This guidance is based on the area of the opening and the safe distance to combustible materials when glazed screens are installed in compartment walls. These distances exceed what may be regarded as safe for means of escape and are based on the assumption that the glazed screens do not form the boundary of an escape route.

12.4 Interaction with wall construction

The performance of a glazed screen or window can be substantially affected by the type of wall in which it is installed, together with the method of fixing the framing to the wall, because this influences the restraint available to resist deflection/distortion. With respect to masonry or concrete walls, it is generally accepted that the following rules apply:

- A test result obtained for a non-insulated glazed screen tested in a solid masonry or concrete wall is applicable to the same type of construction with a thickness and density equal to or greater than that used in the test.
- With an insulated glazed element the influence of any decrease in density of the surrounding construction must be taken into account when assessing the unexposed face temperature.
- In all cases the fixings used shall provide an equivalent level of restraint and fixity to that demonstrated in the test. Any change in the restraint level shall be the subject of an extended field of application analysis or an additional fire resistance test.
- Walls providing reduced levels of restraint may be acceptable when the glazed element incorporates a continuously framed surround which is independent of the wall into which it is installed. The risk of an integrity failure developing between this frame and the wall shall be the subject of an extended application analysis, as will the ability of the wall to restrain the glazed element.

12.5 Sprinkler implications

The maximum fire resistance currently achievable from common forms of fire-resisting glass is 120min and consequently this restricts its application in this guidance, particularly in respect of its use in compartment walls where 240min fire resistance is required, for example, in: non-sprinklered retail warehouses and superstores; industrial-ordinary hazard groups OH3 and OH4 and high hazard process; storage and other non-residential. Clear ceramic glass may however be used, subject to satisfactory performance in any personnel safety situations, as laid down, for instance, in Approved Document N to the Building Regulations 2000 (the current Regulations in England and Wales).

The Building Regulations 2000, Approved Document N, *Glazing – safety in relation to impact, opening and cleaning.*

The integrity of glazing systems in a sprinkler-protected fire compartment is not known, and, consequently, the use of glazing should be restricted to those glasses that are not sensitive to thermal differentials caused by water spray. It is considered that the following glass types will not be adversely affected by water spray in the early stages of a fire and may be used in the boundary of a sprinklered compartment, subject to compliance with the fire resistance levels specified in Key Table 2 or 3 and Key Table 5:

- integral wired, soda-lime glass (GWPP);
- glasses of borosilicate composition;
- clear ceramics;
- multi-layer insulating glasses (not less than 4 glass layers).

Other types of glass may be used if there is evidence to show that they are not adversely affected by the application of sprayed water on the fire exposed side either at the beginning or during the fire exposure period.

12.6 Durability of glasses

All monolithic glasses are stable and unaffected by moisture, temperature fluctuations or chemicals and as such are considered to be durable.

Laminated insulating glasses with clear intumescent interlayers are prone to humidity or moisture ingress problems which, while not necessarily reducing the fire resistance, may lead to them being considered to be aesthetically unacceptable. Such glasses should be edge sealed and then sealed in place by means of suitable impermeable sealants, for example, silicone, to prevent degradation by moisture.

Glass is a durable material and is unaffected by almost any conditions. The interlayers, particularly in intumescent glasses, are more likely to be degraded by the effects of moisture and chemical, but they are protected in all cases by the layer of glass on either side. Many gaskets are inert, for example, ceramic fibre glazing tape, but when active gaskets are used, for example, intumescent, then only those materials that have been shown not to degrade significantly during exposure to moisture or chemical should be used. If this is not possible then all gaskets shall be sealed with a silicone capping that shall be maintained in good condition.

Intumescent Fire Seals Association, IFSA Information Sheet No 4, *The Ageing Performance of Intumescent Seals.*

Some intumescent based glazing systems may be adversely affected by humidity and chemical attack and intumescent materials should only be used when supported by evidence showing that they are not prone to failure in use (see IFSA Information Sheet No 4 for further information).

12.7 Framing

The framing system, whether for a window or a glazed screen, is an integral part of the complete element and as such its specification is vital to the achievement of the desired fire resistance. Where possible the framing system should be of a tested design, supplied by the manufacturer in compliance with the tested specification and preferably either factory glazed, or glazed on site by the manufacturer's nominated installers.

Framing systems may be of timber for durations up to 60min, or be of steel sections or constructed from cementicious members for durations up to 240min, as appropriate. Framing systems shall comply with LPS 1158 (or an equivalent standard) and any additional requirements specified here. Restrictions imposed by the field of application of test evidence given in LPS 1158, for example, shall be noted.

It may be possible for the window or screen to be site-constructed to conform with a published specification but in all cases the glazing of such assemblies must be undertaken by trained staff because of the critical nature of fire-resistant glazing.

BS 6180: 1999: *Barriers in and about buildings. Code of practice.*

BS 5234: Part 1: 1992: *Partitions (including matching linings). Code of practice for design and installation.*

It is important that the design of any glazed screen or large window is able to withstand the appropriate loadings either in accordance with BS 6180: 1995, covering barrier loads, and/or BS 5234 and rated as Heavy Duty or better in respect of physical strength. Further information can be obtained from the Glass and Glazing Federation, www.ggf.org.uk.

12.8 Double glazed units

Double glazed units shall only be accepted if there is evidence of performance to support their use. In a fire if two panes of non-insulating fire-resisting glass are unvented the expansion of the air between the units can cause them to 'burst' during the early stages of fire exposure. This does not apply to integral wired glass, which will fracture and release the pressure in a double glazed unit in the first few minutes of a fire. When aluminium spacers are used between panes these will melt out leaving the panes loose in the glazing pocket, leading to a premature integrity loss and, even worse, a loss of the cool edge which is vital if extended periods of fire resistance are to be satisfied. Even when a pane of fire-resisting glass is incorporated in a double glazed unit with a non-fire-rated pane the unit may only achieve the claimed level of fire resistance in one direction, normally with the non-fire-resisting glass being sacrificial and facing the anticipated direction of fire attack.

12.9 Surface decoration

The use of applied decorative or security films is not recommended unless they have been shown by test not to compromise the integrity when affixed to the protected face. Etching of fire-resisting glass with logos or as a form of manifestation is not permitted on non-insulating, clear glasses. Etching of integral wired glass does not impair its fire performance.

12.10 Maintenance

Windows and glazed screens are fixed elements and, as such, do not require any conventional maintenance other than perhaps an annual check to ensure that all of the beads are firmly in place and any gaskets have remained undamaged. However, cleaning will take place and the excessive use of liquids may well damage intumescent materials or even some of the glasses that contain intumescent interlayers, and for that reason all cleaning schedules should use special cleaning materials or use only minimal amounts of water and be dried off before any gaskets can be adversely affected. During the cleaning process, particularly with unwired monolithic glasses, it is important that no scratches are caused by diamond rings or other sharp instruments as these may impair the fire resistance.

Any cracked or badly scratched glass shall be replaced immediately. If the glass and glazing system carries a metal plate then it is important that any replacement is done by competent installers because of the special needs that this plate will indicate.

PART 2: BUILDING SERVICES: THE PROTECTION OF SERVICES PENETRATIONS

Building services

Water, gas and electricity, air conditioning, heating, communications, drains etc for buildings, which are supplied or collected by pipes, ducts and cables.

BS 5588: Part 9: 1999: *Code of practice for ventilation and air conditioning ductwork.*

ISO 10294: 1996: *Fire resistance tests - Fire dampers for air distribution systems,* Part 1: *Test method.*

BS EN 1366: Part 2: 1999: *Fire dampers.*

LPS 1162, *Requirements and tests for fire dampers.*

Fire-resisting damper

A damper installed in an air distribution system, that, when tested to BS EN 1366: Part 2 or ISO 10294: Part 1, provides the required fire resistance and other requirements of this design guidance.

ASFP

An industry guide to the design for the installation of fire and smoke resisting dampers, 2005.

Fire-resisting duct

A duct used for the distribution of air, that when tested to BS 476: Part 24: 1987 (ISO 6944: 1985) or BS EN 1366: Part 1, provides the required fire resistance and other requirements of this design guidance.

BS 476: Part 24: 1987: *Method for determination of the fire resistance of ventilation ducts.*

Fire-resisting smoke extraction duct

A duct, which passes through compartment walls or floors and, which, in the event of a fire, is designed to extract smoke to outside the building. For the purposes of this Guide, this duct shall satisfy the requirements of BS EN 1366: Part 1 and BS EN 1366: Part 8.

BS EN 1366: Part 8: *Smoke extraction ducts.*

13. General

All penetrations for building services through compartment walls and floors shall be provided with a closure independently certified to meet the requirements of a third-party certification scheme.

Where larger enclosures surround pipes or ducts passing through a compartment floor or floors, then the fire-resisting floors within such enclosures shall be sufficiently strong to take the weight of maintenance or other personnel. A suitable, lockable door or doors shall be fitted where necessary. (If the strength of such flooring is ever in doubt then the premises' management needs to display prominent notices to that effect.)

13.1 Protection of ducts

Air distribution ducts

Air distribution ducts shall be protected in accordance with BS 5588: Part 9 and the additional requirements given here.

- Where fire-resisting dampers are used, these shall be tested in accordance with ISO 10294: Part 1: 1996 or BS EN 1366: Part 2 and also satisfy the requirements given in LPS 1162 (or an equivalent standard). Where the use of the damper falls outside the field-of-application section of BS EN 1366: Part 2, additional tests or assessment shall be undertaken to validate the suitability of the application. The required integrity of the dampers shall not be less than that given in Key Table 2 or Key Table 3. To meet the recommendations of this design guidance all fire dampers, as well as being fitted with a fusible link, shall be linked to a fire detection and alarm system approved by an accredited third-party certification body to appropriate standards. Suitable heat/smoke detectors are to be fitted within the ductwork, in pairs, one on each side of each damper. Dampers that rely only on a fusible link to close are not acceptable.
- Where fire-resisting ducts are used, these should be tested in accordance with BS 476: Part 24: 1987 (ISO 6944:1985) or BS EN 1366: Part 1 and have a fire resistance in terms of stability, integrity and insulation of not less than that specified in Key Table 2 or Key Table 3. Where the duct falls outside the field of application section of BS EN 1366: Part 1, further testing or assessment shall be undertaken to validate the suitability of the application.

Smoke extraction ducts

- These shall be tested in accordance with BS EN 1366: Part 1 and BS EN 1366-8 and meet the fire resistance specified in Key Tables 2 and 3. These tests are designed to ensure that fire-resisting compartmentation is maintained where smoke extracting ductwork

Fire-resisting service duct

A duct used to enclose building or other services, that, when tested to BS EN 1366: Part 5, provides the required fire resistance and other requirements of this design guidance, as appropriate.

BS EN 1366: Part 5: 2003: *Service ducts and shafts.*

prEN 1366: Part 10: *Smoke control dampers.*

passes through compartment walls and floors but they do not evaluate the efficiency of the complete smoke extraction system to extract smoke under fire conditions. That aspect is outside the scope of this guidance.

- Care should be taken to ensure that the use of a smoke extraction system does not adversely affect the response time of sprinklers. Consult a sprinkler specialist for guidance.
- Dampers used in smoke extraction ducts shall be tested to the appropriate part of prEN 1366-10.

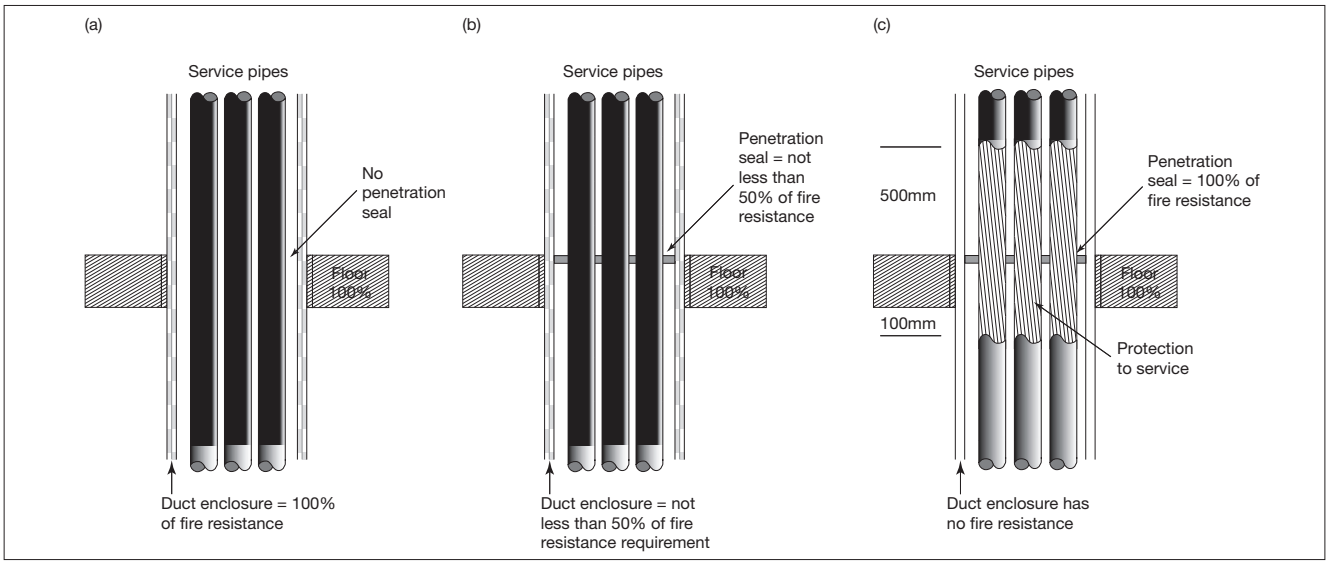


Fig. 3. Service duct, with and without penetration seal around service pipes at the floor level.

(a) Within service ducts that satisfy the requirements for integrity and insulation for the specified periods.

(b) Within ducts having not less than 50% of the fire resistance of the compartment floor, provided that penetration seals are fitted having at least the same fire resistance as the duct. Designers should consider specifying fire resistance periods for both the service duct and the penetration seals in excess of 50% of the total requirement. This is to allow for the possibility of thermal shock overwhelming the secondary line of fire resistance in a fully developed fire scenario.

(c) Within ducts that are not fire resisting, provided that penetration seals are fitted to satisfy the requirements for integrity and insulation for the specified periods. The insulation criteria should additionally be satisfied for a distance of 500mm into the compartment above and 100mm into the compartment below.

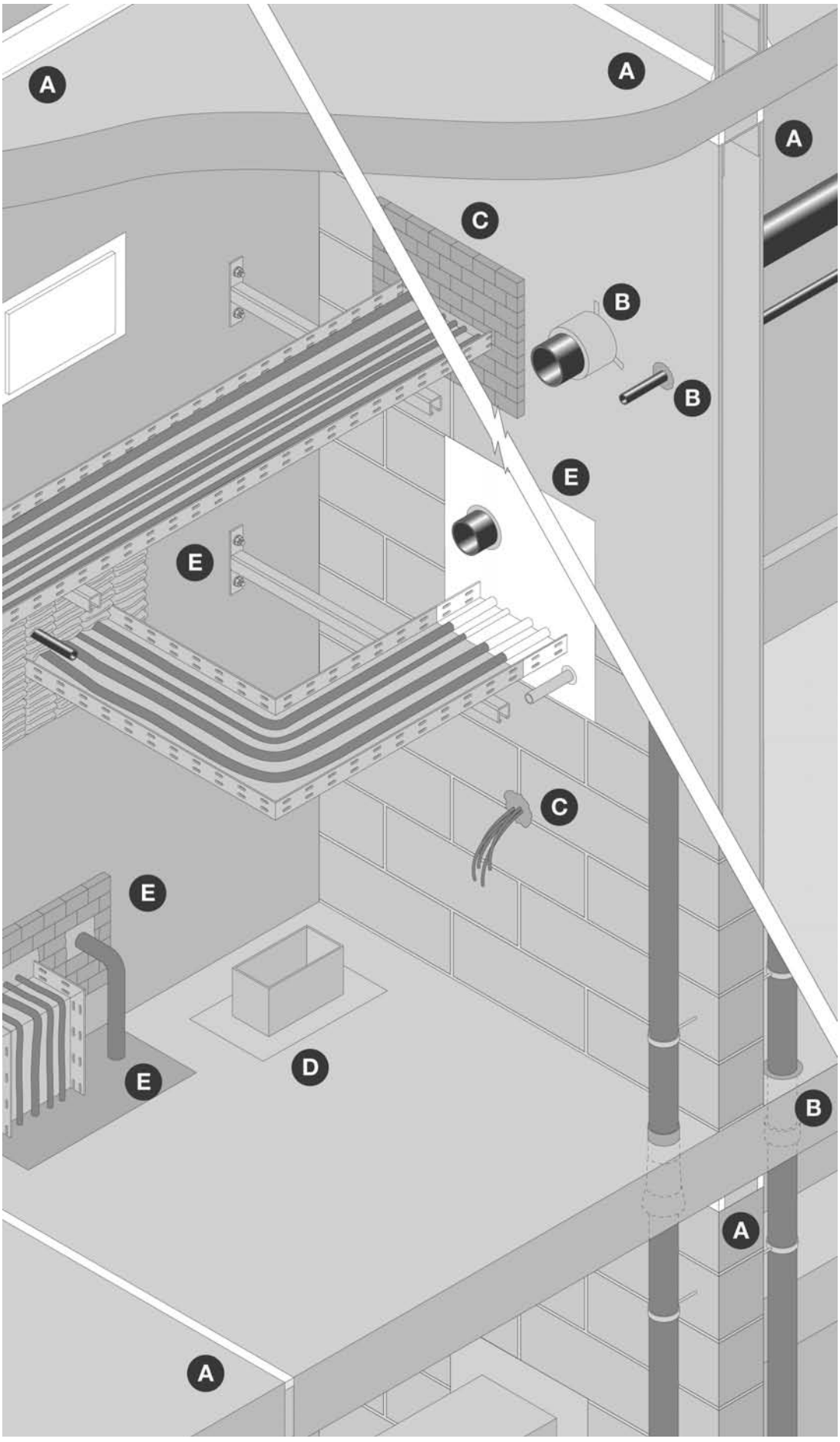
Service ducts

- Service ducts used to enclose pipes and cables passing through compartment walls and compartment floors should be tested in accordance with BS EN 1366: Part 5. Where the duct falls outside the field of application section of BS EN 1366: Part 5, further testing or assessment shall be undertaken to validate the suitability of the application.
- Service ducts may pass through a compartment wall or floor subject to the maintenance of integrity and insulation performance not less than that given in Key Table 2 or Key Table 3. See Fig. 3(a)-(c).
- Service ducts are not required to have fire resistance where the penetration seal is able to provide the same fire resistance as required for the compartment wall or floor, unless they contain pipes containing volatile fluids or combustible gases.
- Pipes containing volatile fluids or combustible gases shall be contained within a service duct having a fire resistance of not less than 60min in terms of integrity and insulation, with the penetration at the compartment wall or compartment floor being protected by a penetration seal having a fire resistance the same as the compartment wall or compartment floor. Ventilation shall be provided to service ducts enclosing pipes containing volatile fluids or combustible gases.

Some design features and Standards relating to penetrations

The illustration opposite and the following table are intended to depict certain design features and inform designers about the test-related Standards with which products will need to comply if they are to be specified for inclusion in their designs. (The illustration is reproduced by kind permission of Hilti (Gt Britain) Limited.)

Feature	Standard no.	Title
Air distribution duct	BS 5588: Pt 9: 1999	Code of practice for ventilation and air conditioning ductwork
	ISO 10294: Pt 1: 1996	Fire resistance tests – Fire dampers for air distribution systems: Test method
	BS EN 1366: Pt 2: 1999	Fire dampers
	LPS 1162	Requirements and tests for fire dampers
Cables, electrical	IEC 60332: Pt 3: 2000	Tests on electrical cables under fire conditions: Tests on bunched wires or cables
	NFPA 262: 2002	Standard method of test for flame travel and smoke of wires and cables for use in air-handling spaces
	BS EN 50200: 2000	Method of test for resistance to fire of unprotected small cables for use in emergency circuits
Cavity barrier, fire resistance testing	BS 476: Pt 22: 1987	Methods for determination of the fire resistance of non-load bearing elements of construction
	BS EN 1634: Pt: 1: 1999	Walls
Ceiling, fire resistance	BS 476: Pt 22: 1987	Methods for determination of the fire resistance of non-load bearing elements of construction
Fire-resisting damper	BS EN 1366: Pt 2: 1999	Fire dampers
	ISO 10294: Pt 1: 1996	Fire resistance tests – Fire dampers for air distribution systems: Test method
	ASFP guidance	An industry guide to the design for the installation of fire and smoke resisting dampers
Fire-resisting duct	BS 476: Pt 24: 1987 (ISO 6944: 1985)	Fire tests on building materials and structures: Method for determination of the fire resistance of ventilation ducts
	BS EN 1366: Pt 1: 1999	Ducts
Fire stopping	BS EN 1366: Pt 3	Penetration seals
	prEN 1366: Pt 4	Linear gap seals
Linear gap seals	prEN 1366: Pt 4	Linear gap seals
Penetration seal	BS EN 1366: Pt 3: 2004	Penetration seals
Platform floor	BS 476: Pt 20: 1987	Methods for determination of the fire resistance of elements of construction (general principles)
Service duct	BS EN 1366: Pt 5: 2003	Service ducts and shafts
Service sealings, fire resistance testing	ISO/DIS 10295	Fire tests for building elements and components – Integrity and insulation performance testing of service installations.
	BS 476: Pt 20: 1987	Method for determination of the fire resistance of elements of construction (general principles)
Smoke extraction duct	BS EN 1366: Pt 8: 2004	Smoke extraction ducts
	BS EN 1366: Pt 1: 1999	Ducts
	prEN 1366: Pt 10	Smoke control dampers



Penetrations and sealing: the design considerations

The illustration shows places where services penetrate walls and floors. Among the problem areas for designers are:

A Possible movements at joints

B Pipework (metal and plastic)

C Cables

- single cables
- cables in jackets
- bundles of cables
- cable trays

It may be necessary to effect permanent sealing of a penetration during construction or a temporary sealing to permit the installation of additional cables at a later date.

D Ductwork

Metal ductwork (with fire dampers) for the purposes of heating, ventilation or air conditioning can involve penetrations of walls and floors and such penetrations will require adequate sealing.

E Multiple penetrations

A penetration may be the path for more than one type of the services mentioned above.

Firestopping

This design guidance emphasises the need to maintain compartmentation and the importance of sealing services' penetrations so that the fire resistance of compartment floors and walls is not reduced and they maintain their ability to resist the effects of a fire and perform their structural functions. Part 2 reviews the principal considerations and provides appropriate advice.

14. Penetration seals

Penetration seal

A system for sealing any void in a compartment wall or floor, through which building services pass, which, when tested to BS EN 1366: Part 3, provides the integrity requirement specified in this design guidance.

14.1 General

It is important that when a vertical or horizontal compartmenting element is penetrated by a service, the fire resistance of the construction is not decreased. Thus, designers/specifiers shall ensure that the penetration seal specified is suitable for the particular service, size of service, material(s) and the type of wall/floor penetrated by the service. In the case of the element being penetrated by fire-resisting service ducts, the seal between the duct and the element forms part of the test assembly and the same form of sealing system shall be used in practice. Combustible services shall be so arranged that they are not located nearer than 500mm to air distribution ducts that are protected by uninsulated dampers, unless the outer surface of the duct is suitably insulated.

BS EN 1366: 2004: Part 3: *Penetration seals.*

Where metal pipes, plastic pipes or cables penetrate such elements, it is important that a sealing system is used that is appropriate to the service(s) in question. More detailed information, important to the designer, is given in 14.3 (see also Appendix E). For a small penetration passing through a small aperture then the fire resistance can generally be maintained by a suitable sealant.

Where a large number of different services are involved and the aperture is larger, then a complete system incorporating a bulkhead barrier in combination with the appropriate sealing materials is normally used.

Hot flues

As a matter of design principle such flues shall not penetrate compartment walls or floors unless absolutely unavoidable. In such circumstances, refer to FPA Recommendations RC16b *Recommendations for cooking equipment (other than fish and chip frying ranges)* for guidance.

RC16b, *Recommendations for cooking equipment (other than fish and chip frying ranges),* Fire Protection Association, 2003.

14.2 Performance requirements for penetration sealing

All sealing of penetrating services shall satisfy the fire resistance requirements described below:

Table 4. Fire resistance requirements for sealing service penetrations.

Purpose groups (see Key Table 2)	Integrity and insulation	Distance from compartment wall/floor
2, 3, 4 and 5	As in Key Table 2 or Key Table 3	150mm[1] each side
6 and 7	As in Key Table 2 or Key Table 3	500mm[1] each side

1 Metal pipes of less than 13mm diameter are exempted from this requirement as are penetrations consisting of up to four cables each with a core diameter no greater than 4mm.

- The fire resistance shall be established by means of testing to BS EN 1366: Part 3, ISO/DIS 10295 or similar ad-hoc procedures based upon the methodology of BS 476: Part 20.
- The test shall have been performed using services and a substrate that covers the intended application within the field of application of the result.
- Where the test was performed on a small specimen (for example, 1m x 1m) the effect of deflection/distortion of the element and the method of supporting the service sealing system shall be considered to ensure it meets these requirements.

ISO/DIS 10295: *Fire tests for building elements and components – Integrity and insulation performance testing of service installations.*

BS 476: Part 20: 1987: *Method for determination of the fire resistance of elements of construction (general principles).*

- Drywall partitions, in particular, can be subject to significant levels of distortion in fires. Testing of seals for use in such walls should therefore be undertaken at full scale dimensions.

14.3 Specific penetration seal applications

There are a number of sealing systems available and further guidance in respect of these is given in data sheets on the FPA's website (www.thefpa.co.uk/Resources/Design+Guide/).

Examples of such seals or sealing systems is given below:

fire-resistant cementicious materials

gunnable or hand applied sealants (ablative and intumescent)

mineral and ceramic fibre gaskets

mineral fibre batts (coated and uncoated)

sealing blocks/bricks

pre-fabricated intumescent/resilient foam sandwiches

pipe closing collars

cable transits

sealing bags or pillows*

pipe wraps†

Approved installer

A competent installation company which is approved/certificated under a recognised third-party installer scheme.

Any other tested system may be used subject to correct installation by approved installers.

14.4 Plastic pipes

Plastic pipes, being of low melting point, can readily cause a breach of the compartmentation unless properly sealed. All plastic pipes passing through compartment walls or floors shall be properly sealed by a suitable pipe closing collar. The device fitted shall be supported by test evidence for the required duration that relates to the following parameters:

- orientation - vertical/horizontal;
- pipe diameter;
- wall thickness;
- type of plastic (this is extremely important, even a foamed version of a specific plastic may perform differently from the standard version);
- end conditions (open or closed).

For further details on how these factors influence performance see the data sheets on service sealing on the FPA website, www.thefpa.co.uk/Resources/Design+Guide/.

14.5 Cable trays and cables

The evidence of performance shall relate to the type of cable tray to be used, together with the number and distribution of cables. The cables shall be of a core diameter and insulation thickness and type covered by either the field of application report (derived from the test data) or approval certification.

* Sealing bags or pillows may only be allowed if they are covered by a management procedure that includes frequent examination and a permit system usable by all contractor staff installing new services. This may also be needed for any system where new services are being frequently added, for example, communications rooms.

† Pipe wraps are not acceptable for use in compartment walls or floors.

14.6 Metal pipes

The risk of fire spread by means of pipes penetrating compartment walls or floors is generally as a result of insulation failure on the service or an integrity loss due to a breakdown of the sealing system. When installing sealing systems around pipes the evidence of performance shall be appropriate for:

- pipe diameter;
- pipe material;
- orientation;
- end conditions (open or closed);
- support conditions.

The selected fire stopping material must be able to accommodate thermal movement in normal service. The nature of the material in the pipe may need to be considered in certain circumstances, for example, volatile liquids or gases.

15. Cavity barriers

15.1 General

Hidden voids have the potential to allow the concealed spread of fire to parts of a building remote from the place of origin (the seat of the fire). Because the fire may be hidden, detection and firefighting can be very difficult. For this reason the recommendations in this guidance are that large or critically positioned hidden voids (as defined below) be sub-divided using fire-resisting cavity barriers in order to restrict lateral fire spread. Cavity barriers may also be appropriate for closing voids where they bypass lines of compartmentation that do not separate different occupancies or occupancy types.

Cavity barrier

A fire-resisting barrier, not less than 100mm high, installed in a ceiling or floor void or roof space, that is able to provide the required fire resistance (and other) requirements of this design guidance, as appropriate.

To satisfy the recommendations of this guidance, cavity barriers shall not be used as an extension of compartment walls separating different occupancies (buildings in different ownership) and preferably shall not be used above compartment walls separating different purpose groups. In these cases the compartment wall shall always be extended up to the compartment floor or roof above.

In such cases the compartment line must be continued up to the adjacent roof, floor or wall with any small gaps being filled with a fire-stopping system or linear gap seal that provides the same fire resistance level, in terms of integrity and insulation, as specified in Key Table 3. This shall be able to accommodate any fire-induced or in-service deflection. (See Glossary for difference between cavity barrier and fire stopping.) Similar restrictions apply to the use of cavity barriers above compartment walls separating storage areas from purpose groups 4 or 6 (see Key Table 2) or below a fire-resisting wall on a platform floor.

Linear gap fire seal

A fire-resisting barrier, installed in a gap not more than 100mm wide in a wall or floor, or around building services, that is able to provide the required fire resistance and other requirements of this design guidance, as appropriate. Linear gap seals may be static in action or may be intended to allow movement between adjacent construction elements under normal service conditions, and under fire conditions maintain the integrity and, where specified, insulation of the gap.

15.2 Applications

The main recommended applications of cavity barriers are summarised below. They shall be:

- installed in line with compartment walls or floors, except between different occupancies or different occupancy types to maintain the fire resistance of the compartment whilst absorbing any mechanically or thermally induced movements;

- used to provide sub-divisions in voids between ceilings and floors, voids in platform floors and in roof spaces above suspended ceilings, whilst absorbing any mechanically or thermally induced movements.

Examples of where specific applications for cavity barriers would occur are:

- any large cavity* within a wall, floor or ceiling must be separated from large cavities in adjacent walls, floors or ceilings. This applies whether these building elements are fire-resisting or not;
- hidden voids above suspended ceilings†;
- cavities below floors†;
- resistance should have a cavity barrier in the same plane as the element;
- cavities in walls†

Where cavities are narrow (100mm or less), then fire stopping or linear gap seals may be a more appropriate solution than cavity barriers; it must, however, be ensured that the product used can accommodate any fire-induced or in-service movement that may occur (see Appendix E).

15.3 Performance requirements

Fire resistance

The fire resistance levels required for cavity barriers are given in Table 5.

Table 5. Fire resistance requirements for cavity barriers

Application	Fire resistance (min)		Location
	Integrity	Insulation	
Compartment walls separating different occupancies	NOT ALLOWED		
At compartment walls or floors separating different purpose groups	It is recommended that the compartment walls are extended right up to the floor or roof above		Compartment wall or floor
Sub-division in roof/floor voids	30	30[1]	Spaced at not more than 20m apart or in line with walls above or below
Sub-division of wall voids	30	30	In line with all fire separating walls and floors

1 Some cavity barriers are available that provide reduced insulation performance. The insulation requirements may be relaxed, and the use of these barriers may be appropriate where:

- there are no combustible materials used in the construction of the building within 3m of the barrier; and
- it is impossible, or highly unlikely, that combustible materials will at any time be stored within 3m of either side of the barrier (this does not apply to flammable liquids; where these may be present, fully insulating barriers shall always be used).

Cavity barriers used to sub-divide roof or floor voids should, wherever possible, be placed so as to coincide with the fire-resisting partitions in the compartment above the floor or below the ceiling, in order to continue the line of fire protection. This may require location of barriers at less than the maximum 20m spacing in Table 5. Where a compartment has many fire-resisting partitions, it should not be necessary to have a cavity barrier above every one, so long as the maximum limit on void dimensions is not exceeded.

* For the purposes of this guide a large cavity is one that is more than 600mm high or deep.

† Where the cavity extends more than 20m in any direction, including around corners.

Where any large vertical voids reach roof height the opportunity should be taken to cap them below roof level, so providing additional protection to the roof structure.

The fire resistance of cavity barrier systems can be established either by fire resistance testing or assessment against the principles for non-load bearing separating elements in BS 476: Part 22: 1987 or BS EN 1364: Part 1. Any evidence of performance for cavity barriers must be able to demonstrate the suitability of:

BS 476: Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction.*

BS EN 1634: Part 1: 1999: *Walls.*

- any joint systems that are to be used in the barrier material (either vertical or horizontal, as appropriate);
- the barrier fixing system, which must be appropriate to the structure from which the barrier is to be supported (for example, steel, timber, steel roof decking etc);
- the barrier itself, in the orientation in which it is to be used;
- any mechanism or detail included to accommodate the transit of services, beams, ducts etc through the cavity barrier (for example, penetration sealing systems);
- that the barrier can be used in conjunction with a compartment wall without reducing the fire resistance of the wall. This would necessitate the testing of the cavity barrier and compartment wall together with the top edge of the wall being tested unrestrained to represent installed conditions.

Where a barrier is to be used at a height greater than that for which either test or a field of application assessment evidence exists, then the suitability of the cavity barrier for that application must be established by an independent fire safety engineering analysis.

Surface spread of flame

Both exposed surfaces of any cavity barrier shall satisfy the Class 0 provisions in building regulations.

15.4 Accommodating deflection

Cavity barriers may be required to provide fire resistance when the building structure which bounds the barrier is distorting under the influence of the fire. An example of this would be a cavity barrier above a steel framed suspended ceiling, where the ceiling may bow downwards as the steel heats up, due to linear thermal expansion and loss of strength. It must be ensured that the barrier can accommodate this deflection whilst maintaining fire resistance.

Alternatively, the distortion of the elements bounding the void may be restricted by the application of additional fire protection protection, a topic discussed in the companion publication *Fire compartmentation.*

Rigid barriers must be able to cope with any load transfer from above, if the soffit of the void distorts, whilst both rigid and flexible barriers may need either to restrain or to accommodate the deflection of the adjoining structure at their base.

It is not feasible to make a general statement about what degree of distortion will need to be allowed for in the above situations; the type of element, its degree of exposure, end conditions and loading will all affect

its distortion. Wherever possible the building designer should make or obtain an analysis of the anticipated deflection in fire and match the cavity barrier system to that deflection. Where this is not feasible, then as guidance, a horizontal fire-resisting load bearing and/or separating element may bow up to a distance of L/40 at mid-span, if uniformly loaded, at its designed fire resistance. It must be ensured that the support to the barrier will be capable of holding the barrier in place for the required period of fire resistance, without gaps opening up between it and the soffit of the cavity. This may be affected by:

- the inherent fire resistance of the support;
- applied fire protection; or
- the protection provided by the barrier itself.

Fire stopping

A seal designed to make good any imperfections in fit such that the required fire resistance of the wall or floor, in terms of integrity, and insulation if appropriate, is maintained.

16 Fire stopping and linear gap sealing

General

Gaps can be present in fire-resisting compartment walls and floors for the following reasons:

- as joints to accommodate in-service movement;
- due to imperfections in fit or manufacturing clearances;
- around items installed in the element subsequent to its construction etc.

Fire stopping

BS EN 1366: Part 1: 1999: *Ducts.*

BS EN 1366: Part 3: 2004: *Penetration seals.*

ISO 10294: 1996: *Fire resistance tests - Fire dampers for air distribution systems,* Part 1: *Test method.*

BS 476: Part 24: 1987: *Method for determination of the fire resistance of ventilation ducts.*

It is essential that the fire protection provided by the element is not reduced by joints or gaps and where such gaps are made or develop then the fire protection shall be restored at the earliest possible time, by filling these gaps using an appropriate sealing system. This may, if appropriate, simply be a restoration of the material from which the element is constructed, subject to it being able to meet the requirements, or it may be by means of a proprietary fire-stopping product. All gaps should be sealed by a system that, when tested to BS EN 1366: Part 3 or ISO/DIS 10295: Part 1, or similar procedures, achieves the fire resistance in terms of integrity and insulation given in Key Table 2 or Key Table 3. For sealing gaps around fire-resisting air distribution ducts, such seals should have been tested as part of the duct protection system in accordance with BS 476: Part 24: 1987 or BS EN 1366: Part 1.

Where parts of a composite separating element (for example, a foam-cored sandwich panel system) have been removed, then conventional fire-stopping systems may not be suitable to restore its fire resistance. In such cases expert advice should be sought.

Linear gap sealing

prEN 1366: Part 4: *Linear gap seals.*

'Linear gaps' are gaps of a fairly constant width, which is small compared to their length (commonly a length/width ratio of 10:1 or more), and may have to accommodate movement, either in-service or in the case of fire. It is particularly important to consider floor slab edge detail where curtain walling systems are employed, for example. Linear gap sealing systems shall comply with the requirements specified in prEN 1366: Part 4.

16.1 Performance requirements: fire stopping and linear gap seals

For fire-stopping and linear gap seals used in compartment walls or floors, the following fire resistance levels are applicable:

Table 6. Fire resistance levels for fire stopping and linear gap seals.

Application	Integrity (min)	Insulation (min)
Gaps not greater than15mm wide	As for Key Table 3	15
Gaps over 15mm wide	As for Key Table 3	As for Key Table 3

16.2 Design considerations

In part E of the Appendix guidance is given on the factors which need to be considered when specifying sealing systems. That guidance ranges over the size and nature of the gap to be sealed and other conditions which influence choice of system.

17 Protection of services

17.1 General

- Materials and components used in the construction of a building shall not make a significant contribution to fire growth.
- This may be achieved by specifying services to meet that objective, or alternatively, by protecting the service installation from a fire.
- The presence of combustible services on a large scale may significantly increase the fire load in any compartment and adequate precautions need to be taken.
- Combustible services shall not be placed closer than 500mm to unprotected air distribution steel ducts.

This section goes on to make recommendations on how these objectives can be achieved.

17.2 Protection of electrical cables etc, by general location

Cables located in ceiling voids

Cavity barriers shall be provided in each direction at not more than 20m centres and have the fire resistance specified in Table 5.

Where the depth of the ceiling void is greater than 600mm and the total area of cables exceeds 0.2m^2/m width of cavity then:

- the ceiling should have a fire resistance of 60min in terms of integrity and insulation when tested to method 9 of BS 476: Part 22: 1987.

BS 476: Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction.*

Where cables located in a ceiling void have a total cross-section area (conductor, insulation, armour, sheath etc) greater than 0.1m^2/m width of cavity then:

- they should be protected by an imperforate fire-resisting ceiling having a fire resistance of 30min in terms of integrity and insulation when tested to method 9 of BS 476: Part 22: 1987.

In both cases, the following alternatives need to be considered:

- electrical cables should have been tested and approved to IEC 60332: Part 3 or other equivalent specification; or

IEC standard 60332: *Tests on electrical cables under fire conditions:* Part 3 (various sub-Parts): 2000: *Tests on bunched wires or cables.*

- the cavity be protected by an automatic gaseous or sprinkler system; or
- the cables are sealed in trunking, ducting etc (not acceptable for applications requiring prolonged operation during a fire). Consideration should be given to sealing within enclosed trunking where compartment walls or floors are penetrated.

Cables should not be located nearer than 500mm to air distribution ducts unless the outer surface of the duct is suitably insulated.

Cables located in voids below platform floors
(for communication room applications see 17.3)

Where cables are located within a void below a platform floor, cavity barriers should be provided as follows:

Table 7. Cavity barrier spacing in platform floors.

Depth of void (mm)	Distance between cavity barriers in each direction	Fire resistance
Less than 600mm	20m	see Table 5
Greater than 600mm	10m	see Table 5

The effectiveness of cavity barriers must be maintained and it is important that those located in the voids of platform floors are checked at regular intervals and any damage rectified by specialist contractors.

Where the total area of cables (conductor, insulation, armour, sheath etc) exceeds 0.2m^2/m width of cavity, or in service additional cables may be provided to exceed 0.2m^2/m width of cavity, then the following additional measures should be considered:

BS 476: Part 20: 1987: *Method for determination of the fire resistance of elements of construction (general principles).*

- the platform floor should have fire resistance of 15min integrity and insulation when exposed to the heating conditions of BS 476: Part 20: 1987; or
- the electrical cables specified should have been tested and approved to IEC 60332: Part 3 or other equivalent specification; or
- the cavity is protected by an automatic gaseous or sprinkler system;or
- the cables are sealed in trunking, ducting etc (not acceptable for applications requiring prolonged operation during a fire). Consideration should be given to sealing within enclosed trunking where compartment walls or floors are penetrated.

Services located in vertical shafts

All combustible services not otherwise protected (electrical cables in sealed trunking, ducting etc) shall be located in a fire-resisting service shaft meeting the requirements given in 13.1.

17.3 Cables for special applications

Cables in communication rooms

Communication rooms are to be regarded as high risk and high value. Cavity barriers shall be installed to meet the requirements given in 15.2 and, in addition, the following shall be considered:

Where cables are installed in a cavity of 300mm or greater, then:

- the platform floor shall have fire resistance of 15min integrity and insulation when exposed to the heating conditions of BS 476: Part 20: 1987, and either:

- the cavity shall be protected by an automatic gaseous system (connected to a fire detector and alarm system) or a sprinkler system; or
- the cables shall have been tested and approved to NFPA 262 (formerly UL 910).

NFPA 262, *Standard method of test for flame travel and smoke of wires and cables for use in air-handling spaces,* 2002.

Cables for use in emergency circuits

These should be tested in accordance with BS EN 50200, including a 15min duration water spray test. Cables used for fire detector and alarm systems shall have PH 90 classification.

BS EN 50200: 2000: *Method of test for resistance to fire of unprotected small cables for use in emergency circuits.*

17.4 Pipes within floor and ceiling voids and vertical shafts

Pipe insulation

The insulation used on pipes carrying liquid or gas, whether flammable or not, shall conform to the basic requirements of this Guide that materials should not make a contribution to fire growth.

In addition, the insulation shall be impervious to liquids, for example, oil leaking from another pipe.

Pipes containing liquids and gases

- These shall be enclosed in a separate fire-resisting service duct as described in 13.1.
- The temperature of the pipes shall be kept below critical temperatures for the liquid or gas.
- Where it is not practical to provide protection against leakage, the provision of automatic shut-off valves close to the compartment wall is advisable to assist the control of any leakage.
- Such pipes shall not be routed in concealed spaces over rooms containing business-critical activities.
- Flammable gases shall not be routed below floors unless suitable leakage detection and ventilation is provided.
- Electrical cables and equipment shall not be sited in the same under-floor void as pipes containing flammable liquids and gases.

Appendix: Explanatory/technical information

A. Doors

A1. Effects of door type on maximum size

Door leaves forming part of hinged or pivoted side hung door assemblies, distort under heating either as a result of differential shrinkage or expansion. The degree of such distortion is normally a function of leaf size construction and the restraint at the perimeter of the leaf.

BS EN 1634: Part 1: 2000: *Fire doors and shutters.*

Some guidance on the applicable field of direct application for different door types is given in BS EN 1634: Part 1 on which the following advice has been based.

A2. Hinged or pivoted timber doorsets

Leaf dimensions

The performance of timber doors is directly related to the height-to-width ratio of the door leaf for any particular mode, configuration, hardware/ironmongery and seal combination and this relationship is frequently expressed in the form of an 'envelope' of approval approved sizes. Such an 'envelope' is described in Appendix B8 and when checking whether a particular size of door is approved it is important that it lies within the envelope of approved size. These envelopes are generated taking into account both the direct field of application and when appropriate, also the extended field of application which may be based on the results of additional testing.

General requirements

Hinged or pivot hung 'timber' or mineral cored, timber faced and edged leaves shall:

- meet with the requirements of Table 8 as appropriate for the intended use
- satisfy the appropriate recommendations of BS 8214: 1990
- be hung in a frame of a type that has been tested, or otherwise approved, for its intended purpose and location and incorporate the exact specification of any heat activated (intumescent) seals. The nature, size and position of such seals are vital to the performance of the door assembly and evidence of performance must be available to justify any change from the tested specification.
- be listed as complete door assemblies which have been certified by an accredited, independent third-party certification body as meeting the requirements of an established and approved standard, or
- be supported by a performance assurance issued by an accredited, independent third-party certification body and be manufactured under ISO 9002 conditions.

BS 8214: 1990: *Code of practice for fire door assemblies with non-metallic leaves.*

BS EN ISO 9002: 1994: *Quality systems. Model for quality assurance in production, installation and servicing.*

Table 8. Cyclic test requirements of door types related to intended use

Duty level	Type of operation[1]	Examples of door types	Number of cycles (expected life)	CEN classification
SEVERE	(a)	Hinged doorsets in commercial use Passenger lifts	200000	C5
HEAVY	(a)	First closing leaf of double leaf assemblies	100000	C4
MEDIUM	(a)	Some commercial hinged doorsets Industrial lift doors	50000	C3
LIGHT	(a) or (b)	Hinged doorsets in private residence Large industrial doors/shutters	10000	C2
LOW	(c) or (d)	Permanently held open or locked in closed position	500	C1

1 The types of normal operation are identified as follows:

(a) normally maintained closed but used regularly (that is, doors with self closing devices),

(b) normally held open during periods when buildings are occupied but closed daily (that is, doors with release and close mechanisms),

(c) permanently held open but fitted with release and close mechanism,

(d) permanently kept closed and locked (for example, secure room/ cupboard doors).

It is unlikely that a 'timber' leaf will provide an equivalent level of fire resistance when hung in a metal frame and specific evidence shall always be provided to substantiate the performance of such assemblies.

It may be possible to achieve the level of fire resistance given in Key Tables 2 or 3 (see also Appendix, B5.1) by using a double door, that is, two leaves 'in tandem' (one on each side of the opening), or by forming a lobby arrangement with a fire-resisting door at each end.

Cyclic testing

All door and shutter assemblies installed in compartment walls, shafts or compartment floors should, together with their self closing device, be cyclic tested to the number of opening and closing cycles given in Table 8. Routine maintenance as prescribed by the manufacturer's maintenance instructions is permitted during the cyclic testing.

Doors subjected to cyclic testing should still be able to close correctly at the end of the cyclic testing. Doors that meet this requirement are deemed to have sufficient durability to meet the recommendations of this book. The values in Table 8 are taken to indicate that such doors will have a 25 year life cycle for the intended use category.

A3. Hinged or pivoted metal doorsets (including glazed steel doors)

Hinged or pivoted steel doors should meet the requirements of a test standard such as LPS 1056 (or an equivalent). If the doors are classified as uninsulated, then the safe distances for storage of combustible materials shall be not less than those given for uninsulated single shutters in Fig.1.

LPS 1056, *Requirements and tests for fire doors, lift landing doors and shutters.*

Door and Shutter Manufacturers' Association, *Code of Practice for fire-resisting metal doorsets.*

Additional guidance can be found in the code of practice produced and issued by the Door and Shutter Manufacturers' Association.

For uninsulated steel doorsets the increases possible for height and width dimensions will generally be larger than those for insulated steel doorsets since, in the latter case, there is a greater risk of reducing the

integrity rating as a result of differential distortion. It is not normal to express the size limits for steel doors by means of an envelope of approved size. Additional door hardware may be required to control distortion in larger door assemblies. It is therefore more important for the largest possible practical size of door to be used for testing purposes, than it is for timber doors.

A4. Hinged and pivoted glass doorsets (fully glazed fire doors)

Glass doorset

Hinged or pivoted doorset where the hinges or pivots are attached directly to and support the glass panel.

For health and safety in use reasons, most fire-resisting door assemblies incorporate vision panels glazed with fire-resisting glass to maintain the integrity, and where appropriate, the insulation levels provided by the door. Increasingly, especially in commercial premises, the amount of glass is being increased to the point where most of the leaf is glass. The increase in the quantity of glass is due to a number of factors, for example, security (ability to observe the personnel within), energy (the ability to reduce the lighting demand by use of borrowed light), but frequently purely for aesthetic purposes.

Hinged or pivot hung glass doorsets should meet the requirements of a test standard such as LPS 1056 (or an equivalent). If the doorsets are classified as uninsulated, then the safe distances for storage of combustible materials shall not be less than those given for uninsulated shutters in Fig. 1.

Glass doors shall incorporate 'manifestations' as recommended in support of the Building Regulations of England and Wales and be of a safety glass.

The long-established recommendation for the doors from protected shafts to provide only half the level of fire resistance of the shaft itself encourages the use of such doors, especially if ground floor entrance security is at a high level. It is unlikely, but not impossible, for such doors to be installed at the interface between the commercial offices of a company and the production area, especially if the manufacturing processes are such that the company wishes to use them to promote an image.

Glazed and glass door assemblies include;

1. Solid timber framed, joinery constructed doors with one or two openings (in the trade these are frequently known as '2GG' or 'Pattern 10').
2. Flush timber leaves with various core constructions where the core is replaced in part by a large area, or areas, of fire-resisting glass.
3. Architectural metal doors (invariably of steel, but not exclusively so) constructed from metal tube profiles welded or spigoted to form a framing to house one or two glazed openings, in a similar way to timber joinery doors.
4. Flush steel leaves where the facing and core has been removed to accommodate a large area, or areas, of fire-resisting glass.
5. Frameless glass doors consisting of panes of 'robust' fire-resisting glass incorporating attachments at edges or boundaries for hinges, latches/locks, handles and closers.

Since various glass types are able to satisfy both the integrity and insulation criteria of the fire resistance test the incorporation of large areas of glass should not compromise the fire performance, although the

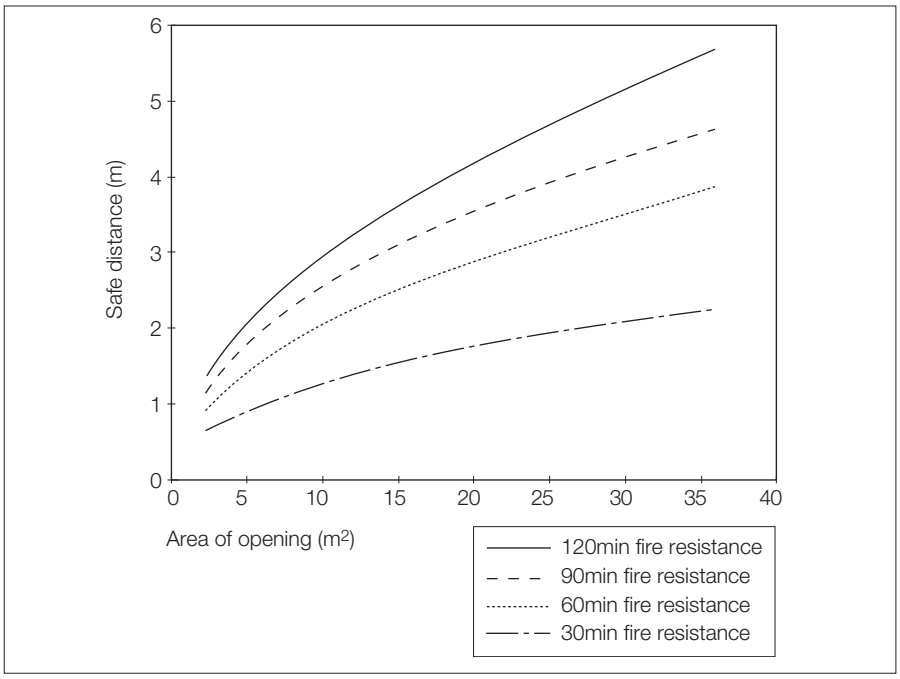


Fig. 4. Safe distance for combustible materials from a 6mm thick monolithic non-insulating fire-resisting glazed screen.

door assembly incorporating such glass areas must itself demonstrate its ability to satisfy the fire test criterion. It has to be recognised, however, that glass does not provide the same levels of strength and impact resistance as the timber and metal components framing them and therefore, in use, they are unlikely to be as resistant to abuse, that is, as robust, as their solid counterparts. Damage can seriously restrict their fire resistance contribution.

Uninsulating doors when tested to BS 476: Part 22: 1987 will not use the cotton pad for measuring integrity and in BS EN 1634: Part 1 will only be evaluated by means of the cotton pad until the time when the unexposed face temperature exceeds the insulation temperature. The gap gauge will then be used. Whilst metal framed doors may be attributed levels of integrity sometimes greater than those claimed by timber door assemblies, if the cotton pad criterion were to be used instead of the gap gauge then the actual integrity protection may be theoretically less in risk terms.

BS 476: Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction.*

BS EN 1364: Part 1: 1999: *Walls.*

There is no restriction on the use of glazed screens consisting of insulating glass fixed into insulated frames. Where the glass and the frame is uninsulating then the heat transfer to the protected area as a result of radiation can present a risk and needs to be restricted. Figure 4 gives guidance on the safe storage distance for various areas of non-insulating fire-resisting glazing.

If a door is expected to satisfy the insulation criterion in total, particularly a 'metal' framed door leaf, it is likely to be physically weakened by the incorporation of insulation material into the framing, particularly in the vicinity of hinges and pivots. For this reason it is deemed acceptable for the framing to provide a lower level of insulation, that is, permit increased unexposed face surface temperatures, on these framing members. (A temperature of 350°C may not jeopardise the level of fire safety for such doors and may be considered to be suitable subject to a risk assessment demonstrating this to be so.)

Frameless doors are able to provide up to 120 minutes integrity, albeit only borosilicate or ceramic composition glass is likely to provide these levels,

but weight and economic issues will make it unlikely that fully glazed doors will provide in excess of 60 minutes insulation. Clear ceramic will require lamination if it is to meet the safety in impact requirements.

A5. Vertical rolling shutter doors and laterally operating shutters

Roller shutter doors and laterally operating shutters should meet the requirements of LPS 1056 or an equivalent standard. The safe distances for storage of combustible materials shall be not less than given in Figs 5 (single shutter) and 6 or when the doors are installed in tandem, in Fig. 8.

Specific considerations for the use of uninsulated shutters are given in 3.1 and section B of the Appendix. Additional guidance can be found in the code of practice for fire roller shutters which is produced by the Door and Shutter Manufacturers' Association.

A6. Folding shutters

Folding shutter doors should meet the requirements of LPS 1056 or an equivalent standard. The distances for safe storage of combustible materials from uninsulated folding shutter doors shall be not less than those given in Fig. 1 and if used as double doors (that is, in tandem) in Fig. 8.

Specific considerations for the use of uninsulated products are given in 3.1 and in B2 of the Appendix.

A7. Sliding doors

Sliding doors should meet the requirements of LPS 1056 or an equivalent standard. The safe distances for storage of combustible materials for uninsulated sliding doors shall be not less than those given for uninsulated shutters in Fig. 1 and when installed in tandem in Fig. 8. Specific considerations for the use of uninsulated products are given in 3.1 and in section B2 of the Appendix.

A8. Restraint on the leaf and direction of exposure

When a door is used at sizes close to its maximum permitted size then the achievement of the required fire resistance at this size will often vary dependent upon the restraint provided to prevent distortion of the leaf, leaves or curtains. This restraint can take a number of forms:

- Nature, types and make of retaining devices such as latches, locks etc.
- Door closing devices, for example, overhead face fixed closers.
- Pressure generating intumescent seals, particularly in respect of insulated leaf assemblies, where pressure forming leaf/frame edge seals are used, to prevent integrity failure due to the cotton pad.
- Control of leaf-to-frame gaps, particularly in respect of metal-faced assemblies, where the expansion of the leaf into the fixed frame or guides/tracks causes the assembly to lock into a closed position. (It is imperative that the assembly is installed in an identical way to that which was tested or subsequently assessed and no substitution of hardware or intumescent seals is permitted without being the subject of a fire engineering judgement. Control of the door-to-frame gaps or expansion allowances is also important since significant changes in these gaps can affect the effectiveness of seals, reduce that amount of penetration of latch/lock fore-ends or upset the predicted expansion/restraint behaviour.)

Further guidance on these aspects is to be found in the appropriate data sheets (www.thefpa.co.uk/Resources/Design+Guide/).

B. Insulated and uninsulated doorsets

B1. Integrity

Integrity losses generally occur in uninsulating doorsets and shutter assemblies as a result of the development of gaps between the frame and the leaf, or between adjacent leaves. The size of the assembly can influence the generation and size of such gaps. Gaps may also develop at the interface between vision panels and the leaf. Flaming from oil/grease or core components may develop at piercings made for building hardware.

B2. Radiation from uninsulated doors

Even when a doorset or shutter assembly is fully closed the high temperature exhibited by the unexposed face is able to cause fire spread by radiation heat transfer. The safe storage distance for combustible elements is influenced by the intensity of the radiation, the area of the radiating surface and the height/width ratio and the susceptibility of the stored material/goods, furniture etc to ignition by radiation. This is discussed further in B9 below.

The unexposed face temperatures used in establishing the safe storage distances given in Fig. 4 are derived empirically using test data generated from steel, single-skin roller shutters but would be similar for steel, uninsulated flush doors.

The safe distance for storing combustible materials from the face of the assembly is based on the thermal conductivity of the door, its emissivity, its area and aspect ratio. Guidance for establishing safe distance is given in the caption to Fig. 5. This is based on a lateral separation between adjacent doors of not less than 3m and relates to doors having the same height and width as this represents the worst case in terms of maximum radiation intensity at the centre of the door.

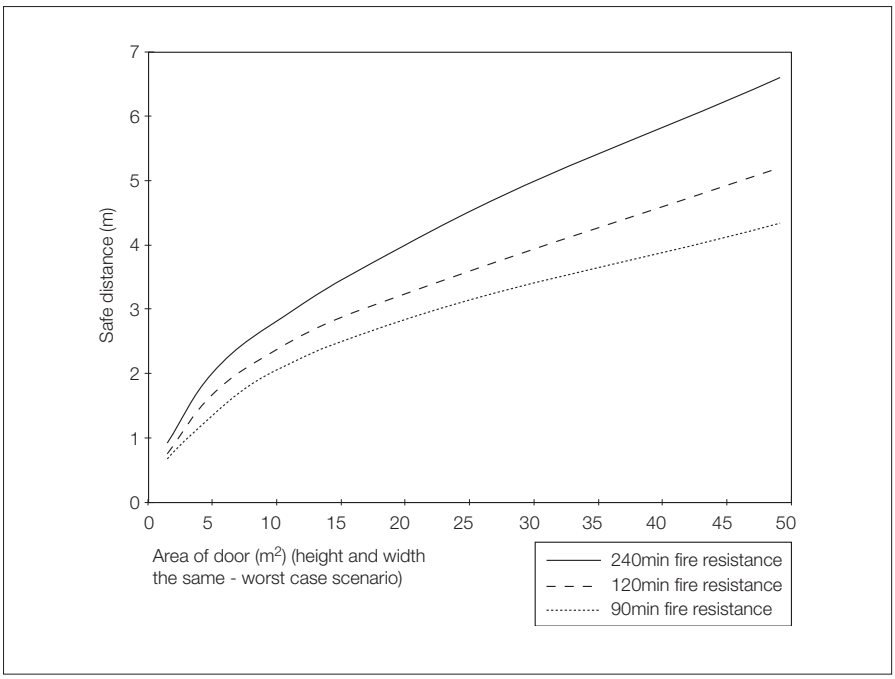


Fig. 5. Shows the safe distances (m) for the positioning of combustible materials from an uninsulated 90, 120 and 240 minute fire-resisting shutter doors based on area of door (m^2). (This value is just in excess of the distance where the auto-ignition of cotton fabrics will occur - 25 kW/m^2 - and is based on the peak value of radiation at the centre of the door and assumes that the height and width are the same, as this represents the worst case.)

For guidance the safe distance for 90, 120 and 240 minute fire-resisting double roller shutters (two shutters in tandem, one each side of the wall opening), is shown in Fig. 6. This relates to doors which have the same height and width, since this represents the worst case in terms of maximum radiation intensity from the centre of the door.

Fig. 6. Safe distances for combustible material (roller shutters in tandem).

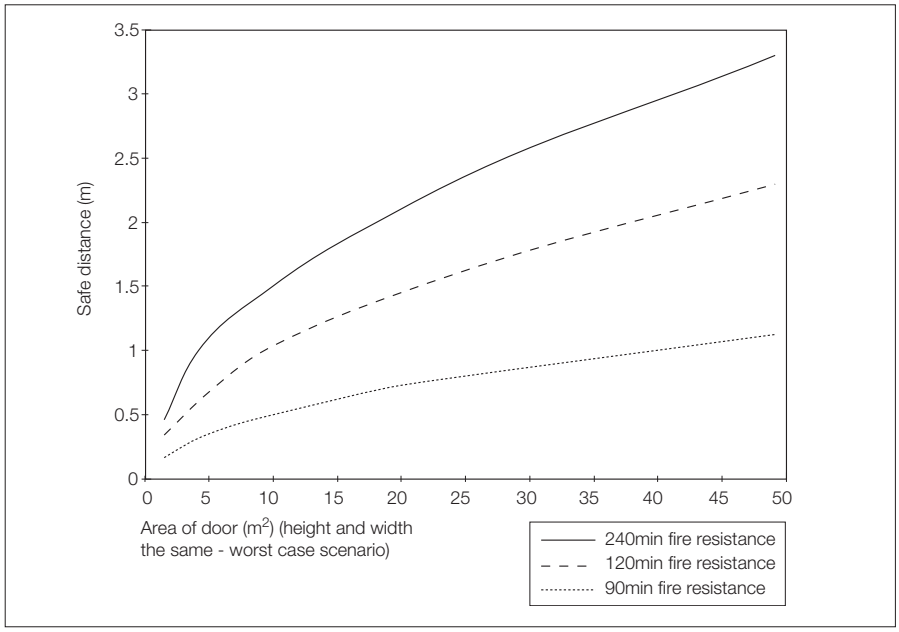
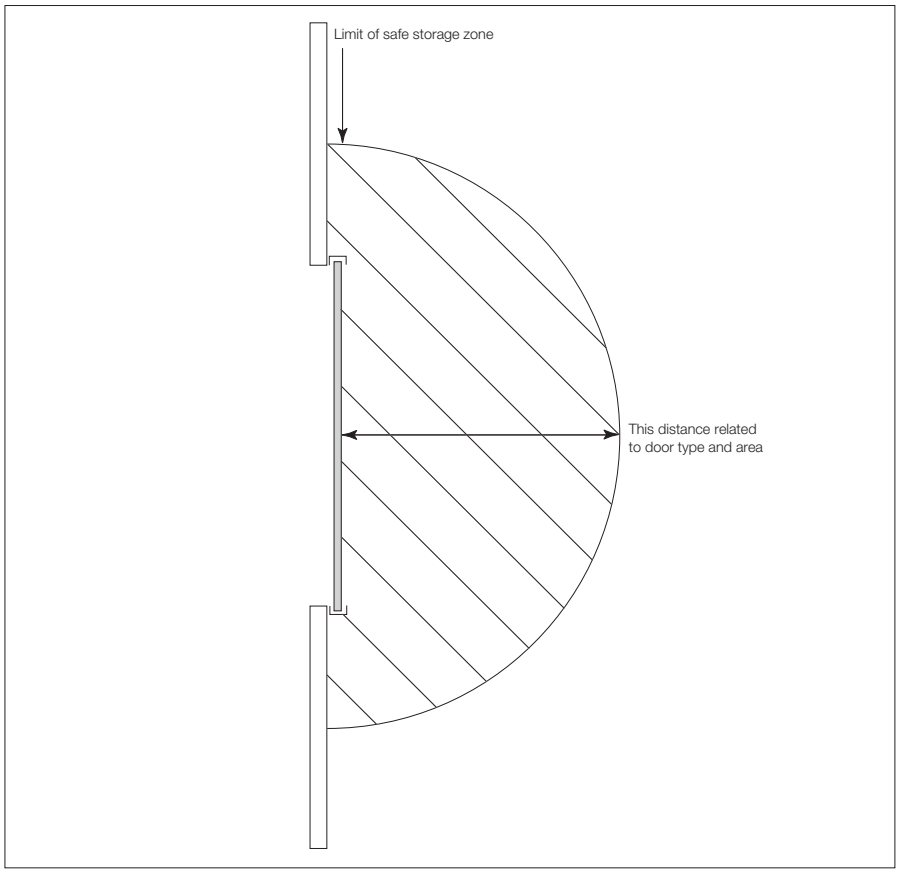


Fig. 7. Establishing the limit of a zone which is safe from the effects of heat radiation.



Where double uninsulated door assemblies are installed one on each side of the opening, that is, in tandem, then the safe distance from combustible materials can be reduced, see Fig. 6. If further reduction is required, then consideration should be given to the incorporation of a lobby, see B7 in this Appendix, or the use of insulated doors.

As shown in Fig. 7 a reduction in radiation occurs away from the centre of a door. Figure 8 depicts the radiation profile for a 7m by 7m roller shutter door. Any combustible material should be stored beyond the distances shown.

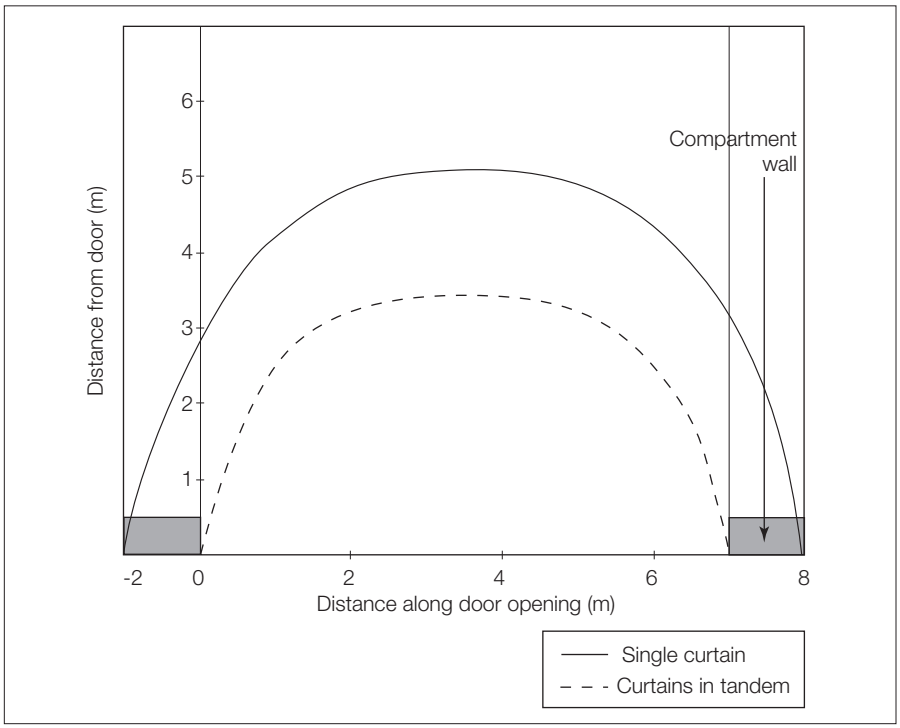


Fig. 8. Radiation profile for establishing safe distances for the storage of combustible material from a 7m x 7m roller shutter door, single or in tandem.

B3. Insulated doors

Insulating doors can typically be either of timber construction, generally up to 60 minutes fire resistance, or of a timber faced, and possibly lipped, mineral cored and/or framed construction, or be of an insulated steel faced flush door or a metal framed stile and rail construction incorporating insulating glass. In all cases the cotton pad integrity test shall always be used to establish the integrity of the construction regardless of the method of manufacture.

In the context of this design guidance a door is considered to be insulating even when it includes a vision panel glazed with fire glass that does not satisfy insulation for the full integrity period as long as it does not exceed 10% of the leaf area and does not extend below 850mm above floor level.

B4. Heat activated seals

Heat activated seals generally play a more important role in maintaining the integrity of insulated door assemblies when compared to non-insulating constructions. The type, quality and positions of these seals should not be changed from those given in any test report or field of direct application unless covered by a qualified assessment. Changes in these seals may well be used to justify classification of the assembly at a size greater than that tested or covered by the field of direct application provided that a qualified assessment is available.

Only intumescent seals with performance proven to be resistant to the effects of ageing should be used in door assemblies designed to meet the requirements of this design guidance. Further information on the selection of intumescent seals for door/frame sealing is to be found on www.thefpa.co.uk/Resources/Design+Guide/, or in the Intumescent Fire Seals Association (IFSA) Information Sheet No 1 on the use of intumescent materials in doorsets. Information on the ageing of intumescent sealing materials is available in the IFSA's Information Sheet No 4.

IFSA

Information Sheet No 1, *The role of intumescent materials in the design and manufacture of timber based fire-resisting doorsets.*

Information Sheet No 4, *The ageing performance of intumescent seals.*

B5. Specific considerations when specifying fire-resisting doorsets and shutter assemblies

Double door (doors in tandem)

In the context of this design guidance, the use of two or more door assemblies in series, that is, in tandem, in order to provide increased fire resistance with respect to one or more criteria.

B5.1 Use of double doors (also referred to as multiple doors and doors in tandem)

Where it is not possible to achieve the level of fire resistance at the required size and to satisfy the insulation and/or radiation criteria to provide the necessary safe storage distances it may be possible to use two door assemblies in tandem. The safe storage distance for combustible materials will be significantly reduced when two non-insulating door or shutter assemblies are installed in tandem, see Fig. 5. This method is particularly recommended when combustible materials are likely to be stored close to the edges of the door opening.

The use of this technique shall, however, be considered carefully when assemblies incorporate critical components that are made from temperature sensitive materials, for example, glass vision panels, aluminium overhead closers, etc.

Soda/lime glass slumps once its mean temperature reaches approximately 700°C and consequently the effect of putting two doors in tandem will not be additive in respect to fire resistance. In practice two glazed doors will only add a brief extra duration above the fire resistance of a single door (see 12.2 for further information on fire-resisting glass and its behaviour).

The introduction of lobbies (see B7 in this Appendix) is also an acceptable method of providing doors in tandem.

B5.2 Separation between adjacent doors

The information on safe distances to combustible materials are based on a minimum separation between adjacent doors of 3m. For doors having an opening area of less than 16m^2 this can be reduced to 1m. This is shown in Fig. 9 below.

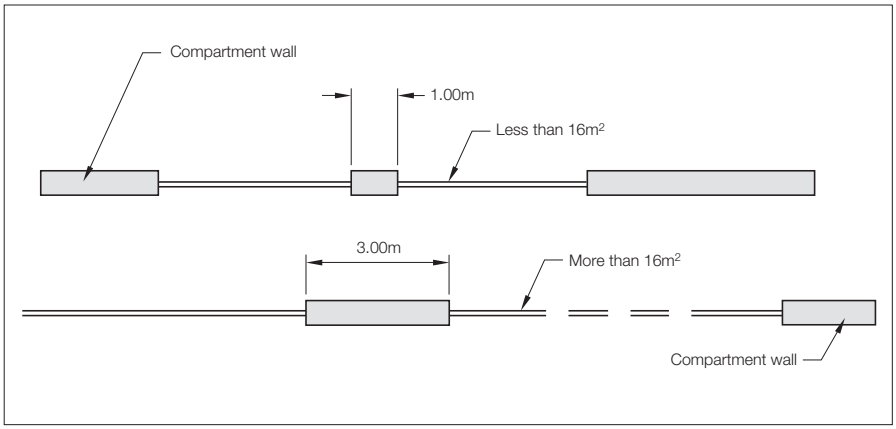


Fig. 9. Minimum separation between adjacent doors in a compartment wall.

B6. Decorative finishes

Where a paint finish is not expected to contribute to the fire resistance of the door, alternative paints to that which was tested are acceptable and such types of paints may be added to door leaves or frames/guides for which unfinished specimens were tested.

Where products incorporate the use of paint finishes which may contribute to the fire resistance capability, such as intumescent paints, then alternative finishes are not permitted without additional supporting test evidence.

Decorative laminates and timber up to 1.5mm thickness may be added to or exchanged for the faces but not the edges of doors, which satisfy the insulation criteria. All other decorative laminates shall be tested as part of the specimen and may only be exchanged for similar types/thickness of material.

B7. Doors and their use in lobbies

In order to meet the fire resistance requirements for compartment walls specified in Key Tables 2 and 3, if a door assembly is unable to meet the required fire resistance level or provide safe distance from combustible materials, then consideration needs to be given to the provision of a lobby as shown in Fig. 10, provided the aggregate fire resistance of the two doors, or door and lobby wall, is not less than that specified in Key Tables 2 and 3.

- The depth of the lobby shown as A in Fig. 10 shall not be less than that given in Table 9. Particular care needs to be taken when lobby doors are glazed with non-insulating glass, see B5.1, and the dimension of the lobby given shall be calculated to ensure that premature failure of the glass remote from the fire should not occur.

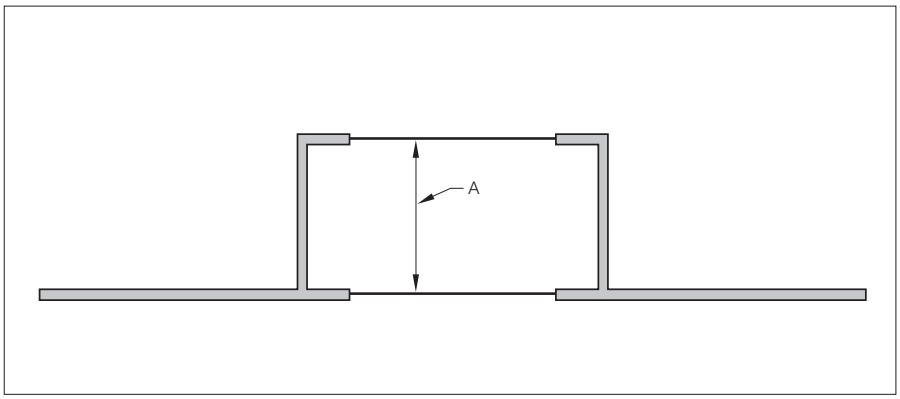


Fig. 10. Minimum depth of lobby (see Table 9).

- The walls and ceiling/roof to the lobby and the junction to the compartment wall shall have a fire resistance equal to that of the wall in which the door assemblies are installed and shall be constructed from 'robust' materials, see Table 10.
- The fire resistance shall be established from the appropriate direction and in the case of the ceiling/roof of the lobby this shall be from above. For fire above, test evidence relating to floors with fire below can be used provided the upper side is protected in the same manner.
- Lobbies used for enhancing the fire resistance shall not be ventilated. Should means of escape or fire fighting recommendations require a vent, such a vent shall be protected by a suitable damper or intumescent grille (see 8.6)

Table 9. Minimum fire resistance for doors installed in lobbies and depth of lobby.

Door type	Depth of lobby (Dim A of Fig. 9) (m)	Integrity for each assembly (Key Table 2 or 3)	Recommended maximum area of door opening (m^2)
Timber doors (unglazed, single leaf)	no restrictions	60%[1]	See Table 2
Timber doors (glazed, single leaf)	$2.5m^2$		
Timber doors (unglazed, double leaf)	no restrictions		
Timber doors (glazed, double leaf)	$2.8m^2$		
Hinged steel doors (unglazed, single leaf)	no restrictions	50%	
Hinged steel doors (glazed, single leaf)	2.0m		
Hinged steel doors (unglazed, double leaf)	no restrictions		
Hinged steel doors (glazed, double leaf)	2.25m		
Hinged glass doors	Not recommended		
Uninsulated industrial type doors or shutters	no restrictions		

1 Each door used for the construction of such lobbies should, when tested, achieve an integrity rating 10% greater than that which equals 50% of the compartmentation separating duration, for example, 66min for 120min barriers.

2 This can be reduced to 1.5m if insulated glass is fitted which has an insulation rating equal to 50% of the compartmentation separating duration.

B8. Expressing the approved size of door leaves by means of a size envelope

Conventionally hung hinged or pivoted fire-resisting timber doorsets, particularly those with single point latching/locking at approximately mid-height on the opening stile(s), are generally approved for use at sizes which are expressed as the maximum height or the maximum width that can be supplied without invalidating the performance level claimed. However, unless these dimensions are restricted unnecessarily the maximum approved height will not normally be permitted in combination with the maximum approved width. Maximum height will normally be given at the nominally conventional width and maximum width at the nominally conventional height, although the 'conventional' height and width will be related to the tested size, in accordance with the field of direct application, or extended application.

This interrelationship between dimensions is often expressed as an envelope of approved size. The approved height for any given fire resistance rating is indicated on the vertical axis and the approved width is indicated on the horizontal axis.

The slope between maximum height and maximum width is generally expressed as a linear interpolation and indicates the maximum widths that can be used at heights less than the maximum.

An example of a 'typical' envelope of approved sizes is given in Fig. 11 below.

The size of the envelope is defined as much by the restraint applied to the leaf, that is, the number and types of fixings and the type and nature of any intumescent seals fitted, as it is on the leaf construction. Thus no form of leaf construction has a 'universal' envelope but may well have a

Table 10. Guidance on robust materials that could be used for compartment walls and floors to give sufficient resistance to impact and other mechanical damage.

Product description	Dimensions
Brick and blockwork	Density not less than 600kg/m^3 and not less than 100mm thick*. *Subject to a slenderness ratio (thickness/height) not less than 0.025.
Studs	
timber	> 47mm x 89mm softwood > 400kg/m^3
steel	> 50mm x 150mm mild steel channel or Z section - 1mm thick
Joists	
timber	> 47mm x 225mm softwood > 400kg/m^3
steel	> 70mm x 250mm mild steel - 1mm thick
Boards/Linings	
Gypsum based	
Plasterboard	19mm thick as a single layer
Plasterboard	12mm thick as part of a multiple layer
Reinforced plasterboard	15mm thick as a single layer
Reinforced plasterboard	10mm thick as part of a multiple layer
Glass reinforced gypsum	12mm thick as a single layer
Glass reinforced gypsum	9mm thick as part of a multiple layer
Calcium silicate based	
Flexural strength (dry) 5-7.5 (N/mm^2)	15mm as a single layer
Flexural strength (dry) 5-7.5 (N/mm^2)	10mm as part of a multi-layer system
Flexural strength (dry) Above 7.5 (N/mm^2)	12mm as a single layer
Flexural strength (dry) Above 7.5 (N/mm^2)	9mm as part of a multi-layer system
Composite boards	
Gypsum based chipboard	15mm as a single layer
Gypsum based chipboard	10mm as part of a multi-layer system
Cement based chipboard	12mm as a single layer
Fire resisting glazing	
Wired glass (fire and safety)	6mm
Laminated fire resisting glass	12mm or greater
Solid fire resisting monolithic glasses	10mm thick or greater
Glazing installed behind permanent screen protection (See Approved Document N, The Building Regulations 2000)	
Metal-faced insulated panels Steel faced mineral wool panels. Density of mineral wool not less than 100kg/m^3 and a minimum thickness of 100mm. Thickness of steel not less than 0.7mm.	

The Building Regulations 2000, Approved Document N, *Glazing – safety in relation to impact, opening and cleaning,* 1998 (amended 2000).

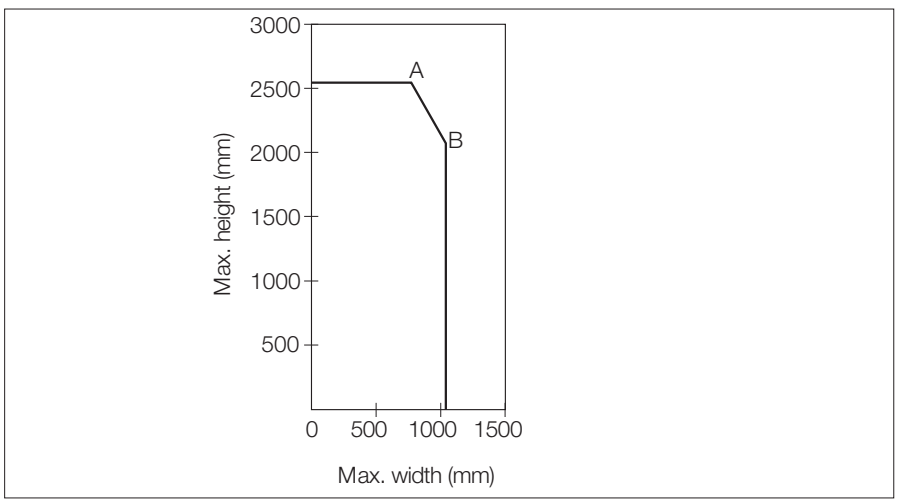


Fig. 11. The envelope of assessed sizes for a door assembly. Any combination of width and height that falls within the graph axes and the line on the graph are assessed. Point A represents the point of maximum height and its conventional width. Point B represents the maximum width and the conventional height.

range of size envelopes reflecting the mode, the configuration, the hardware, the seals and possibly the presence of glazed apertures if they are of a significant size.

For insulated steel doorsets all sizes under the graph line are not permitted. The field of direct application from BS EN 1634: Part 1 limits the size reduction to 75% height and/or 50% width of the size of the specimen tested.

BS EN 1634: Part 1: 2000: *Fire doors and shutters.*

B9. Calculation of safe distances for combustible materials

The intensity of the radiation is the product of the surface temperature of the assembly and the emissivity of the surface. The unexposed face temperature of the doorset or shutter assembly is, in turn, dependent upon the thermal conductivity of its construction. The standard temperature/time conditions used in establishing the fire resistance of such assemblies (as given in BS 476: Part 20 or BS EN 1634: Part 1) do not necessarily represent a worst case. Many fires will exhibit temperatures in excess of those given in this standard and for critical situations a qualified assessment based on fire engineering principles will be required from a professionally expert organisation.

BS 476: Part 20: 1987: *Method for determination of the fire resistance of elements of construction (general principles).*

The safe distance for storage of combustible materials from uninsulated doors or shutters have been calculated from data from fire resistance tests. The figures are intended to give guidance only and it is recommended that the actual safe distances available shall be determined when the actual width and height of the door assembly is known. The figures given are based on the worst case, that is when the door opening height and the width is the same.

As doors are normally used for access, it is appropriate to anticipate that combustible materials will not be stored directly in front of the door opening, but none the less, these values should be taken into account by

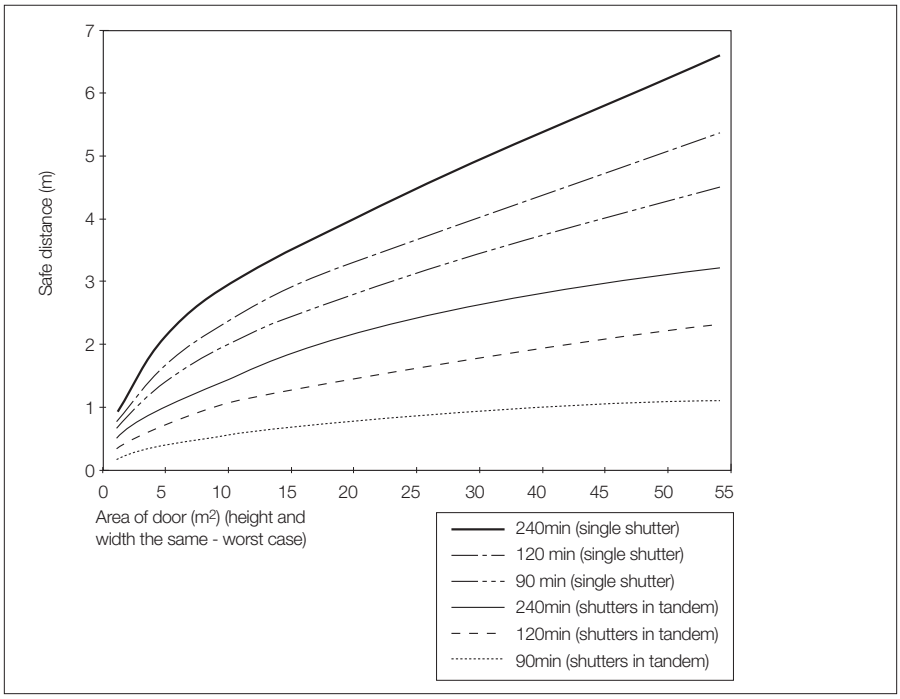


Fig. 12. Comparison between safe distances for combustible materials from single shutters and shutters in tandem.

the building designer. Where there is a possibility that combustible materials may be located by the compartment wall and near the edge of the opening, doors installed in tandem may have to be considered.

To give a direct comparison between the safe distance available from single doors and doors in tandem, the curves given in Figs 5 and 6 are combined and shown in Fig. 12.

The separation specified in B5.2 and shown in Fig. 9 has been based on ensuring that the radiation profile, an example of which is given in Fig. 8, does not overlap with the radiation profile from an adjacent door. In this situation the peak radiation intensity and consequent safe distance increases. It can be seen from Fig. 8 that part of the profile can cover part of the compartment wall when single shutters are used.

C. Glasses and glazing considerations

The following sections provide some important information that needs to be taken into account by the building designer before specifying a fire-resisting glazed screen assembly.

C1. Types of glasses

Non-insulating glasses

The most obvious sub-division of the non-insulated glasses is between those that incorporate wire and those that do not. Glasses without wires are generally known as monolithic clear glasses. However, even these divisions require further sub-divisions if performance guidelines are to be given. The following sub-categories are needed:

Integral wired glass - where the wire is introduced into the molten glass at the time of manufacture

Non-integral wired glass - where the wire is cold bonded into a resin interlayer between two panes of soda-lime glass

Monolithic clear glasses - where the glass is a single pane without wires and is of one of the following types:

- soda-lime composition;
- borosilicate composition;
- ceramic composition.

Insulated glasses

This grouping covers a range of glasses that are capable of providing a significant reduction in the temperatures measured on the unexposed face of the glass during exposure to the fire, due to the activation of thermally activated material. Two sub-categories exist:

- **specialist laminated glasses** - incorporating both clear intumescent interlayers and human impact safety interlayers;
- **'gel' glasses** - where two layers of glass are spaced apart and the void filled with a heat activated gel

Note: Some laminated products may produce excessive smoke from the protected face. The FPA Design Guide: *Fire compartmentation* places restriction on the use of such glasses for that reason.

Other glass types

For reason of strength, safety or to provide intermediate levels of insulation a number of other laminated glass types are available such as those that follow:

- wired glass/toughened glass laminates (strength);
- clear ceramic/soda-lime glass laminates (safety);
- borosilicate/insulating glass laminates (security);
- soda-lime/intumescent interlayer/soda-lime laminates (partial insulation).

This is not an exhaustive list and others may be available. The combustible nature of some of the laminating materials may mean that the fire resistance of these products are uni-directional. Any tendency for the product only to be able to provide the required level of fire resistance from just one direction shall be established and taken into account when specifying or approving such products.

In addition, there are other glasses known as partially insulating, but as this design guidance does not specifically give recommendations for such products, these are not included at present.

Glass blocks

Walls constructed from glass blocks are able to satisfy the integrity criteria for up to 60min and insulation for 30min. No guidance is given in respect of the use of these in this document but if evidence exists of their performance appropriate to an intended use then they may be considered suitable.

D. The framing system: Its importance and influence

- Glass does not inherently have any level of fire resistance and any fire resistance duration claimed will be related to a particular form of framing system and invariably a specific glazing system. With the exception of clear ceramic glass, exposure of monolithic glasses to high temperatures causes glass to loose stiffness and start to flow. The amount of flow can be controlled by the edge conditions and a 'cool edge' can help resist the tendency for panes to slump, or clamping/gluing techniques may be used in a similar manner.
- Timber framing, which is insulating, is able to contribute to the production of a cool edge although, because the timber erodes away, it can make little contribution to any clamping system.
- Steel framing is conductive and needs to be used in conjunction with highly insulating glazing systems if it is to produce a 'cool edge' but being strong it can be used to produce a clamping system.

Any glass intended to be used in a fire-resisting glazed screen will achieve different levels of fire resistance in the two framing systems and results are not therefore interchangeable unless the change has been the subject of a fire engineering analysis.

It has to be recognised that it is very difficult to achieve 60min integrity in timber framed glazing applications when using non-insulating glass. There are

only a handful of glass/glazing systems that are capable of providing evidence of performance at this level and in all cases such evidence needs to be obtained and examined or a fire safety engineered analysis be undertaken.

D1. Edge cover

Edge cover has an important influence on the fire-resisting capabilities of glazed screens and vision panels and detailed guidance, taking into account the various parameters involved, is given in the data sheets on fire-resistant glazing at www.thefpa.co.uk/Resource/Design+Guide/.

D2. Influence of glazing system on maximum size

In order to maintain the 'cool edge', see above, needed to extend the duration of fire resistance, the glazing system shall be chosen for its ability to retain the glass in position at the specified size, for the appropriate period and detail guidance is given in the glazing data sheets at www.thefpa.co.uk/Resource/Design+Guide/. Where intumescent materials are used in glazing systems they shall be of a type for which evidence of durability exists. Further information on the subject of intumescent materials for use in glazing systems is to be found in the joint IFSA/FRGGSA Information Sheet No 2.

IFSA Information Sheet No 2 (with FRGGSA), *The Role of Intumescent Materials in Timber and Metal Based Fire-resisting Glazing Systems.*

In order to achieve the extended durations at medium to large pane sizes, that is, above 1.2m^2, some tested glazing systems incorporate high temperature adhesives or are pressure glazed systems. Because of the risk of these not being used in any subsequent reglazing operation, following accidental breakage or similar, the use of systems which rely upon such adhesives is deprecated. When used, such systems shall carry a permanently attached metal plate advising of the need to use adhesives of the correct specification in any reglazing.

E. Specifying sealing systems

The following factors need to be taken into consideration when specifying sealing systems.

- the width of the gap to be sealed
- the available depth of support to the seal
- the type of construction on either side of the gap. It is important to know whether differential movement will occur and/or whether the surface erodes during heating
- the depth of seal required to achieve the level of fire resistance
- the orientation of the gap

  for example:

  - vertical gap/horizontal element
  - vertical gap/vertical element
  - horizontal gap/vertical element;
- the requirement for joints in the seal (if pre-formed);
- the possibility of the loss of the arrises on the gap edges, through charring, melting or spalling;

- environmental conditions (especially moisture resistance);
- the ability of the seal to restrict the passage of both hot and 'cold' smoke;
- resistance to mechanical damage;
- the longevity of the seal, so that it will perform satisfactorily for the life of the building, subject to maintenance in accordance with the manufacturers' instructions;
- the adhesion to the surface to which the seal is to be applied (including adhesion in the hot state);
- the ability of the seal to accommodate in-service movement, and its ability to perform its fire-resisting function in a gap at the limits of that movement.

Of particular importance is the ability of the seal to accommodate the deflection of the structure on either side, due either to load transfer or to thermally-induced distortion. Due to the wide range of building elements in which these gaps may be present, it is not possible to state with any reliability what magnitude of deflection may need to be accommodated. It is recommended that this is determined from an engineering analysis of the element(s) by suitably qualified persons.

Where this is not feasible, rule-of-thumb guidance is that conventional fire-resistant elements may be expected to deflect by around L/40 at mid-span or height (where L is span or height) if non-load-bearing or if uniformly loaded within their design parameters. Horizontal elements will tend to distort downwards, while vertical elements with a steel structure normally distort towards the fire at mid-height. Where fire resistance test evidence is available for the element then this should provide deflection data taken during the test, and should always be consulted by the designer or specifier of these seals.

Where differential movement takes place in service or during fire exposure then a flexible product is preferred to a rigid sealant. Where erosion of one or both surfaces forming the gap takes place then an intumescent seal may be more suitable than ablative materials. In vertical joints a seal with good adhesive properties is likely to be more successful than a 'non-sticky' product.

Foamed-in-place polyurethane foams are not suitable for fire stopping or linear gap seal applications.

References

British and European Standards

BSI DD 171:1987: *Guide to specifying performance requirements for hinged or pivoted doors (including test methods).*

BS 476: *Fire tests on building materials and structures.*

Part 8: 1972 (date restriction): *Test methods and criteria for the fire resistance of elements of building construction.*

Part 11: 1982: *Method for assessing the heat emission from building materials.*

Part 20: 1987: *Method for determination of the fire resistance of elements of construction (general principles).*

Part 21: 1987: *Methods for determination of the fire resistance of load bearing elements of construction.*

Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction.*

Part 24: 1987: *Method for determination of the fire resistance of ventilation ducts.*

Part 31.1: 1983: *Methods for measuring smoke penetration through doorsets and shutter assemblies. Method of measurement under ambient temperature conditions.*

BS EN 1154: 1997: *Building hardware. Controlled door closing devices. Requirements and test methods.*

BS EN 1155: 1997: *Building hardware. Electrically powered hold-open devices for swing doors. Requirements and test methods.*

BS EN 1363: 1999: *Fire resistance tests, Part 1: General requirements.*

BS EN 1364: *Fire resistance tests for non-load-bearing elements.*

Part 1: 1999: *Walls.*

Part 3: 2001: *Smoke control doors and shutters.*

BS EN 1366: *Fire resistance tests for service installations.*

Part 1: 1999: *Ducts.*

Part 2: 1999: *Fire dampers.*

Part 3: 2004: *Penetration seals.*

Part 4: 2003: *Linear gap seals.*

Part 5: 2003: *Service ducts and shafts.*

Part 6: 2004: *Revised access and hollow core floors.*

Part 7: 2004: *Conveyors systems and their closures.*

Part 8: 2004: *Smoke extraction ducts.*

prEN Part 10: *Smoke control dampers.*

BS EN 1634: *Fire resistance tests for door and shutter assemblies.*

Part 1: 2000: *Fire doors and shutters.*

Part 3: 2003: *Smoke control doors and shutters.*

BS 5234: Part 1: 1992: *Partitions (including matching linings). Code of practice for design and installation.*

BS 5268: *Structural use of timber.*

Part 4: Section 4.1: 1978: *Fire resistance of timber structures. Recommendations for calculating fire resistance of timber members.*

Part 4: Section 4.2: 1990: *Fire resistance of timber structures. Recommendations for calculating fire resistance of timber stud walls and joisted floor constructions.*

BS 5588: *Fire precautions in the design, construction and use of buildings.*

Part 9: 1999: *Code of practice for ventilation and air conditioning ductwork.*

Part 12: 2004: *Managing fire safety.*

BS 476 and BS EN 1634

A new series of European standards, under the designation EN 1634, is being developed as a series of fire tests for building products. It will gradually replace the BS 476 range of tests. The CEN standard has been introduced so that manufacturers of building products with fire resistance properties can demonstrate the compliance of their products with a Standard which is accepted across Europe. As parts of the EN 1634 series are ratified then they will be adopted as new British Standards. BS 476 and BS EN 1634 tests will be accepted in parallel for some time in the UK (the timescale for phasing out the BS 476 series has yet to be agreed) but most new testing is likely to be to the BS EN.

During the changeover, specifiers and contractors will need to take care that items intended for use together have all been tested to the same standard. It will not be possible to interchange or mix products tested alternatively to BS 476 and BS EN 1634.

BS 5839: *Fire detection and alarm systems for buildings.*

Part 1: 2002: *Code of practice for system design, installation, commissioning and maintenance.*

Part 3: 1988: *Specification for automatic release mechanisms for certain fire protection equipment.*

BS 6180: 1999: *Barriers in and about buildings. Code of practice.*

BS 8110: *Structural use of concrete.*

Part 1: 1997: *Code of practice for design and construction.*

BS 8214: 1990: *Code of practice for fire door assemblies with non-metallic leaves.*

BS EN ISO 9002: 1994: *Quality systems. Model for quality assurance in production, installation and servicing.*

BS EN ISO 13501: *Fire classification of construction products and building elements.*

Part 1: 2002: *Classification using test data from reaction to fire tests.*

Part 2: 2003: *Classification using test data from reaction to fire tests excluding ventilation services.*

PrEN 13916: *Fire resisting doorsets. Requirements and classification.*

BS EN 14013: *Smoke control doorsets. Requirements and classification.*

BS EN 50200: 2000: *Method of test for resistance to fire of unprotected small cables for use in emergency circuits.*

BS EN 50266: *Common test methods for cables under fire conditions. Test for vertical flame spread of vertically-mounted bunched wires or cables (various parts).*

ISO International Standards

ISO 10294: 1996: *Fire resistance tests - Fire dampers for air distribution systems,* Part 1: *Test method.*

ISO/DIS 10295: *Fire tests for building elements and components – Integrity and insulation performance testing of service installations.*

Part 1: *Penetration seals.*

Part 2: *Linear joint (gap) seals.*

International Electrotechnical Commission

IEC standard 60332: *Tests on electrical cables under fire conditions:* Part 3 (various sub-Parts): 2000: *Tests on bunched wires or cables.*

Fire Protection Association

Adair Lewis and William Dailey, *Fire risk management in the workplace,* 2nd edition, 2000.

LPC Rules for Automatic Sprinkler Installations incorporating BS EN 12845, Fire Protection Association, 2003.

RC16B, *Recommendations for cooking equipment (other than fish and chip frying ranges),* Fire Protection Association, 2003.

Loss Prevention Certification Board

List of Approved Fire and Security Products and Services (annual), LPCB.

Loss Prevention Standards

LPS 1056, *Requirements and tests for fire doors, lift landing doors and shutters.*

LPS 1132, issue 4, *Requirements and tests for LPCB approval of wall and floor penetration and gap seals, 1999.*

LPS 1158, issue 2, *Requirements and tests for fire-resisting glazing systems.*

LPS 1162, *Requirements and tests for fire dampers.*

LPS 1181, issue 2, *Requirements and tests for wall and ceiling lining materials and composite cladding materials.*

LPS 1182: Issue 2: 1994: *Requirements and tests for LPCB approval of fixed fabric smoke curtains, fixed metal smoke curtains and powered smoke curtains.*

LPS 1197, *Requirements for maintenance and repair of doors and shutters.*

LPS 1208, *Fire performance requirements for metal-faced fire-resisting insulated panels.*

National Fire Protection Association (USA)

NFPA 262, *Standard method of test for flame travel and smoke of wires and cables for use in air-handling spaces, 2002.*

Official documents

The Building Regulations 2000, Approved Document B, *Fire safety,* 2000 (with 2000, 2002 amendments).

The Building Regulations 2000, Approved Document N, *Glazing – safety in relation to impact, opening and cleaning,* 1998 (amended 2000).

Workplace (Health, Safety and Welfare) Regulations 1992.

The Scottish Building Standards: Technical Handbook: Non-Domestic, section 2, *Fire*, Scottish Building Standards Agancy, 2004.

The Building Regulations (Northern Ireland), *Technical Booklet E: Fire Safety,* Department of Finance and Personnel, 1994 (with amendments).

Trade associations' publications

Association of Builders Hardware Manufacturers

Code of Practice for Hardware Essential to the Optimum Performance of Timber (non-metallic) Fire-resisting Doorsets.

Association of Specialist Fire Protection

Ensuring best practice for passive fire protection in buildings, 2003.

Fire protection for structural steel in buildings, the Yellow Book, 3rd edition, 2004.

Firestopping and penetration seals for the construction industry, the Red Book, 2nd edition, 2004.

Fire rated and smoke outlet ductwork, the Blue Book, 2000.

Fire rated non-loadbearing partitions, the Purple Book, 2003.

An industry guide to the design for the installation of fire and smoke resisting dampers, the Grey Book, 2005.

Door and Shutter Manufacturers' Association,

Code of Practice for fire resisting metal doorsets.

Code of Practice for fire resisting roller shutters.

Guild of Architectural Ironmongers

Code of Practice for Architectural Ironmongery Suitable for use on Fire-resisting Self Closing, Timber and Emergency Exit Doors.

Intumescent Fire Seals Association

IFSA Information Sheet No 1, *The Role of Intumescent Materials in the Design and Manufacture of Timber Based Fire-resisting Doorsets.*

IFSA Information Sheet No 2 (with FRGGSA), *The Role of Intumescent Materials in Timber and Metal Based Fire-resisting Glazing Systems.*

IFSA Information Sheet No 3, *Guide to the Use of Smoke Seals in Doorsets.*

IFSA Information Sheet No 4, *The Ageing Performance of Intumescent Seals.*

Passive Fire Protection Association

Guide to demonstrating the performance of passive fire protection products, 2004.

Guide to undertaking assessments in lieu of fire tests, 2000.

Royal Institute of British Architects

'Services supplement: Design and Management', in *Standard form of agreement for the appointment of an architect,* SFA/99, 2004.

Other standards

TRADA Certification Ltd schedule of requirements, *Fire-resisting door assemblies with non-metallic leaves,* 1996.

Underwriters Laboratories Inc, UL 910, *Standard for safety test for flame-propagation and smoke-density values for electrical and optical-fiber cables used in spaces transporting environmental air.*

Glossary of terms

The following explanations apply to terms used in this publication.

Air transfer grille

Non-ducted grille installed in doors or partitions to allow air to transfer naturally from one room or zone to another without connection to a mechanical ventilation system.

Approved installer

A competent installation company which is approved/certificated under a recognised third-party installer scheme.

Building services

Water, gas and electricity, air conditioning, heating, communications, drains etc for buildings, which are supplied or collected by pipes, ducts and cables.

Cavity barrier

A fire-resisting barrier, not less than 100mm high, installed in a ceiling or floor void or roof space, that is able to provide the required fire resistance (and other) requirements of this design guidance, as appropriate.

Compartment floor

A horizontal, fire-resisting floor designed to contain fire within an area for a predetermined duration in order to minimise the risk of fire spread. (Insurers formerly referred to a compartment floor of 240 minutes fire resistance as a Fire-break floor.)

Compartment wall

A loadbearing or non-loadbearing vertical fire-resisting wall designed to contain a fire within an area for a predetermined duration in order to minimise the risk of fire spread. (Insurers formerly referred to a compartment wall of 240 minutes fire resistance as a Fire-break wall.)

Compartmentation

The division of a building into fire-resisting compartments, comprising one or more rooms, spaces or storeys, by elements of construction designed to contain a fire for a predetermined duration.

Conveyor closure

BS 476: *Fire tests on building materials and structures:* Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction.*

A device or system that in the event of a fire will close automatically and seal the openings in compartment walls or floors provided for the passage of goods on conveyor systems that when tested to BS 476: Part 22: 1987 or to BS EN 1366: Part 7 satisfies the appropriate fire resistance and other requirements of this design guidance.

BS EN 1366: Part 7: 2004: *Conveyor systems and their closures.*

Door closer

A type of self-closing device fitted to the face or edge of a hinged doorset and its frame to ensure that the door automatically returns to its closed position each time it is used.

Door hardware

All ironmongery for a door, whether essential door hardware (see below) or non-essential door hardware (see below).

Doorset

A complete, factory-produced door unit, comprising its frame, the door itself, stops, architrave and hardware.

Double door (doors in tandem)

In the context of this design guidance, the use of two or more door assemblies in series, that is, in tandem, in order to provide increased fire resistance with respect to one or more criteria.

Elements of construction

This term covers: structural framework, walls (internal and external), floors, roofs, stairs and enclosures to floor openings.

In this design guidance it is given a slightly broader meaning than in some official guidance. It includes, for example, the roof of a building, a feature not covered by the definition of the similar term 'element of structure' in Approved Document B to the Building Regulations.

Essential door hardware

Ironmongery which performs essential functions for its hanging, locking, closing or weather protection.

Field of direct application

Specific rules given in BS EN 1634: Part 1 which permit the variation of sizes, details and/or material contents away from the tested specimen.

BS EN 1634: *Fire resistance tests for door and shutter assemblies:* Part 1: 2000: *Fire doors and shutters.*

Field of extended application

Extent of approved variations in the construction based on calculation or best available knowledge and experience (expert judgement) which may in turn be supported by additional indicative testing. Variations covered are principally for larger sizes or arrangements/materials other than those incorporated in standard fire test specimens.

Fire engineering *see* Fire safety engineering

Fire hazard

A source or situation which has the potential to cause a fire.

Fire integrity *see* Integrity

Fire resistance

Often cited in terms of a length of time, fire resistance is the ability of a building material or an element of construction, in a fire:

- to continue to bear a certain load for that length of time without failure or deflection; or
- to prevent fire passing from one compartment to another for that duration; or
- both the above.

Various test criteria exist under the different Parts of BS 476 in relation to the fire resistances of different building materials/elements for varying applications.

Fire-resisting damper

A damper installed in an air distribution system, that when tested to BS EN 1366: Part 2 or ISO 10294: Part 1, provides the required fire resistance and other requirements of this design guidance.

Fire-resisting doorset or shutter assembly

A doorset or shutter assembly, of any design and construction which, when tested to methods 6,7 or 8 given in BS 476: Part 22:1987 or when tested to BS EN 1634: Part 1, provides the specified level of fire resistance and any other requirements of this section of the Design Guide, as appropriate to its design and use. The doorset or shutter may be insulated or uninsulated.

Fire-resisting duct

A duct used for the distribution of air, that when tested to BS 476: Part 24:1987 (ISO 6944:1985) or BS EN 1366: Part 1, provides the required fire resistance and other requirements of this design guidance.

BS 476: Part 22: 1987: *Methods for the determination of the fire resistance of non-load bearing elements of construction.*

Fire-resisting glazed screen assembly

An assembly of glass panes, mounted in a steel or timber frame, which when installed forms part of a fire compartment wall, that when tested to method 10 of BS 476: Part 22:1987, provides the required fire resistance and meets the requirements of LPS 1158 or equivalent and in addition any other requirements of this design guidance.

BS EN 1366: Part 5: 2003: *Service ducts and shafts.*

Fire-resisting service duct

A duct used to enclose building or other services, that when tested to BS EN 1366: Part 5, provides the required fire resistance and other requirements of this design guidance, as appropriate.

BS 476: Part 24: 1987: *Method for determination of the fire resistance of ventilation ducts.*

Fire-resisting smoke extraction duct

A duct, which passes through compartment walls or floors, which in the event of a fire, is designed to extract smoke to outside the building. For the purposes of this design guidance, this duct shall satisfy the requirements of BS EN 1366: Part 1 and BS EN 1366: Part 8.

BS EN 1366: Part 1: 1999: *Ducts;* BS EN 1366: Part 8: *Smoke extraction ducts.*

Fire risk

The product of the probability of fire occurring and the magnitude of the consequences of that fire.

Fire safety engineering

The application of scientific and engineering concepts to the design and construction of a building so that the building will satisfy the fire safety demands placed on it in relation to its size, layout, use and location.

Fire stopping

A seal designed to make good any imperfections in fit such that the required fire resistance of the wall or floor, in terms of integrity, and insulation if appropriate, is maintained.

Glass doorset

Hinged or pivoted doorset where the hinges or pivots are attached directly to and support the glass panel.

Glazed doorset

Hinged or pivoted doorset where the glass panel represents more than 50% of the leaf area where hinges or pivots are attached to the non-glazed perimeter.

Height of building

Depends on the type of building and the roof configuration. For guidance see Diagram C3 of Appendix C to Approved Document B to the Building Regulations (accessible via www.odpm.gov.uk and follow links to 'Building Regulations – Documents and publications').

Insulated door

Insulated doors can typically be either of timber construction, generally up to 60 minutes fire resistance, or of a timber faced, and possibly lipped, mineral cored and/or framed construction, or be of an insulated steel faced flush door or a metal framed stile and rail construction incorporating insulating glass. The performance of an insultaed door is evaluated via the procedures of clause 6 of BS 476: Part 22.

Insulation

The ability of an element of construction to restrict the transfer of heat from the fire side to the non-fire side of the element.

Integrity

The ability of an element of construction to restrict the spread of fire, smoke and combustion gases from the fire side to the non-fire side of the element.

Lateral shutter

A door comprising a horizontally moving curtain primarily used for closing off large openings such as occur at the entrance to individual shops or for atrium protection normally in shopping centres.

Linear gap fire seal

A fire-resisting barrier, installed in a gap not more than 150mm wide in a wall or floor, or around building services, that is able to provide the required fire resistance and other requirements of this design guidance, as appropriate. Linear gap seals may be static in action or may be intended to allow movement between adjacent construction elements under normal service conditions, and under fire conditions maintain the integrity and, where specified, insulation of the gap.

Material of limited combustibility

For the purposes of this Design Guide, a material of limited combustibility is:

- any non-combustible material;
- any material of density 300kg/m^3 or more which, when tested to BS 476: Part 11, does not flame and for which the rise in temperature on the furnace thermocouple is not more than 20°C;
- any material with a non-combustible core at least 8mm thick having combustible facings (on one or both sides) not more than 0.5mm thick (where a flame spread rating is specified, these materials should also meet the appropriate test requirements);
- any material of density less than 300kg/m^3 which, when tested to BS 476: Part 11, does not flame for more than 10s and for which the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and on the furnace thermocouple is not more than 25°C.

Non-combustible

A material may be considered to be non-combustible if it satisfies the requirements for non-combustibility when tested in accordance with BS 476: Part 4 or Part 11, that is, it does not flame and there is no rise in temperature on certain specified test thermocouples.

Non-essential door hardware

Parts fixed to a door for decorative purposes rather than the functions described under *Essential door hardware*. Sometimes called door furniture.

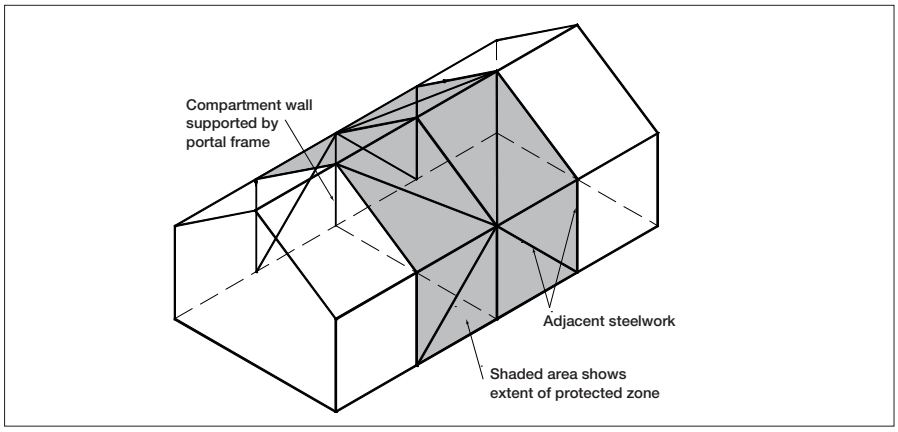
Penetration seal

PrEN 1366: Part 3: *Penetration seals.*

A system for sealing any void in a compartment wall or floor, through which building services pass which, when tested to prEN 1366: Part 3 provides the integrity requirement specified in this design guidance.

Protected zone

The protected zone comprises those sections of the roof, external walls and supporting frame of a single-storey building (and, where applicable, a multi-storey building) adjacent to and within a specified distance on each side of a compartment wall.



Qualified assessment

An assessment based on fire engineering principles and/or guidance, which has been prepared by a nationally accredited, competent body.

Qualitative Design Review

A process which establishes the fire safety objectives for a building under design, as part of a fire safety engineering analysis, and is normally carried out by a multi-disciplinary team.

Release mechanism

A series of links or control devices capable of holding open and releasing a fire-resisting or smoke control doorset so as to close automatically on receipt of a signal of a fire.

Self-closing device

A device or mechanism to be attached to or be part of a fire-resisting doorset or shutter assembly which provides a return to the closed position. Rising butt hinges are not permitted.

Smoke barrier

A doorset or vertical dropping shutter assembly with a two-stage operation, to meet the requirements of prEN 12101: Part 1, which may or may not be fire resisting, which prevents the uncontrolled spread of buoyant smoke.

prEN 12101: Part 1

Smoke leakage control door

A doorset or shutter assembly to meet the requirements of BS EN 1634: Part 3, which may or may not be fire resisting, which is provided to reduce smoke leakage. (The ambient temperature smoke door is designed to be a back-up provision.)

BS EN 1634: Part 3: 2003: *Smoke control doors and shutters.*

Supporting construction

Any rigid or flexible type of wall construction which is capable of supporting a fire-resisting doorset or shutter assembly.

Uninsulated door

An insulated door does not possess the ability to rstrict the rise of temperatures on the non-fire side of the door which would result in fire being transmitted only when integrity fails. that is, it does not restrict the passage of conducted and radiated heat in the manner of an *Insulated door.*

Index

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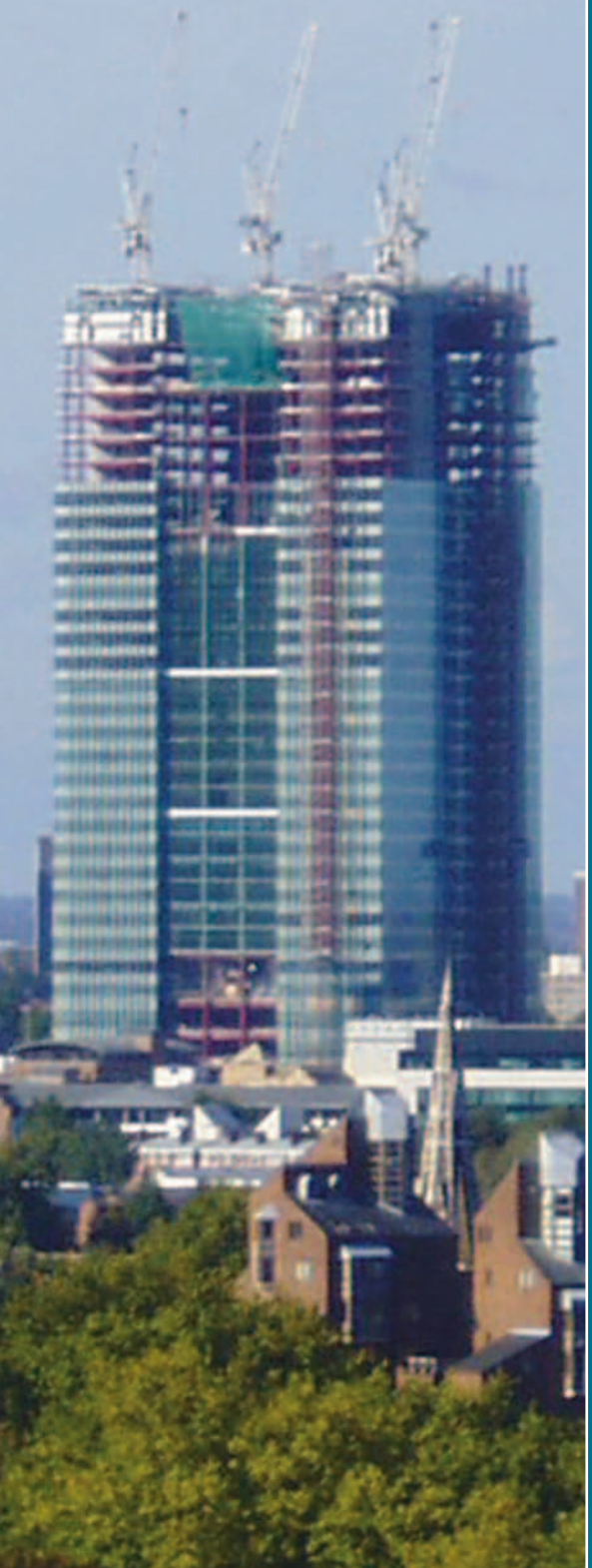
Design guide

FPA DESIGN GUIDE:
THE FIRE PROTECTION
OF BUILDINGS

Core document

PROTECTION OF OPENINGS AND SERVICE PENETRATIONS FROM FIRE



FPA
Fire Protection Association

InFiReS