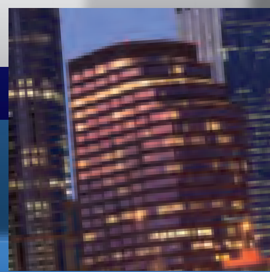
warrington certification



Technical Directory of Certificated Fire Products and Services

Part 1

Principles of Passive Fire Protection of Buildings

Technical Directory of Certificated Fire Products and Services Part 1 Principles of Passive Fire Protection of Buildings

Warrington Certification

Technical Directory of Certificated
Fire Products and Services

Part 1:
Principles of passive fire protection of buildings

Warrington Certification Technical Directory: Part 1: Issue 1: February 2008

Warrington Certification

Technical Directory of Certificated Fire Products and Services for Buildings

This publication is one of the series which comprises the Technical Directory of fire products and services which have been approved by Warrington Certification. In each Part of the Technical Directory there is a section of introductory text to help the designer/specifier, followed by listings of relevant products/systems for which certificates have been issued by Warrington Certification. The complete list of the publications available or in preparation is as follows:

Part 1: Principles of passive fire protection of buildings

Part 2: List of FIRAS certificated installation contractors

Part 3: Certificated fire risk assessors

Part 4: Products certificated against the requirements of the CPD

Part 5: Timber doorsets (including hardware, glazing and seals)

Part 6: Fire stopping (penetration seals, linear gap seals and cavity barriers)

Part 7: Steelwork protection

Part 8: Glass and glazing systems

Part 9: Steel doorsets (including hardware, glazing and seals)

Part 10: Industrial doorsets (including hardware, glazing and seals)

Part 11: Lift landing doors

Part 12: Separating elements of construction including external walls and sandwich panels

Part 13: Air transfer grilles

Part 14: Wall and ceiling linings

Part 15: Ductwork

Part 16: Dampers

Part 17: Smoke and heat extract fans

Part 18: The smoke and toxicity performance of materials following ignition

Part 19: Thermal insulation products

Part 20: Floor coverings

Contents

Introduction

WHAT IS CERTIFICATION AND WHY HAVE IT?

Third-party assessment or certification is conformity assessment carried out by a body that is independent of both supplier and customer organisations.

The International Organisation for Standardisation, ISO, lists eight different systems of assessment, each valid as a third-party scheme. These range from type testing of samples of a product through to 100% testing, with various intermediate levels.

In the fire industry we are most accustomed to third-party product certification; the system comprises type testing of the product, assessment and surveillance of the factory production control system and audit testing. Labelling of the product and listing in a widely available publication are also usual features of these schemes.

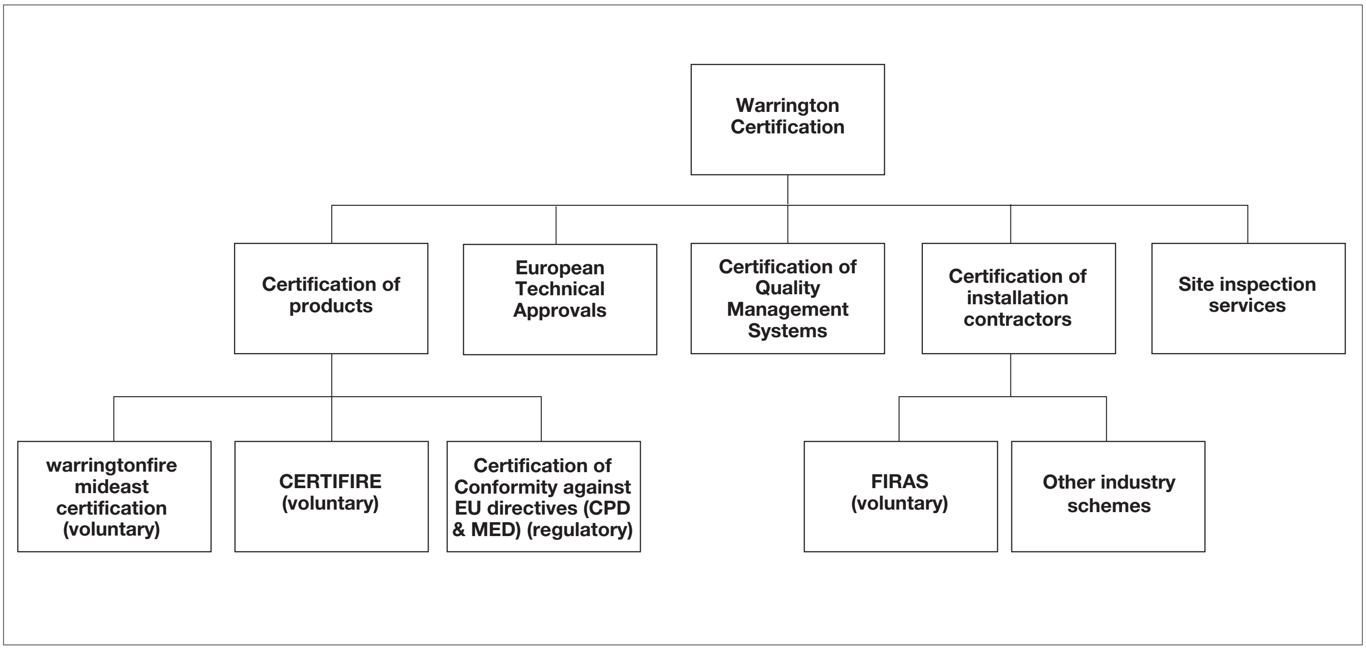
The fundamental benefit of third-party certification - put simply - is that it gives the specifier, customer, end user, regulator or any combination of these an informed choice when purchasing or selecting the product. Choosing a product, which carries the badge or mark of a reputable third-party certification body, will provide safeguards as to the performance of the product. Testing (to national or international standards) will have verified that it meets the specification, while inspection of the manufacturing process has checked that there is consistency in quality and conformity of manufacture. Also, in the rare event of a failure, choice of a certificated product will help to mitigate against a possible accusation of negligence, which may be directed towards the specifier or other individual concerned.

In North America, certification is also referenced in the US codes and standards as the term listing; ‘listed’ is defined officially by the National Fire Protection Association (NFPA) as equipment, materials or services included in a list published by an organisation that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states that the equipment, material or service meets appropriate designated standards or has been tested and found suitable for a specific service (clause 3.2.5, NFPA 101, 2006 edition). The term ‘labelled’ is defined as equipment or materials to which has been attached a label, symbol or other identifying mark of an organisation that is acceptable to the authority having jusrisdiction and concerned with product evaluation, that maintains periodic inspection of production of labelled equipment or materials, and by whose labelling the manufacturer indicates compliance with appropiate standards or performance in a specified manner (clause 3.2.4, NFPA 101, 2006 edition). In the middle-east region, where NFPA 101 is often referred to by local regulators for fire safety design of buildings, the terms listed and certified are alternately used to reference the process of product testing, evaluation, factory production control and labelling by a third-party accredited and approved agency.

Third-party certification equally applies to the installers of the products and in reading this Directory the word ‘product’ can be considered also to embrace the installation contractor. In this volume much emphasis is placed on the need to use certificated products and systems, as well as on the need for them to be fitted by competent, specialist and certificated installation contractors.

Warrington Certification is a third-party certification body, accredited by the United Kingdom Accreditation Service (UKAS). Third-party certification services are provided by Warrington Certification and comprise:

- certification of products and systems under CERTIFIRE;
- certification of installation contractors under FIRAS;



Schemes operated by Warrington Certification

- European Technical Approvals
- attestation of conformity for the Construction Products Directive (CPD) and Marine Equipment Directive (MED);
- quality management system certification to ISO 9001: 2000;
- certification of products/services under the Warringtonfire – mideast certification scheme;
- certification of security products;
- inspection services.

CERTIFIRE certification (for products and systems) and FIRAS certification (for installation contractors) are operated by Warrington Certification, an independent, third-party testing and approvals organisation accredited by the United Kingdom Accreditation Service (UKAS).

CERTIFIRE certification

CERTIFIRE is voluntary third-party certification (for fire protection products), operated by Warrington Certification, accredited by UKAS to BS EN 45011, for a number of product categories.

Certification comprises:

Initial type testing

Testing against industry-agreed Technical Schedules (see Appendix).

Quality Management System

Certification and surveillance of the manufacturer's quality management system to ISO 9001: 2001.

Factory production control

Assessment and surveillance of the manufacturer's production control system.

Product audit testing

Periodic audit testing of the product.

Labelling

Fixing of labels as appropriate.

Directory

Certificated products are listed in this Directory (see the list on page 2) and on a website at www.warringtonfire.net. Categories of fire protection products certificated under CERTIFIRE include the following:

- fire protection of structural steelwork;
- cavity barriers;
- penetration seals;
- ductwork;
- fire-resisting doorsets;
- fire door hardware;
- intumescent and smoke control door edge seals;
- fire-resistant glass and glazing systems;
- wall and ceiling linings.

FIRAS certification

FIRAS is voluntary, third-party certification for installation contractors (installers of fire protection systems), operated by Warrington Certification, accredited by UKAS to BS EN 45011, for a number of installer categories.

Certification comprises:

Technical assessment of an installation contractor's capability

Assessment of an installation contractor's technical capability, in accordance with the relevant industry-agreed scheme document, and includes competence assessment of the contractor's relevant personnel.

Quality Management System assessment

Certification and surveillance of the contractor's quality management system to ISO 9001: 2001 or assessment against the requirements of the relevant industry-agreed scheme document where ISO 9001: 2001 is not appropriate.

Regular surveillance inspections of on-going installations

Continual assessment of technical competence of personnel and workmanship.

Certificates of Conformity

Contractors demonstrate compliance by issuing Certificates of Conformity for each installation.

Directory

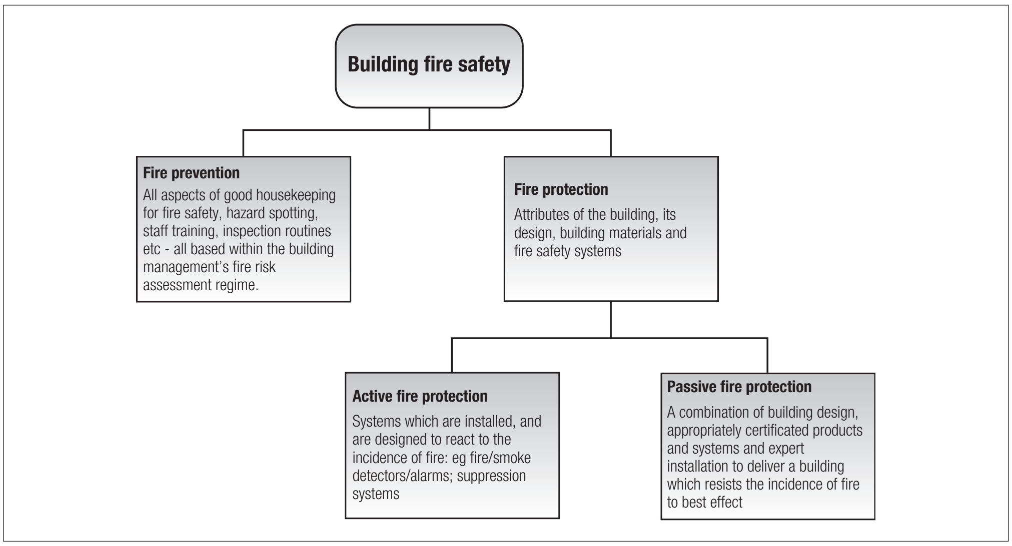
Certificated installation contractors are listed in this Directory and at www.warringtonfire.net. The categories of products which may be installed by FIRAS certificated contractors include:

- steel protection;
- board cladding;
- reactive coatings (intumescent paint);
- spray coatings;
- penetration and linear gap seals;
- cavity barriers;
- timber fire doors;
- steel fire doors;
- rolling shutter doors;
- glass and glazing systems;
- ductwork;
- separating elements (partitions and ceilings);
- residential and domestic sprinkler systems;
- commercial and industrial sprinkler systems.

Objective of this directory

The principal purpose of Part 1 of the Technical Directory is to provide a description of passive fire protection and to aid an informed choice of third-party certificated products and systems.

Most Parts of the Directory will deal with different elements of construction and the requirements for building products and systems which have a role in passive fire protection. Section 1 which follows this introduction briefly sets the subject in context by summarising the legislation and related standards which affect the work of designers, product specifiers and builders in relation to fire protection. The book is aimed at the broad audience of those people.



The two terms,

- fire prevention and
- fire protection

are in common use in relation to fire safety in buildings. They may be considered as having different meanings.

Fire prevention

Fire prevention encompasses fire safety measures which can work together to prevent the outbreak of fire in a premises. If fire does break out, fire prevention measures can then work to limit its effect. An example of a fire prevention measure is the training of staff to spot and report hazards which may lead to a fire, such as damaged electrical equipment or fittings.

Aspects of fire prevention may be simple to specify but difficult to apply; it would be easy to issue an instruction that staff are not going to use multiple electrical adaptors on power sockets but possibly not so simple to enforce it. Fire prevention leans heavily on good housekeeping with respect to fire hazards – see also 'Risk assessment', page 9.

Fire protection

Fire protection, for a building, involves designing and providing for the building a range of attributes related to fire safety, such features being linked to the type of building and the uses to which it is to be put. Fire protection measures will act to reduce the effects of heat and smoke on a building if fire breaks out. It will be necessary to ensure that the building is designed and constructed in compliance with any legislative requirements and related standards. The designer/specifier will need to be well informed about:

- the essentials of fire-safe design
- existing legislation and technical standards
- constructional safeguards
  - building materials
  - design choices
- escape routes and exits
- installation of fire detection and alarm equipment
- portable fire extinguishing equipment
- other active systems, for example, smoke control equipment or sprinklers.

Measures which arise from such considerations fall into two broad categories. Some are classed as active fire protection; for example

- automatic smoke detection/alarm systems
- automatic fire detection/alarm systems
- automatic suppression systems, for example sprinklers, CO_2 systems etc.

Active fire protection equipment and systems are, by their nature, built-in extras, which act to implement protective procedures once they detect fire and/or smoke. They are provisions which enhance the fundamental benefits of passive fire protection.

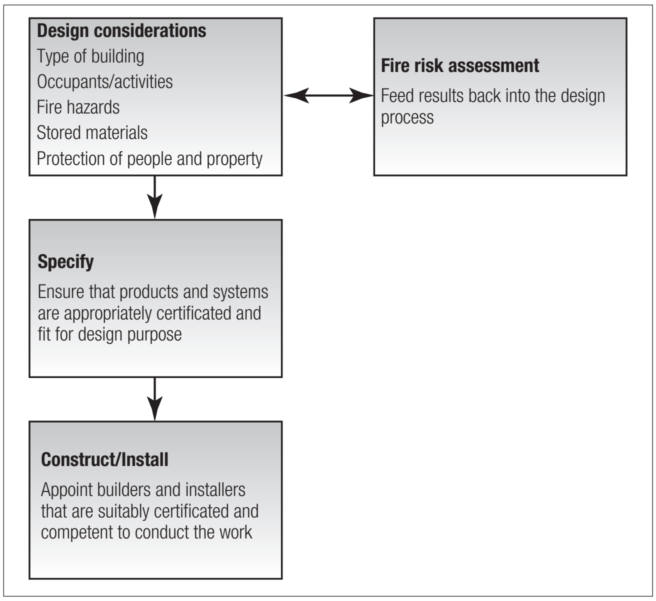
Passive fire protection measures generally result from a combination of design, assembly and materials' choice and may include:

- the protection of a building's structural elements against the effects of fire;
- the use of building materials which will not contribute to the growth of a fire;
- the provision of compartments with fire-resisting walls and floors to inhibit the spread of fire;
- designing and siting the building to reduce the likelihood of fire entering from outside.

The design approach

The designer will take a broad approach to designing a building. Fire protection will be one of the key considerations and to incorporate appropriate fire protection the designer will:

- assess the purpose and function of the building
- look more closely at the potential fire hazards in terms of activities, manufacturing processes and stored materials
- design the elements of construction to withstand the effects of a fire for a predetermined design duration, with reference to legislation, official guidance and standards and the levels of safety specified therein;
- incorporate compartmentation so that
  - as far as possible fire hazards are separated
  - any outbreak of fire (and resulting smoke) is effectively isolated
  - the uncontrolled spread of fire and smoke is prevented



Stages in the design-and-build process.

- occupants will find it less hazardous to evacuate the building;

- ensure that the separating elements of compartmentation (the compartment walls and floors) are specified to perform adequately in the event of fire.

Section 2.2 takes this topic further and considers questions which the designer should ask about the choices of passive fire protection components and materials.

Design duration

This book makes frequent use of the term 'design duration' as shorthand for the period of fire resistance required for the various features of the building being designed. It is for the designer to determine the duration of fire resistance and care is taken in this publication not to be specific about any such durations.

Insurance requirements

As well as collaboration with the client the designer of an industrial/commercial building should consult the likely insurer to determine if there may be additional design requirements for that type of building arising from insurance considerations. Much of the UK's legislation related to building fire safety has life safety as its objective, with emphasis on means of escape provisions. Insurers look beyond that objective in considering property protection and related matters – the building fabric, the building contents and related values, and the business interruption effects that might attend a fire.

Leading UK insurers, via the Fire Protection Association, are funding the Insurers' Fire Research Strategy (InFiReS), which is a programme of work aimed at developing guidance on best practice for the protection of property and business from loss due to fire and other risks. One outcome of the programme is a series of publications dealing with aspects of passive fire protection, under the umbrella title of *Design Guide: the Fire Protection of Buildings* (ref.1). The stated purpose of the Design Guide (ref.2) is to assist in:

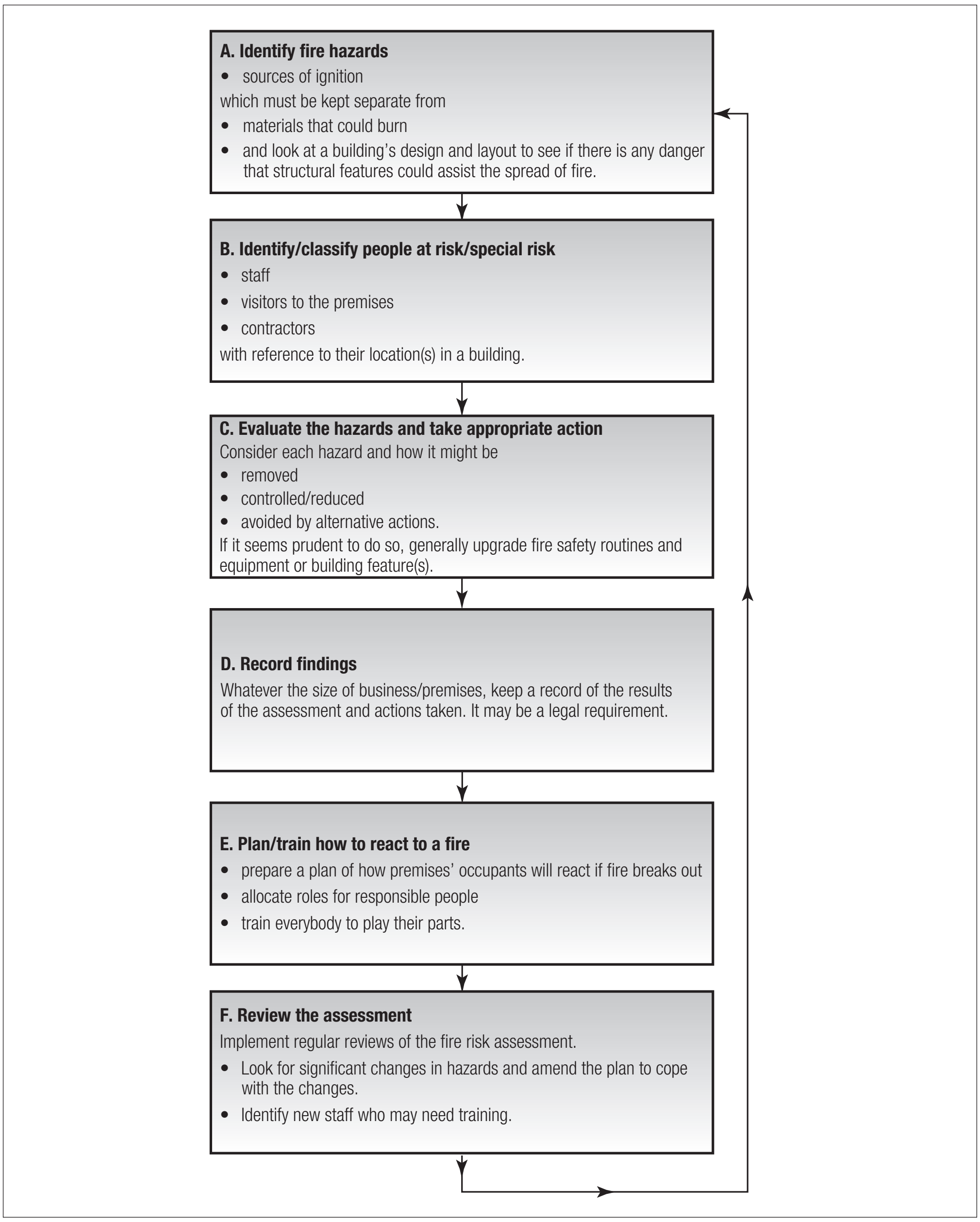
- minimising the effect of fire on a business
- limiting the effects of business interruption
- allowing a business to be trading within 24 hours of a fire
- protecting the buildings within a business.

One of the constituent publications has the title *Essential Principles* (ref.2) and it lists a set of 12 principles to be observed in the design and construction of commercial and industrial premises. Of particular relevance to the message of this Directory (which can apply as well to domestic premises) are principles 10 and 11:

- **specify only third-party certificated fire protection products**
- **commission competent, specialist contractors to install fire protection products/systems.**

Risk assessment

Owners or occupiers of business premises face a new regime of fire legislation following the implementation of the Regulatory Reform (Fire Safety) Order 2005. The Order is discussed in more detail in section 1.4. One of its effects is that owners or occupiers will be more directly responsible for the fire prevention measures in their premises, including the need to carry out a fire risk assessment. This management task should be considered in advance of the design of any new commercial premises and the designer's discussions with whoever is the responsible person at the new workplace should include the likely results of the fire risk assessment. For reasons outlined above it is highly desirable that there is insurer input at the fire risk assessment stage.



Key stages in fire risk assessment

Certificated products are essential

The effectiveness of a building's design with respect to its performance in a fire depends crucially upon the materials used in its construction. Later sections of this book will touch upon criteria affecting the performance of products and materials. At this juncture it is emphasised that all products which play a part in passive fire protection shall have been tested satisfactorily to standards appropriate to their end use and certificated by an independent, UKAS-accredited certification body such as Warrington Certification. It cannot be stressed too strongly that building designers and others involved in the specification of passive fire safety products should specify only certificated products and systems.

The same applies to active fire safety systems, although they are outside the scope of this book at this time.

In the cases of both passive and active fire protection, construction and installation should be carried out by appropriately trained operatives working for contractors certificated to perform such work. The best of designs and the most suitable of products and systems will only provide the planned performance in a fire if construction and installation work is carried out properly.

1. Legal background and relevant standards

LEGISLATION

This first edition of Part 1 primarily addresses the current regulatory regime in the United Kingdom and does not attempt to cover all Regulations in all countries at this time. The intention is that a later edition will address Regulations in other parts of the world and the document will be amended accordingly.

1.1 General

Those who consult this book should need little introduction to the legislative background but it may help to set the scene by reviewing how building work in the United Kingdom is regulated.

- Parliament produces Statutes (Acts of Parliament), edicts of the legislature. Without intending to trivialise it may be useful to think of an Act – an item of primary legislation – as ‘the game’.
- Most modern Acts contain provisions which authorise others, office-holders or bodies (for example, a Secretary of State), to make regulations on particular subjects within the scope of application of an Act. Think of such regulations (secondary legislation, called Statutory Instruments) as the rules for playing a particular part of the game.
- Finally, official bodies, such as departments of state, may publish approved documents which (a) give advice about compliance with an Act or Regulations and (b) may cite other sources of relevant information (such as British Standards). A bit like hints on how to play to the rules.

Figure 1.1 shows the legislative arrangement which exists for building control in England and Wales.

1.2 Building legislation and fire safety

There are two principal branches of building legislation and fire safety in the United Kingdom:

- Building control is effected by the Building Act 1984 and its subsidiary legislation and guidance documents (see 1.3). It regulates new building work or material alterations to existing buildings.
- Requirements to establish and maintain fire safety in buildings in use are contained in the Regulatory Reform (Fire Safety) Order 2005 (see 1.4).

The Act	**Building Act 1984** The Building Act consolidated much of the primary legislation relating to building which then existed in other Acts of Parliament. Much of the Act is concerned with building regulations and related matters.
The Statutory Instrument	**Building Regulations 2000 (SI 2000, No. 2531)** The current Building Regulations are the descendants of a long line of Statutory Instruments on the topic and the 2000 version has been amended several times since first issued. The Building Regulations present the requirements which must be complied with, in terms of design and construction, broadly to ensure the health and safety of those who occupy or visit buildings. Table 1.1 lists the 14 Parts of Schedule 1 of the Building Regulations.
Guidance documents	**Building Regulations Approved Documents** There exists a series of Approved Documents, approved and issued by the Secretary of State, aimed at providing guidance for those seeking to comply with the provisions of the Building Regulations. See also Table 1.1.

Fig. 1.1. The family of legislation and guidance documents directly affecting building. (The Building Regulations 2000 apply to England and Wales but there are similar regulations for Scotland and Northern Ireland.)

Table 1.1. Topics in the Building Regulations and supporting approved documents (2007).

Topic in the Building Regulations	Approved document available?
Sch.1 Part A. Structure	Yes, 2004 with amendments
Sch.1 Part B. Fire safety	Yes, two volumes, April 2007. Vol 1 *Dwellinghouses,* Vol 2 *Buildings other than dwellinghouses*
Sch.1 Part C. Site preparation and resistance to contaminants and moisture	Yes, 2004
Sch.1 Part D. Toxic substances	Yes, 1992 with 2002 amendments
Sch.1 Part E. Resistance to the passage of sound	Yes, 2003 with 2004 amendments
Sch.1 Part F. Ventilation	Yes, 2006
Sch.1 Part G. Hygiene	Yes, with 1992 and 2002 amendments
Sch.1 Part H. Drainage and waste disposal	Yes, 2002
Sch.1 Part J. Combustion appliances and fuel *storage systems*	Yes, 2002, *Guidance and supplementary information on the UK implementation of European standards for chimneys and flues*
Sch.1 Part K. Protection form falling, collision and impact	Yes, 1998 with 2000 amendments
Sch.1 Part L. Conservation of fuel and power	Yes, 2006 as follows: L1A. *New dwellings* L1B. *Existing dwellings* L2A. *New buildings other than dwellings* L2B. *Existing buildings other than dwellings*
Sch.1 Part M. Access to and use of buildings	Yes, 2004
Sch.1 Part N. Glazing – safety in relation to impact, opening and cleaning	Yes, 1998 with 2000 amendments
Sch.1 Part P. Electrical safety	Yes, 2006
Regulation 7. Materials and workmanship	Yes, 1992 with 2000 amendments

1.3 Building Regulations

It was seen in the preceding sections that in England and Wales the design and construction of buildings matters is controlled by the Building Regulations 2000. In England and Wales, Part B of Schedule 1 of the Building Regulations 2000 deals with fire safety in new buildings or in buildings subject to material alterations. Paragraphs B2 to B4 of the Schedule deal with fire spread inside and outside a building and the need to use methods of construction and building materials which will inhibit fire spread. Approved Document B (ref. 3) (for England and Wales) gives suggestions for technical solutions for fire safety problems in various types of buildings to aid compliance with the Building Regulations.

In Scotland and Northern Ireland (and also in the Republic of Ireland, where a similar system exists) other legislation and guidance documents apply; their regulatory requirements and technical guidance are very similar to those that exist for England and Wales.

This edition of Part 1 primarily addresses Regulations current in the UK and does not attempt to cover all Regulations in other countries at this time.

Building regulation in the United Kingdom

England and Wales

Figure 1.1 lists Statutory Instrument 2000 No. 2531, Building Regulations 2000, as the subsidiary building control legislation in England and Wales, and Table 1.1 lists the set of supporting Approved Documents.

Scotland

In Scotland the relevant legislation is the Building (Scotland) Regulations 2004 (Scottish Statutory Instrument 2004 No. 406). Guidance on achieving the standards set in those Regulations is contained in the Scottish Technical Handbooks (revised in May 2007), which are available in two volumes, dealing with Domestic and Non-domestic buildings (ref. 4). The Handbooks are available to view online or download in full or part in PDF format via www.sbsa.gov.uk/tech_handbooks/tbooks2007

Northern Ireland

In Northern Ireland the controlling legislation is the Building Regulations (Northern Ireland) 2000 (Statutory Rule 2000 No. 389, (as amended)). Building control matters are the responsibility of the Department of Finance and Personnel, which produces a series of Technical Booklets to aid compliance with the Regulations. Technical Booklet E covers fire safety (ref. 5): for more information go to www.dfpni.gov.uk and search successively for Building Regulations and Technical Booklets.

Isle of Man

In the Isle of Man building control operates via the Manx Government's Building Regulations 2003, Statutory Document No. 829/03, made under the Island's Building Control Act 1991.

Channel Islands

The procedure for building control varies across the islands but is broadly similar to the system in England and Wales, comprising an item of subsidiary legislation (Regulations in Guernsey, Byelaws in Jersey) supported by a set of technical guidance publications.

1.3.1 Building Regulations: Principal aims

In summary, the principal aims of the Building Regulations, in the event of fire in a building, are to ensure:

Means of warning and escape

- provision of means of giving an alarm of fire
- provision of a satisfactory means of escape for persons

Internal fire spread (linings)

- that fire spread over the internal linings of buildings is inhibited
- that fire growth in terms of heat release (Class 0) is limited

Internal fire spread (structure)

- the stability of the building in fire
- a sufficient degree of separation within the building and between it and adjacent buildings
- the presence of an automatic system of fire suppression if necessary
- that there are measures to inhibit the unseen spread of fire and smoke in concealed spaces

External fire spread

- external walls and roofs have adequate resistance to the spread of fire over the external envelope
- spread of fire from one building to another is restricted

Access and facilities for the fire service

- satisfactory access for fire appliances to buildings
- the provision of facilities in buildings to assist firefighters in life-saving operations

1.3.2 Building Regulations: Functional requirements

The 2000 Regulations (unlike some of the earlier versions) are not prescriptive. They do not contain precise details of technical requirements to specify exactly what type of steel section or brick or glazing to use for particular purposes. Instead they contain, in Part B of Schedule1, for example, descriptions of how a building should perform in a manner which safeguards the occupants should fire occur, that is, the functional requirements of that performance. It is the functional requirements of Part B that are of prime relevance in this book and it is Approved Document B (now in two volumes) that provides technical advice and suggested solutions to problems of designing fire safety.

Approved Documents B (just like others in the series) make it clear that their proposed solutions to problems commonly encountered in building work take the form of **guidance which does not have the force of law** and that there may be other methods of achieving a solution with regard to a particular functional requirement.

At the same time they draw attention to the provision in Regulation 7 (Materials and workmanship) of the Building Regulations that any building work subject to the requirements imposed by Schedule 1 should be carried out with proper materials and in a workmanlike manner. They also draw attention to the importance of using certificated products for purposes of passive fire protection and go on to state:

> 'Since the fire performance of a product, component or structure is dependent upon satisfactory site installation and maintenance, independent schemes of certification and accreditation of installers and maintenance firms … will provide confidence in the appropriate standard of workmanship being provided.'

1.4 The Regulatory Reform (Fire Safety) Order 2005

The UK Government carried out a major review of many existing pieces of legislation relating to fire safety, the main aim being to arrive at a single, simplified fire safety regime which would have general application across workplaces and non-domestic premises. The result was the Regulatory Reform (Fire Safety) Order 2005, which came into effect on 1 October 2006 and applies in England and Wales. It covers 'general fire precautions' and other fire safety duties needed to protect 'relevant persons' in case of fire in and around most 'premises'. The Order requires fire precautions to be put in place where necessary and to the extent that it is reasonable and practicable in the circumstances of the case.

The new system of regulation is risk-assessment based and includes the provision that the person responsible for a premises should undertake duties for fire safety therein. Risk assessment is a vital part of the planning process and is dealt with below.

Experienced designers will know all about the Building Regulations as they apply to domestic or other types of buildings. They may only just be finding out about the possible effects of the Regulatory Reform Order. It is a Statutory Instrument which repeals a great deal of existing fire safety legislation and while a full account of its provisions is beyond the scope of this book the text of the Order is available at www.opsi.gov.uk (the website of the Office of Public Sector Information), search for 'SI 2005 No 1541'. The Department for Communities and Local Government (CLG) has published a series of guides which introduce employers, managers, occupiers and owners to the new fire safety regime as it affects a variety of types of premises, under the generic title 'Fire safety risk assessment'.

While the Order is principally an item of secondary legislation dealing with responsibilities for and practicalities of implementing fire safety in workplaces (and some parts of blocks of flats and of houses in multiple occupation), designers may find that the Order brings them on board much earlier in the process, at the stage of considering fire risk assessments for new workplaces or major alterations of existing premises. Approved Document B indicates that a preliminary risk assessment can be used as part of a Building Regulations submission and can help identify if any additional features need to be considered with respect to the first occupation of a building.

The local fire and rescue authority is the enforcing authority for the provisions of the Order. Guidance on the consultation procedures that should be adopted to ensure that the requirements of all enforcing authorities are addressed at the stage of Building Regulations approval is given in the publication *Building Regulation and Fire Safety – Procedural Guidance* (published jointly by CLG and the Welsh Assembly Government) (ref. 6).

STANDARDS

1.5 National and European Standards

It is common for UK legislation (and supporting documents) which deals with technical matters to make reference to British and European standards as sources of additional information or guidance. It is the intention that later editions of this document will extend to cover the regulatory provisions of other countries, but this first edition is based on provisions applicable in the UK.

1.5.1 Design standards

The series of documents issued under the BS 5588 title, *Fire precautions in the design, construction and use of buildings*, is critical with respect to building. Some of the Parts of BS 5588 are Codes of Practice applying to particular occupancy types and the design of means of escape. See Table 1.2. 9. (A new standard, BS 9999, is in preparation as a successor to BS 5588. At the time this book is going for printing the final draft has been sent out by BSI for public comment.)

Table 1.2. Notes on Parts of BS 5588.

Standard part: date	Title
BS 5588 series	*Fire precautions in the design, construction and use of buildings*
Part 0: 1996	*Guide to fire safety codes of practice for particular premises/applications* This part lists published guidance on fire safety for particular premises/applications.
	Subsequent parts of the BS are codes of practice which provide recommendations and guidance for designers and construction teams in their tasks of incorporating measures that should, if fire occurs, safeguard the lives of those occupying or visiting a premises and may help to protect the building against the effects of fire.
Part 1: 1990	*Code of practice for residential buildings*
Part 5: 2004	*Code of practice for firefighting stairs and lifts*
Part 6: 1997	*Code of practice for places of assembly*
Part 7: 1999	*Code of practice for the incorporation of atria in buildings*
Part 8: 1999	*Code of practice for means of escape for disabled people*
Part 9: 1999	*Code of practice for ventilation and air conditioning*
Part 10: 1991	*Code of practice for shopping complexes*
Part 11: 1997	*Code of practice for shops, offices, industrial, storage and other similar buildings*
Part 12: 2004	*Managing fire safety* Contains a section entitled ‘Designing so that a building can be managed’, which touches on passive fire protection.

1.5.2 Fire test standards

There are also British Standards dealing with the fire resistance properties of building products and materials, principally the BS 476 series, *Fire tests on building materials and structures*, the principal parts of which are listed in Table 1.3.

A similar set of European Standards (the BS EN 13501 series) deal with the fire classification of construction products and building elements. Other European Standards (parts of BS EN 1364, 1365, 1366 and 1634) are the sources of reference for test methods for the various construction products which support the classification standards (see Table 1.3).

Table 1.3. British and European Standards relating to the fire performance of construction elements.

Standard number: date	Title
The fire performance of elements of structure, doors etc is determined by carrying out tests which are defined in British or European Standards	
British Standards	
BS 476	*Fire tests on building materials and structures*
Part 3: 2004	*Classification and methods of test for external fire exposure to roofs*
Part 4: 1970	*Non-combustibility test for materials*
Part 6: 1989	*Method of test for fire propagation for products*
Part 7: 1997	*Method of test to determine the classification of the surface spread of flame of products*
Part 8: 1972	*Test methods and criteria for the fire resistance of elements of building construction* Results obtained via Part 8 are acceptable for items tested before 1988.
Part 11: 1982	*Method for assessing the heat emission from building materials*
Part 12: 1991	*Method of test for ignitability of products by direct flame impingement*
Part 13: 1987	*Method of measuring the ignitability of products subjected to thermal irradiance*
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 loadbearing elements of construction*
Part 22: 1987	*Methods for determination of the fire resistance of non-loadbearing elements of construction*
Part 23: 1987	*Methods for determination of the contribution of components to the fire resistance of a structure*
Part 24: 1987	*Method for determination of the fire resistance of ventilation ducts*
Part 31: 1983	*Methods for measuring smoke penetration through doorsets and shutter assemblies*
European Standards	There are a number of European (CEN) standards being developed as fire tests for building products and they will gradually replace the BS 476 range of tests. As new CEN standards are ratified they will be adopted as new British (BS EN) standards. During the change from BS to BS EN testing, specifiers and contractors will need to ensure that products/components that are intended for use together have all been tested to an identical standard/regime. It is not permissible to interchange products that have been tested variously to BS or BS EN standards. See also the boxed note concerning classification codings.
BS EN 13501	*Fire classification of construction products and building elements*
13501-1: 2003	*Classification using data from reaction to fire tests*
13501-2: 2003	*Classification using data from fire resistance tests (excluding products for use in ventilation systems)*
13501-3: 2005	*Classification using data from fire resistance tests on components of normal building service installations (other than smoke control systems)*

Standard number: date	Title
13501-4: 2007	*Classification using data from fire resistance tests on components of smoke control systems*
13501-5: 2005	*Classification using data from external fire exposure to roof tests.*
	Other European Standards are the sources of reference for test methods for a range of construction products.
	Fire resistance
BS EN 1363-1: 1999	*Fire resistance tests. General requirements*
BS EN 1364-1: 1999	*Fire resistance tests for non-loadbearing elements. Walls*
BS EN 1364-2: 1999	*Fire resistance tests for non-loadbearing elements. Ceilings*
BS EN 1364-3: 2006	*Fire resistance tests for non-loadbearing elements. Curtain walling. Full configuration (complete assembly)*
BS EN 1365-1: 1999	*Fire resistance tests for loadbearing elements. Walls*
BS EN 1365-2: 2000	*Fire resistance tests for loadbearing elements. Floors and roofs*
BS EN 1365-3: 2000	*Fire resistance tests for loadbearing elements. Beams*
BS EN 1365-4: 1999	*Fire resistance tests for loadbearing elements. Columns*
BS EN 1366-1: 1999	*Fire resistance tests for service installations. Ducts*
BS EN 1366-2: 1999	*Fire resistance tests for service installations. Fire dampers*
BS EN 1366-3: 2004	*Fire resistance tests for service installations. Penetration seals*
BS EN 1366-4: 2006	*Fire resistance tests for service installations. Linear joint seals*
BS EN 1366-5: 2003	*Fire resistance tests for service installations. Service ducts and shafts*
BS EN 1366-6: 2004	*Fire resistance tests for service installations. Raised access and hollow core floors*
BS EN 1366-7: 2004	*Fire resistance tests for service installations. Conveyor systems and their closures*
BS EN 1366-8: 2004	*Fire resistance tests for service installations Smoke extraction ducts.*
BS EN 1634-1: 2000	*Fire resistance tests for door and shutter assemblies. Fire doors and shutters*
BS EN 1634-2: 2001	*Fire resistance tests for door and shutter assemblies. Smoke control doors and shutters*
BS EN 1634-3: 2004	*Fire and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware. Smoke control test for door and shutter assemblies.*
	Reaction to fire
BS EN ISO 1182: 2002	*Reaction to fire tests for building products. Non-combustibility test*
BS EN ISO 1716: 2002	*Reaction to fire tests for building products. Determination of the heat of combustion*
BS EN ISO 9239-1: 2002	*Reaction to fire tests. Horizontal surface spread of flame on floor-covering systems. Determination of the burning behaviour using a radiant heat source*
BS EN ISO 11925-2: 2002	*Reaction to fire tests. Ignitability of building products subjected to direct impingement of flame. Single-flame source test*
BS EN 13823: 2002	*Reaction to fire tests for building products. Building products excluding floorings exposed to thermal attack by a single burning item*

Note on European classification codings

Classification of performance of a product, following a fire resistance test, will be cited in minutes of integrity (integrity being indicated by the code ‘E’). In the example of a door, a 30 minute door is designated E30. Its additional capacity, say, to restrict smoke leakage is indicated by ‘S_a’, so a 30 minute door which restricts smoke is coded E30S_a. Other performance parameters are:

R: loadbearing	I: insulation
W: radiation control	C: self-closing.

It is to Standards such as those in the above tabulations that building products and materials will be tested by nationally accredited laboratories. Bodycote Warringtonfire laboratories, for example, carry out over 200 different kinds of tests to national, European or international specifications related to fire performance for the construction, transport and process industry sectors.

1.6 Construction Products Directive 1989

The purpose of the Construction Products Directive (CPD) is to replace existing national standards and technical approval systems with a coherent body of European-wide technical specifications for construction products, thus facilitating an open market in building materials and products within the European Union. As long as a product complies with the requirements of the Directive then it qualifies to carry the CE mark. The Directive's essential requirements include some which relate to performance in a fire and that performance will have been established by testing to the new European Standards. Testing at a notified body such as Bodycote Warringtonfire enables Warrington Certification to certificate products in support of CE marking against various EU Directives, including the CPD.

2. Passive fire protection: material choices

2.1 Purpose groups

Buildings vary dramatically in layout and construction materials/methods but it is frequently the case that buildings used for a particular purpose (for example, office blocks) might have similar attributes and thus similar fire hazards. When assessing the passive fire protection which is suitable for a building, and considering how it might stand up to the effects of a developing fire, relevant factors are:

- the aggregate of combustible materials – the building and its contents – which is available to burn, the fire load
- the relative ease with which the combustible materials can be ignited
- the rate at which fire (and smoke) is likely to spread after ignition – which will in turn be a factor of the types of combustible materials and their locations in the building.

> **Purpose group**
>
> A purpose group is a classification of a building according to the purpose to which it is to be put.

Clearly this is not an easy assessment but in official documents and as an aid to judging relative fire risks buildings have been classified into purpose groups by types of usage and hazards. Table 2.1 overleaf replicates the table of purpose groups over which Building Regulations guidance is applied.

2.2 The questions to ask

This book aims to help designers and others assess and specify the materials or products that are needed to deliver the passive fire protection which is planned for a particular building. What are the questions that need to be asked in reaching conclusions about choices? Some of them have already been previewed in terms of the aims of Part B of Schedule 1 to the Building Regulations. In the following list not all questions apply to all materials and products.

If fire breaks out in a building, will the chosen material/product:

- perform a particular passive fire protection function?
- contribute to fire growth?
- contribute to fire load?
- exhibit slow (good) or rapid (bad) surface spread of flame and heat release?
- maintain its integrity by virtue of its fire resistance?
- help preserve the stability of the structure?
- act to inhibit/restrict temperature rise, by virtue of its insulating properties?
- help resist the spread of smoke?
- inhibit deflection of wall and floor elements or the transference of loads?
- accommodate services without detriment to fire protection?
- exhibit durability?

In later sections of this book these question-topics are repeated in summary form to remind the specifier to review them in considering any particular aspect of fire protection.

Table 2.1. Classification of purpose groups for Building Regulations applications.

Title	Group	Purpose for which the building or compartment thereof is intended to be used
Residential (dwellings)	1(a)	Flat or maisonette
	1(b)	Dwellinghouse which contains a habitable storey with a floor level which is more than 4.5m above ground level
	1(c)	Dwellinghouse 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, home, school or other similar establishment used as living accommodation for, or for the treatment, care or maintenance of persons suffering from disabilities due to illness or old age or other physical or mental incapacity, or under the age of 5 years, or place of lawful detention, where such persons 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	Office or premises used for the purpose of administration, clerical work (including writing, book keeping, sorting papers, filing, typing, duplicating, machine calculating, drawing and the editorial presentation of matter for publication, police and fire and rescue 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, or performance (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 the rental of storage space to the public) 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 manufacturing, altering, repairing, cleaning, washing, breaking-up, adapting or processing any article; generating power or slaughtering livestock.
Storage and other non-residential	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.

Loadbearing capacity is the ability of a loadbearing element to support its load, where appropriate, without exceeding specified criteria with respect to both the extent of, and the rate of, deflection.

Integrity is the ability of a material or product to resist the passage of fire, smoke and combustion gases from the side exposed to the fire to its non-fire side.

Insulation is the ability of a material or product to resist the transfer of heat from the side exposed to the fire to its non-fire side.

2.3 Elements of construction

Subparagraph B3(1) of Part B of Schedule 1 of the Building Regulations requires that:

> ‘The building shall be designed and constructed so that, in the event of fire, its stability will be maintained for a reasonable period.’

And subsequent subparagraphs proceed to deal with:

- separating walls;
- subdivision of buildings by fire-resisting construction;
- the installation of automatic sprinkler systems where appropriate; and
- the need to plan against the unseen spread of fire and smoke within concealed spaces.

The stability of a building depends upon what Approved Document B calls its elements of structure, design features which are defined as:

‘a. a member forming part of the structural frame of a building or any other beam or column;

b. a loadbearing wall or loadbearing part of a wall;

c. a floor;

d. a gallery (but not a loading gallery, fly gallery, stage grid, lighting bridge or any gallery provided for similar purposes or for maintenance or repair);

e. an external wall;

f. a compartment wall (including a wall common to two or more buildings).’

N.B. The Approved Document (B3, para. 7.4) then lists some exclusions from these definitions.

Subsequent sections of this book are devoted to the key aspects of passive fire protection as they relate to both the elements of structure and to other constructional features which, in combination, provide the building’s inherent resistance to fire. The book does not deal with measures of active fire prevention.

2.4 What about Warrington Certification Technical Schedules?

CERTIFIRE provides independent, third-party product conformity certification which is accredited by UKAS. The technical requirements are established with industry through formal liaison panels and are published as Technical Schedules (TSs). The Technical Schedules form part of a series of controlled documents, which comprise the CERTIFIRE product certification scheme. They are prepared in accordance with the requirements of BS EN 45011 for product certification bodies. In addition to the Schedules the other controlled documents are:

- Rules for certification (which include the maintenance of a quality management system certificated to BS EN ISO 9000: 2001);
- General requirements for CERTIFIRE certification of passive fire protection products/systems;
- CERTIFIRE quality manual;
- certificates in the CF000 series, together with any appendices:
- documentation from manufacturer;
- Rules for use of the CERTIFIRE logo.

Technical Schedules normally include provisions for evaluations to ensure the fire performance of a product is maintained throughout a duration which would represent a reasonable working life. These may take the form of durability tests, weathering tests and/or tests to evaluate the effect of exposure to other climatic conditions.

3. Structural stability

3.1 General

It is evident, for reasons listed below, that a building should be designed so that, in the event of a fire, it resists the effects of fire and smoke and retains its structural stability for as long as possible. The reasons are:

- to give the occupants time to evacuate;
- in the case of a large and/or complicated building, to protect refuges where occupants may need to shelter from a fire;
- to help it retain its structure so that firefighters can work with less hazard; and
- it may be necessary that the structure survives so that the fabric can be restored.

Design decisions which take these reasons into account can only be reached after a comprehensive fire risk assessment. Then it will be possible to link considerations of the purpose group to aspects of design (a) to identify are the essential elements of structure and (b) to determine for how long they should be designed to resist a fire (what is generally termed the design duration for the purposes of this publication). After which the structural elements can be designed to provide the basis for the passive fire protection of the entire building.

What are the essential elements of structure? In purely fire protection terms, Approved Document B lists them thus:

- a member which forms part of the structural frame of a building or any other beam or column;
- a loadbearing wall or a loadbearing part of a wall;
- a floor;
- a gallery (but with some listed exceptions for specialised galleries);
- an external wall; and
- a compartment wall (including a wall common to two buildings).

Other authorities include

- a roof

and so does this book; when it is a matter of considering how structural elements act in concert in the face of a fire it may be helpful to consider the roof to be an element of structure, since roof collapse may impose new loads on any structural framework.

3.2 Structural fire resistance

The fire resistance of a building's structure is its capacity to resist the effects of a fire over a period of time. While every separate component of such a structure may be selected on the basis of its satisfactory performance in an appropriate fire test, the designer seeks to achieve a workable period of fire resistance, the design duration, from those components acting in combination. Thus the building's structure must retain its:

- loadbearing capacity – to stand up to its existing imposed loads and not to collapse under any extra loads occasioned by the action of the fire;
- integrity – not to disintegrate under the effects of heat (such as deflection and expansion);
- insulation – not to conduct heat through elements of structure and thus intitiate fires elsewhere in the building.

The protected zone

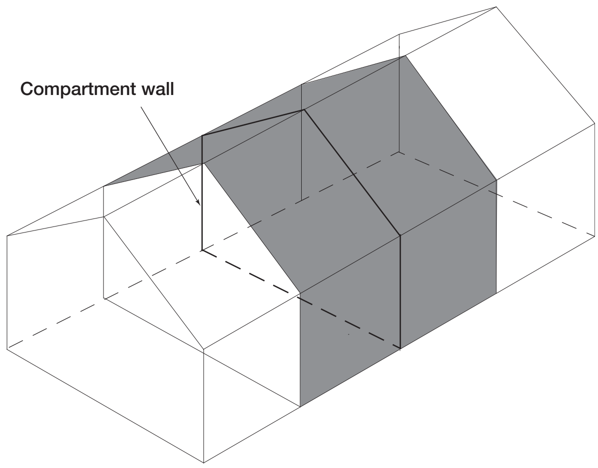


Fig. 3.1. The shaded area indicates the protected zone adjacent to a compartment wall.

The passive fire protection functions of a building's compartmentation, for example (see section 6), can be impaired if due consideration is not given to the requirement for a protected zone. The concept of the protected zone influences design choices in relation to external walls, structural framework, compartment walls/floors and roofs.

In a single-storey building (or multi-storey building, if applicable), it is vital that, in the neighbourhood of a compartment wall, the external walls, roof and supporting framework have adequate fire protection. A compartment wall will in any case go all the way to the underside of the roof, with any gaps appropriately sealed. In addition, extra protection in the protected zone, either inherent in the design and materials or provided by taking additional measures, is necessary to prevent a fire from breaking outside the roof close to such a wall and breaking into the adjacent compartment from the outside.

See, for more details, the FPA's publication *Design Guide: The Protected Zone* (ref. 9).

In these respects – probably more for elements of structure than any other applications – it is necessary to review the list of choices. If fire breaks out in a building, will the material/product chosen to act as an element of structure:

- perform a particular function in passive fire protection?
- contribute to fire growth as the fire develops?
- exhibit slow (good) or rapid (bad) surface spread of flame?
- maintain its integrity by virtue of its inherent fire resistance?
- contribute to the fire load in the building?
- help preserve the stability of the structure?
- act to inhibit/restrict temperature rise, by virtue of its insulating properties?
- help resist the spread of smoke?
- inhibit deflection of wall and floor elements or the transference of loads?
- accommodate services without detriment to fire protection?
- exhibit durability?

Combustible material

A material which cannot satisfy standard tests for non-combustibility when tested against, for example, the requirements of BS 476: *Fire tests on building materials and structures:* Part 4: *Non-combustibility tests for materials* or Part 11: *Method for assessing the heat emission from building materials* (see 15.3 for a short note on the test method).

Non-combustibility

A property of a material which meets the requirements for reaction to fire of BS 476: *Fire tests on building materials and structures:* Part 4: *Non-combustibility tests for materials.*

Answers to these questions will come from an understanding of the results of the fire risk assessment. The design duration of the structural framework will be a matter for determination by the designer after a full consideration of the relevant factors.

3.3 Choices of materials

When considering the choices of materials for elements of structure a designer might note essential principles 1 and 2 of the FPA's Design Guide:

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

Achievement of those aims will require using materials that are non combustible or have limited combustibility . Alternatively, products (which may include a proportion of combustible materials) need to have been satisfactorily tested to an appropriate standard, by an accredited, independent test body, to demonstrate that they do not make any significant contribution to fire growth. Or else, or in addition, with respect to surface spread of flame, products (such as lining boards, for example) shall have surface finishes which are rated as Class 0 (see page 34) over non-combustible cores.

3.3.1 Traditional approaches

Much of the housing stock in the United Kingdom owes its structural stability to a combination of masonry (brick/stone/blockwork) and timber. Other buildings have structural frameworks of timber, steelwork or reinforced concrete, those materials providing the loadbearing elements of structure. The walls may then comprise infill brickwork/blockwork, cladding systems, compostite panels or glazed assemblies, or a combination of those choices.

Designers who wish to know more about designing with masonry might consult the Institution of Structural Engineers' publication *Manual for the design of plain masonry in building structures* (ref.7).

3.4 Structural frameworks

Leaving aside traditional brick and timber constructions, this section considers buildings in which the structural stability is provided by a loadbearing framework or skeleton. Such a framework will act with other elements of structure – walls, floors and roofs – and in combination they provide the overall stability and physical strength of the building.

Structural frames are of three principal types

- column/beam assemblies;
- trussed assemblies;
- rigid (monolithic) frames

constructed variously from timber, steel or reinforced concrete. These three materials behave differently in use and also in the event of fire.

3.4.1 Timber framework

Timber is a tough framework material which is commonly used for roof trusses and floor joists but its obvious shortcoming is its vulnerability to fire. The two physical characteristics which have an effect on the fire performance of a timber member are its density and the size of its cross section.

Timber will char in a fire; timber beams and columns should be specified in sizes which will maintain structural effectiveness while charring is reducing the cross-sectional area of a beam or column and thus diminishing its strength. Timber columns will char appreciably faster than beams. Softwoods normally char faster than hardwoods although there are some exceptions.

It can be difficult to obtain a ready supply of timber in the larger sizes of sections and where these are needed it may be possible to obtain them as made-up laminated beams. Manufacturers' data sheets will address the issues of their suitability for different applications.

While the specification of structural timber members in larger-than-necessary cross sections will deliver improved fire resistance it may result in an aesthetically less pleasing result. Timber sections maybe upgraded to provide increased fire resistance by the use of fire-retardant treatments.

3.4.2 Reinforced concrete framework

The fact that reinforced concrete is very widely used for structural purposes, for floor and wall slabs as well as for structural members, is testimony to its strength and durability. Those attributes vary according to the strength of the concrete mixture and the nature and performance of the reinforcement material; designers might review the differences among reinforced concrete members which are:

- precast;
- cast in situ;
- prestressed.

For members which are precast or cast in situ, the main factors which have a bearing on their performance in fire are their size (in particular, length) and the depth of concrete cover enjoyed by the steel reinforcement. Depth of cover is also important for prestressed concrete members although, unlike regular reinforced concrete, their reaction in a fire is not to fail gradually in a ductile manner but to fail suddenly.

In general terms, however, concrete members have very good loadbearing capacity, do not contribute to fire growth or fire load (being non-combustible), and are of fairly low coefficient of thermal expansion, which is beneficial in respect of tendency to deflect. Concrete has low thermal conductivity, hence good insulation properties, which is a necessary adjunct to its loadbearing performance, since the reinforcing steelwork benefits from its insulation protection which the concrete provides against any loss of strength which the steel may experience in high fire temperatures (see 3.4.3).

3.4.3 Steel framework

Steel is used more than any other metal for structural framework. It is non-combustible, so it will not contribute to fire growth or fire load. It has high loadbearing capacity and is naturally durable.

The drawbacks of steel frameworks, in fire performance, are that (a) steel has a high coefficient of thermal expansion and high thermal conductivity, so is prone to deflection; and (b) steel loses its strength during exposure to higher temperatures – by the time 600°C is reached it will retain approximately only one-third of its original strength. It is therefore essential that structural steelwork is protected by insulating materials. Most commonly, steel members are protected by insulating boards, sprayed coatings or reactive coatings (intumescent paints).

Insulating boards are used to encase steel members but care must be taken to ensure that their protective function is not impaired by defective installation, since there must be no areas of steelwork left unprotected. Designers will understand that (a) such boardwork will increase the 'size' of the structural members and that will need to be taken into account when planning adjacent features; and (b) in industrial buildings, where, for example, errant forklift truckers may encounter steel uprights, additional physical protection measures may be necessary.

Spray coatings constitute mixtures based on mineral fibres or vermiculite-type cements, formulated and applied with the prime purpose of providing insulation.

Intumescent materials will, in a fire, expand to form an insulating layer. They too can be sprayed (or sometimes painted) onto the structural steelwork. Manufacturers' instructions should be followed concerning the preparation of steelwork (including choice of primer) before the application of intumescents, to aid adhesion, while layer thickness is critical and a finishing, sealer coat may be needed.

For either type of coating protection, lifetime durability can be affected by abrasion damage; management's fire protection protocols should include the regular checking of the condition of steelwork coatings.

The design of steel frameworks is a specialist subject, even without fire performance considerations, with particular attention being required in sizing individual beams and columns and their fixings to each other and to the foundations, all related to predicted loads and stresses.

3.5 Standards and other guidance

Structural frames should exhibit the minimum periods of fire resistance obtainable by reference to Tables A1 and A2 of Approved Document B, Volume 2, Appendix A. Table A1 cites testing to BS 476: Part 21 (for loadbearing elements of construction such as a structural frame) or alternatively, the relevant European standards. Those are BS EN 1365, *Fire resistance test for loadbearing elements*, Part 3: *Beams* and Part 4: *Columns*. As for applied protection, see prEN 13381, *Test methods for determining the contribution to the fire resistance of structural members.* This document is currently under revision and will be replaced by two parts which will deal with reactive coatings (Part 8) and passive products (Part 4)*.* Fire-resisting plasterboard-based systems for the protection of structural steelwork are covered by BS 8212, *Code of practice for drylining and partitioning using gypsum plasterboard.*

British Standard 5628: Part 2 is BSI's *Code of practice for permissible stress design (of timber structures)* while BS 8110: Part 1 is *Code of practice for design and construction (the structural use of concrete)*.

Framework materials will be tested to BS 476: Part 21 or the equivalent European standards.

Additional, detailed guidance is given in the Association for Specialist Fire Protection's publication *Fire protection for structural steel in buildings* (ref. 8, and see www.asfp.org.uk) and the Steel Construction Institute (www.steel-sci.org) publishes specialist advice.

3.6 Certification

Certification by Warrington Certification is supported by two directly relevant Technical Schedules, TS 14: *Passive fire protection materials used to provide fire protection to structural steelwork* and TS 15: *Intumescent coatings used to provide fire protection to structural steelwork.* Products listed in Part 7 of this Directory will be certificated against those Technical Schedules.

4. External walls

External walls, just like roofs in section 5, have a general function of withstanding the effects of wind and rain. But the designer knows that with respect to passive fire protection it is much more complicated than that, even if stated fairly simple in the Building Regulations:

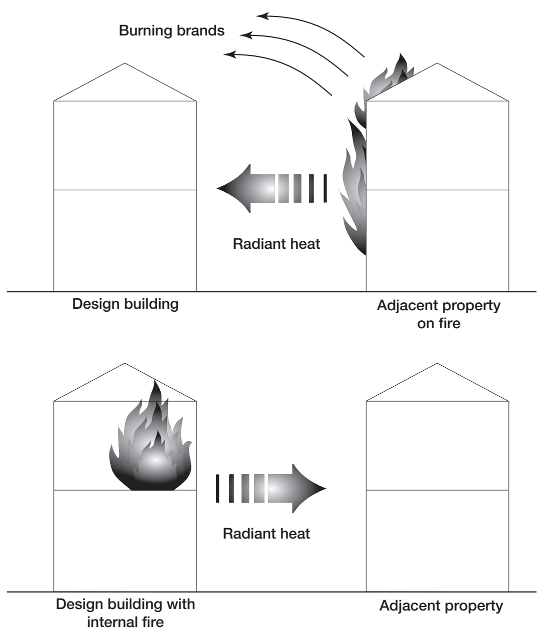
Building Regulations (England and Wales) 2000

Schedule 1, Part B, B4 – External fire spread

(1) The external walls of the building shall adequately resist the spread of fire over the walls and from one building to another, having regard to the height, use and position of the building.

(2) The roof of the building shall adequately resist the spread of fire over the roof and from one building to another, having regard to the use and position of the building.

4.1 General



Radiant heat and burning brands

The roof and external walls of the design building of the design building must be of materials and construction which are non-combustible and resist the likelihood of fire entering from burning brands and radiant heat emanating from a fire in a neighbouring property. The design duration of that effect will be calculated partly from an analysis of the results of the fire risk assessment for the site and the adjacent occupancies.

Should fire break out in the design building itself, its roof and walls must be of materials and construction to contain the fire within the fabric of the building, to restrict its effect on nearby property, in particular by limiting the radiant heat produced outside the walls and roof.

Fig. 4.1. External fabric and inbuilt passive fire protection.

The extract from the Building Regulations (see the start of section 4) is a clear statement of the fire resistance requirements for the external fabric of a building. The requirement of B4 will be met if:

- the external walls are constructed so that they resist the risk of ignition from an external fire source and the spread of fire over their surfaces;
- the amount of unprotected areas (windows, doors) on the sides of a building is restricted, to limit the passage of radiant heat through the walls;
- the roof (see section 5) is constructed so as to restrict the risk of spread of flame and/or penetration from the external fire source.

Each of these factors needs to be taken into account to restrict the risk of fire spread from the design building to adjacent property, or conversely. The subject of unprotected areas is of particular importance and Approved Document B, Volume 2, 13.15-13.20 provides alternative methods for calculating acceptable amounts of unprotected area in an external wall.

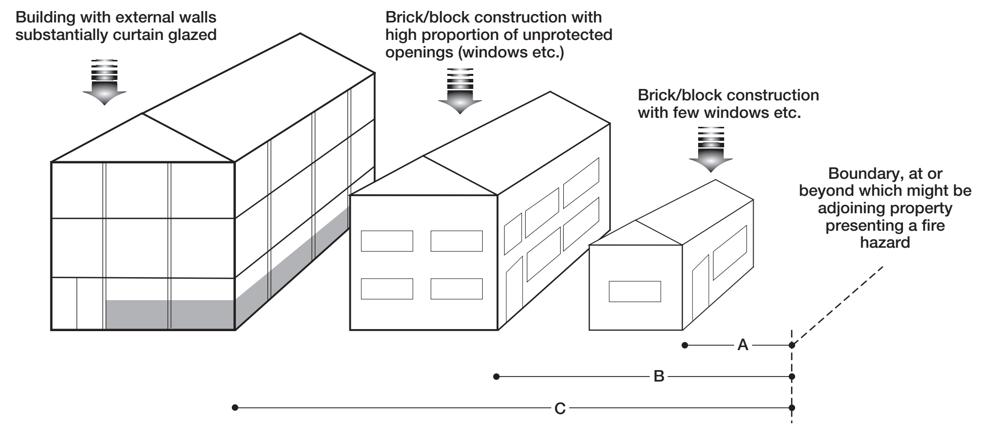


Fig. 4.2. The illustration shows possible sitings of any one of three different buildings in relation to a particular boundary. Consider them just one at a time. The risk assessment will influence the siting of the building, dependent on what type of construction is anticipated. The less able a building is to resist the effects of a fire at the boundary the farther it needs to be sited from the perceived risk.

In addition to those prime considerations the designer will need to calculate the chances of fire spread across the separation space between fire hazards and plan site placement accordingly. See Fig. 4.2.

4.2 External fabric and risk assessment

The pre-design fire risk assessment will encompass any hazards that might be presented by the proximity of other buildings or combustible property (such as plant or stored goods). The risk assessment should look at:

- all adjacent buildings, their sizes and heights;
- neighbouring buildings which contain hazardous occupancies or materials;
- combustible materials stored in the open;
- hazardous plant;
- trees, shrubs and other vegetation; and
- anything else combustible or potentially hazardous which is close to the boundary of the site of the building under design.

The results will help the designer provide a fire-resisting external fabric or envelope which will adequately guard against fire spreading to or from adjacent buildings or other property. Particular attention will need to be paid to windows, doors or other openings in the faces of the building and the hazards which exist in the directions of those faces.

4.3 Fire resistance of external walls

Building regulations in the United Kingdom specify broad functional requirements concerning the performance of external fire spread through the external walls of a building. Such national regulation, it should be understood, is couched in terms which aim to protect the lives of people working in, sleeping in or visiting buildings. It pays little regard to the need to preserve property as distinct from life.

Thus it could be that, for example, when a single-storey building is being designed for a low-risk occupancy, being widely separated from other properties, with few staff and perhaps storage of materials of low combustibility, then the documents supporting building regulations would indicate that external walls of very short duration fire resistance would be acceptable. The designer will need to consider other aspects in those circumstances: perhaps the stored materials are of low combustibility but very high value, for example, the expensive jigs for vital engineering components, in which case the potential insurer would seek walls which were both strong (for purposes of security) and highly fire resistant to help protect the insured value at risk.

External walls of a building should have the appropriate fire resistance duration given in Appendix A, Table A1 of Approved Document B (see both volumes 1 and 2), unless they qualify as an unprotected area, in which case reference should be made to Table A2.

Unprotected area

Relating to a side or external wall of a building, an unprotected area is any one of the following:

- A window, door or other opening; and
- Any part of the external wall which has fire resistance less than that set out in the 'External walls' section of the appropriate volume of Approved Document B; and
- Any part of an external wall which has combustible material more than 1mm thick attached or applied to its external face, for whatever purpose (see page 24 for the definition of 'combustible').

4.4 The relevant boundary

It has already been mentioned that distances between buildings and other property will influence design decisions. If the plan is to produce a four-storey office building with curtain wall glazing, Approved Document B provides guidance on effective space separation and its calculation in some examples. It relates space separation to limits on the extent of unprotected areas (such as openings and areas with a combustible surface) so that it is possible to design for adequate protection against the external spread of fire from one building to another.

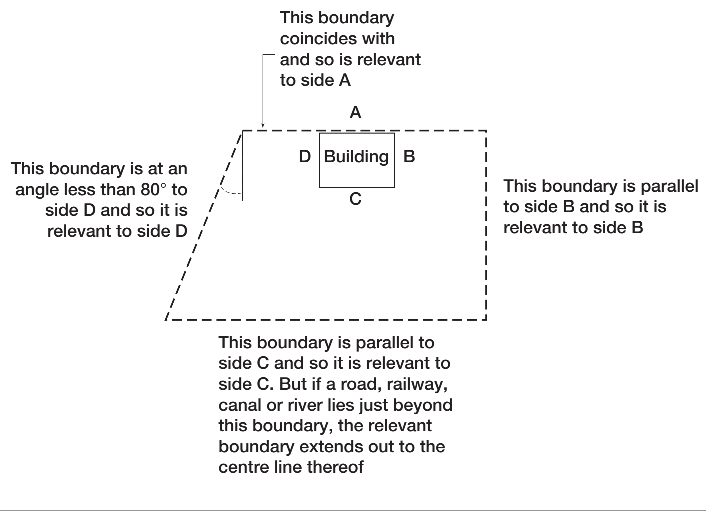


Fig. 4.3. The relevant boundary illustrated.

Essential to such considerations is the concept of relevant boundary (see Fig. 4.3). Approved Document B says: 'The use of the distance to a boundary, rather than to another building, makes it possible to calculate the allowable portion of unprotected areas, regardless of whether there is a building on an adjoining site and regardless of the site of that building or the extent of any unprotected areas that it might have.' The Approved Document refers to BR 187, *External fire spread: Building separation and boundary distances,* and in the FPA Design Guide the assumption is made that building separation and boundary distances are determined using the methods described in BR 187 (ref. 10).

4.5 The protected zone

As explained elsewhere (see page 23), the passive fire protection functions of a building can be impaired if due consideration is not given to the requirement for a protected zone adjacent to where a compartment wall abuts the roof and the external walls. It is vital that, in the neighbourhood of a compartment wall, the external walls, roof and supporting framework have adequate fire protection. A compartment wall must be built up all the way to the underside of the roof, with any gaps there or at the abutment of the compartment wall with the external walls appropriately sealed. In addition, extra protection in the protected zone, either inherent in the design and materials or provided by taking additional measures, is necessary to prevent a fire from breaking out through the external wall close to a compartment wall and breaking into the adjacent compartment from the outside. External walls must be specified appropriately to guard against such an occurrence.

Choice of materials

Does the external wall product/material:

- perform a particular function with respect to passive fire protection?
- contribute to fire growth?
- exhibit good or bad surface spread of flame?
- demonstrate fire resistance (integrity)?
- contribute to the fire load?
- preserve the stability of the structure?
- inhibit/restrict temperature rise (insulation)?
- resist the spread of smoke?
- inhibit deflection of wall and floor elements or the transference of loads?
- accommodate services without detriment to fire protection?
- exhibit durability?

4.6 External walls: choices of materials/products

In their application to external walls, just as in any other application, products and materials should be considered against the boxed questions (above). Before any choice is made, is the designer satisfied with the product certification for the item under consideration, and has the test evidence been reviewed?

The summary general approach to the questions is that materials used to build or otherwise included in external walls:

- must be able to withstand climatic effects as well as possessing the following attributes;
- must not make any significant contribution to the growth or spread of fire;
- must, if required, contribute to the insulation requirement for such a wall;
- shall not be capable of spreading flame on their interior or exterior surfaces;
- shall be capable of preventing the ignition of any materials used as an insulating core as a result of fire started against the external surface of the wall (i.e. an accidental or deliberate fire);
- must be able to accommodate openings for windows and doors which, subject to efficient and effective sealing, will not impair any of the functions listed above.

Loadbearing external walls need to be composed of materials that satisfy testing under BS 476: Part 21 or its European equivalent. Non-loadbearing elements of external walls shall be of materials/products which are satisfactorily assessed only for integrity and insulation, via BS 476: Part 22 or equivalent.

4.6.1 Brickwork/blockwork/stone

External walls constructed of these non-combustible materials will generally conform to the requirements listed above, whether used in the erection of loadbearing external walls (such as in a high proportion of domestic buildings) or as infill, non-loadbearing external walls constructed within structural frames of steelwork or reinforced concrete.

Double skin walls of brickwork/blockwork/stone may include, as cavity (thermal) insulation, proprietary insulating products, which will not cause problems if they are non-combustible. Fire Research Station (FRS) publication, *Fire risks from combustible cavity insulation* (ref. 11), reviews tests by FRS on masonry walls filled with combustible insulation materials, describes their performance characteristics and offers guidance on selection.

4.6.2 Panel and cladding systems

There exists a variety of panel and cladding systems which may be used for the external walls of industrial buildings and other single-storey premises. Common components, whether a panel is prefabricated composite panel or a panel assembled on site from constituent parts, are:

- an outer metal facing;
- some form of insulation sheeting; and
- an interior facing, possibly metal or dry lining board;
- usually fixed to sheeting rails.

From the viewpoint of passive fire protection the essential consideration – although not the only one - is the fire performance of the insulating material. They can frequently be materials which, when exposed to flame or high radiant heat, can make an appreciable contribution to fire growth. **When specifying such products or systems it is vital to seek evidence of performance of the individual components and the whole assembly with respect to contribution to fire growth and fire resistance.** With regard to the former, check that any insulating core materials are completely encapsulated on all surfaces and edges. Fixing methods need to be followed scrupulously, especially at joints between adjacent panels, to maintain fire resistance.

4.6.3 Composite panels

Given the variation in types of cores, especially foams, specifiers need to reassure themselves that composite panels can deliver the required protection (fire growth and fire resistance) needed for the proposed application, checking that any available test results support the anticipated use, size and orientation of panels in the building under design.

4.6.4 Drylining systems

In the case of, for example, a calcium silicate lined system with cavity insulated with mineral wool, the combination of materials that are non-combustible or of limited combustibility will satisfy the fire growth requirement for an extended design duration. To ensure good protection against an external fire, check that any such system is certificated by an accredited body against both internal and external fires.

4.6.5 Panels systems built up on site

Even if all components and an assembled system have been appropriately certificated, that will be no guarantee of satisfactory fire performance unless on-site installation and detail finishing is of the highest standard. Unless that is the case, fire performance may be compromised.

4.7 Standards and other guidance

With regard to fire resistance of loadbearing elements of external walls, materials or products need to demonstrate compliance with BS 476: Part 21: *Methods for determination of the fire resistance of loadbearing elements of construction* or BS EN 1365: Part 1: *Fire resistance tests for loadbearing elements. Walls.* As for non-loadbearing elements, compliance should be with BS 476: Part 22: *Methods for determination of the fire resistance of non-loadbearing elements of construction* or BS EN 1364: Part 1: *Fire resistance tests for non-loadbearing elements. Walls.*

Approved Document B, Volume 2, provides extensive and detailed guidance on the topics of the construction of external walls and on space separation and relevant boundaries, as well as on the calculation of unprotected areas. Both the Approved Document and the FPA *Design Guide* also refer to the methodology in BR 187, *External fire spread: Building separation and boundary distances* (ref.10).

On the subject of cavity insulation materials, see report BR135, *Fire performance of external thermal insulation for walls of multi storey buildings* and also the older FRS publication, *Fire risks from combustible cavity insulation* (ref. 11).

4.8 Testing in the UK

Fire tests on materials and products for application in constructing external walls, to national and international standards, are conventionally provided by most accredited test laboratories in the UK.

4.9 Certification

Certification by Warrington Certification is supported by its Technical Schedule TS54, *External walls including sandwich panels.* Products listed in Part 12 of this Directory will be certificated against this Technical Schedule.

5. Roofs

5.1 General

Roofs have a general function of withstanding the effects of wind and rain but beyond that they can pose two alternative fire protection problems for the designer, who needs to design a roof which resists the incursion of a fire from outside (see Fig. 4.1) as well as containing a fire which may start inside the building.

As with other elements of construction, the design of the roof is an important consideration for those performing the risk assessment for a proposed new building. Even if the building is to be a dwellinghouse there are numerous choices for design and materials, while the considerations for commercial and industrial buildings must involve an understanding of the particular purpose of the building and the activities therein, via the risk assessment.

5.2 Materials

The roof of a modern dwelling can be one of a number of products but usually is found in the following list:

- tiles/slates;
- self-supporting sheets;
- supported metal sheeting.

Roofs of industrial/commercial buildings are among the following generic products:

- composite panels (which variously have cores of polyurethane or polyisocyanurate or mineral wool);
- built-up combinations of an external roof cladding (metal), a core of mineral wool slab and an underside of metal decking; or
- roof cladding protected by dry lining systems (calcium silicate or gypsum boards).

There is an ongoing debate concerning the performance of some composite panels systems, especially when the panels are used in larger sizes and if it is proposed to use them in orientations different from those on which test evidence may be based. Whatever else may be required, in the interests of passive fire protection it is necessary that the materials used for roofs, in any building, should:

- be non-combustible (BS 476: Part 4) or of limited combustibility (BS 476: Part 11); or
- if timber, then as a minimum comply with the fire resistance guidance in Approved Document B as appropriate either to dwellinghouses or to commercial/industrial buildings; or
- be products which incorporate finishes which are Class 0 or Euroclass B (in terms of its definition in Approved Document B).

Class 0

Class 0 is a UK (national) classification relating to the surface-spread-of-flame performance of wall and ceiling lining products in the event of fire.

Subsection 14.1 lists the nationally recognised classifications under BS 476: Part 7, ranging from Class 1, surface of very low extent of flame spread, to Class 4, surface of rapid or extensive flame spread. Class 0 establishes a class of surfaces with better fire performance than Class 1 but it is not a classification identified in any British Standard test (see Approved Document B, Volume 2, Appendix A, paragraph A13). British Standard 476: Part 6 provides the test method used to determine acceptable fire propagation indices for products, which helps in the exclusion of materials which ignite easily, have a high rate of heat release or which may accelerate the time to flashover if involved in a fire.

Such choices of materials/products will at least inhibit any rapid spread of fire across the external surface of a roof if it is exposed to flames or radiant heat from a fire in an adjacent building. It should be appreciated that a fire within a building can adversely affect the roof and not just from inside the building. Fire can break through a building's fabric below roof level and effect re-entry at the eaves.

5.3 Design detail

Design detail is important, particularly with respect to passive fire protection at roof level. In general terms:

- materials and products must be selected with care in relation to the design being adopted;
- points of possible weakness should be identified and treated appropriately, for example the eaves of roofs and any locations of roof penetrations;
- rooflights and ventilators can aid fire spread and need special consideration concerning size and type;
    - it is best to locate rooflights and ventilators in the protected zone (see the boxed information on the protected zone, on page 23);
    - roof decking systems and rooflights that have been successfully tested in the vertical orientation may not perform as well if used horizontally.

Protection of voids beneath roofs (and elsewhere) is provided by the presence of effective cavity barriers. See section 11.

5.4 Standards and guidance

Standards can relate to the likely performances of roofing products or systems which offer protection against either:

- fire from outside the building; or
- fire from inside the building.

British Standard 476: Part 3, *Classification and methods of test for external fire exposure to roofs* has a self-explanatory title and the European classification equivalent is BS EN 13501: Part 5, *Fire classification of construction products and building elements. Classification using data from external fire exposure to roof tests.* The BS 476 classification of roof covering materials is by use of two-letter coding in the range A to D, with AA being the best. The first letter indicates the time to penetration and the second is a measure of the spread of flame.

For protection against fire from inside the building, testing of products/materials will be conducted variously to:

BS 476

Part 21: *Methods for determination of the fire resistance of loadbearing elements of construction*

Part 22: *Methods for determination of the fire resistance of non-loadbearing elements of construction*

or

BS EN 1364-2: *Fire resistance tests for non-loadbearing elements. Ceilings*

BS EN 1365-2: *Fire resistance tests for loadbearing elements. Floors and roofs.*

See Appendix A of Approved Document B, Vol.2, for more detail on the comparisons between choices of materials which have been successfully tested to the British or BS EN standards.

In their application to roofs, just as in any other application, products and materials should be considered against the following questions. Do they:

- perform a particular function with respect to passive fire protection?
- contribute to fire growth?
- exhibit good or bad surface spread of flame?
- demonstrate fire resistance (integrity)?
- contribute to the fire load?
- help to preserve the stability of the structure?
- inhibit/restrict temperature rise (insulation)?
- resist the spread of smoke?
- play any part in inhibiting deflection of wall and floor elements or the transference of loads?
- accommodate services without detriment to fire protection?
- exhibit durability?

And, an extra question for roofs:

- do they offer resistance to external fire attack?

Before any choice is made, is the designer satisfied with the product certification for the item under consideration, and has the test evidence been reviewed?

6. Compartmentation: compartment walls and compartment floors

GENERAL

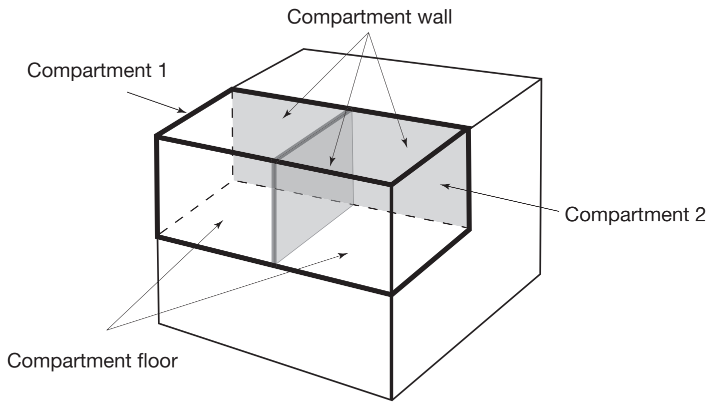


Fig. 6.1. Compartmentation will restrict the spread of fire and smoke.

6.1 Essentials of compartmentation

One of the key concepts of passive fire protection is compartmentation, an essential feature if a building is to resist the effects of a fire. By subdividing a building into compartments which have fire-resisting walls, floors and ceilings then, in the event of fire, such compartments will provide protection against the movement of heat, flames and smoke and will act to confine the fire to its compartment of origin. That is the first in the following list of benefits, since compartmentation will:

- prevent fire from spreading from one compartment to another within a building
- help to stop fire affecting routes which serve as means of escape
- protect a compartment containing high value goods or hazardous materials from a fire which starts elsewhere
- prevent the spread of fire from one building to an adjoining building.

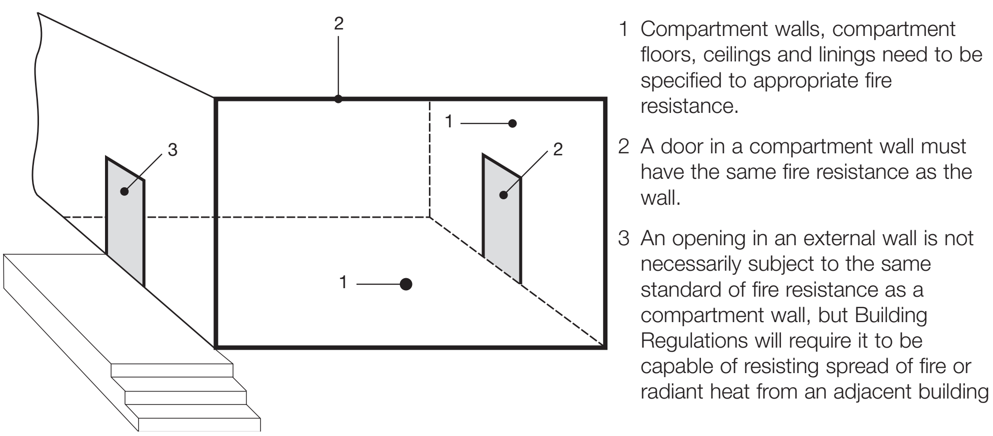
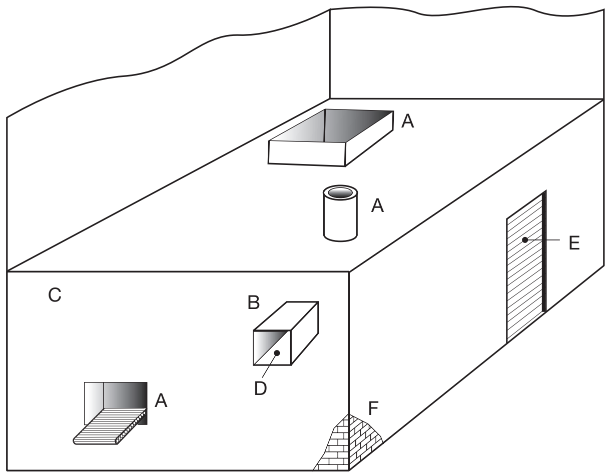


Fig. 6.2. Aspects of compartmentation.



Routes for fire spread from a compartment:

A: Shafts, ducts and other openings which are not protected or do not protect against the spread of fire.

B: Service openings which are inadequately or improperly sealed.

C: Gaps at a structural junction where firestopping is inadequate or non-existent.

D: Ducts which lack dampers to prevent the passage of fire and/or smoke.

E: Substandard (uncertificated) door assemblies.

F: Impact damage can impair the fire resistance of a structure.

Fig. 6.3. Possible routes for fire spread from a compartment.

The need for compartmentation will arise as part of the designer's assessment of risks and of the hazards identified as likely to be present in the building.

Compartment performance specifications are a matter of design judgement linked to official recommendations and guidance provided in Approved Documents to the Building Regulations. See, for example, Approved Document B, 2006, Volume 2 (*Buildings other than dwellinghouses*): its Table 12 cites maximum dimensions for compartments in non-residential buildings and tables in its Appendix A contain specific provisions for the fire resistance of elements of structure, including floors and compartment walls. That guidance, having identified a compartment wall as an element of structure, provides tables of minimum periods of fire resistance (in minutes) for loadbearing capacity, integrity and insulation, durations which have been established by testing wall specimens to the relevant part of BS 476.

Such tables also indicate minimum provisions for fire resistance (in minutes) of construction products in relation to classes given in BS EN 13501-2. Those requirements are listed as a combination of a number (indicating the duration in minutes) and one or more letters which indicate the fire performance attribute(s) which have been established (R = loadbearing capacity, E = integrity, I = insulation).

If a compartment wall separates two different purpose groups (see Table 2.1) then for adequate compartmentation the fire resistance required needs to be that which is appropriate to the more hazardous of the occupancies separated by the wall.

(See section 15 for information about BS 476 testing, European test standards and how they link to certification provided by Warrington Certification.)

6.2 Compartment sizes

Compartment sizes are another matter for the designer's attention. The maximum compartment sizes cited in Approved Document B are those related to life safety considerations (for example, smaller compartments will probably result in shorter travel distances if occupants need to escape from a fire in a compartment). It is worth remembering that insurers may seek even smaller compartments if they judge it necessary to segregate high value goods or areas containing special risks.

6.3 Penetrations of compartments

If it is necessary to make openings in compartment walls – consider the example of a door in a compartment wall which separates a factory workshop from a goods store – then under no circumstances shall the door, its framework and the door glazing or door furniture, result in a section of the wall which has lower fire resistance duration that the wall itself, nor shall it permit the passage of smoke or other airborne products of combustion.

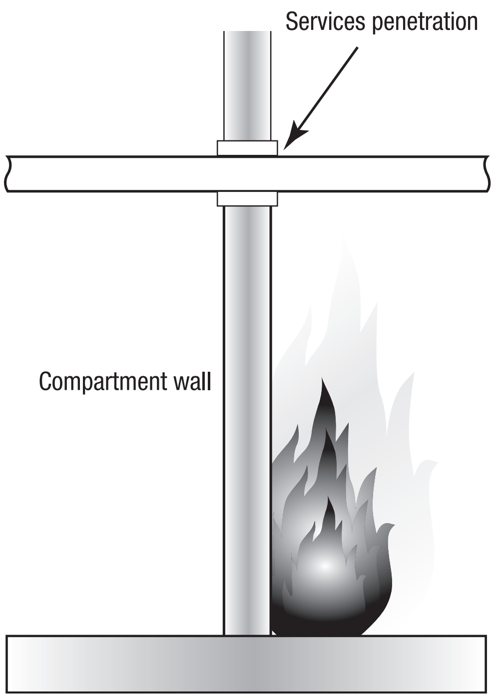
Similarly, where services such as pipework, cabling or air-handling ducts pass through compartment walls, such openings shall be adequately stopped by means which ensure that the fire and smoke resistance performances of the wall are not reduced.

See in particular section 12 on service sealing and also sections 7 and 9 on fire-resisting doorsets, section 10 on glazing and section 8 on door furniture.

6.4 Compartment walls

Compartment wall

A compartment wall is a fire-resisting, vertical wall which is designed to separate one compartment from another to reduce the risk of the spread of fire in a horizontal direction for a particular design duration (specified in minutes). Such a wall may be loadbearing or non-loadbearing.



In the event of a fire:

1. A compartment wall must maintain its loadbearing capacity (if any) for the designed duration of fire resistance and must not deflect or otherwise deform to endanger the structure of the building.

Integrity

2. It must not, over the design duration, develop holes or cracks which would permit the spread of fire or smoke, i.e. it must maintain its integrity.

Insulation

3. It must restrict the conduction of heat so that there is no possibility, for the design duration, of the ignition of combustible materials on the non-fire side of the wall by conducted heat, i.e. its insulation is maintained.
4. Where services pass through the wall, the wall must be able to accommodate any necessary and sufficient stopping (see section 11).

Fig. 6.4. Performance features of a compartment wall.

The principal function of a compartment wall is to restrict the lateral spread of fire between fire-resisting compartments. That is one of a number of its attributes; overall a compartment wall will:

- maintain its integrity for the length of time designed as its fire resistance duration;
- restrict the passage of smoke for the same duration;
- act to restrict an increase in temperature on the non-fire surface of the wall to prevent the spread of fire by conducted heat, by means of its insulating property;
- not contribute substantially to the development of the fire;
- maintain its loadbearing capacity (if any) for its design duration and not deflect or otherwise deform during that time to the detriment of the requirements above;

- be capable of accommodating penetrations for doors and services and, given necessary and sufficient sealing at such penetrations, continue to maintain a barrier to fire and smoke.

6.5 What are the likely products/materials for compartment walls?

There is a wide range of products in use in the construction of compartment walls:

- masonry
  - bricks
  - blockwork;
- stud partitions
  - unreinforced gypsum plasterboard linings
  - reinforced gypsum plasterboard linings
  - calcium silicate board linings
  - cement based board linings
  - wood based board linings
  - steel sheet linings
  - glazed screens
  - sandwich panels.

6.6 Compartment floors

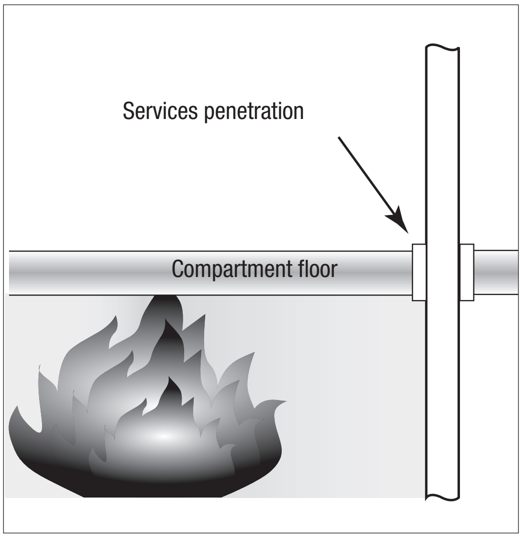
Compartment floor

A compartment floor is a fire-resisting, horizontal floor which is designed to separate one compartment from another to reduce the risk of the spread of fire in a vertical direction, for a particular design duration (specified in minutes). It is assumed that any compartment floor also performs a loadbearing function.

The principal function of a compartment floor is to restrict the vertical spread of fire, either within a multi-storey purpose group or between purpose groups on neighbouring floors. That is the first in the following list, since a compartment floor will:

- prevent fire spread from one compartment to the compartment(s) above by maintaining its physical integrity for the duration for which it was designed
- maintain its loadbearing capacity for the designed duration, thus helping to sustain a building's structural stability
- help to prevent fire spreading into routes which are means of escape
- in the case of a fire below, to act to restrict an increase in temperature on the upper (non-fire) surface of the floor and thus prevent the spread of fire by conducted heat
- in the case of a fire on the floor, not to be capable of spreading flames on its lower surface (the ceiling of the storey below)
- restrict the spread of smoke between floors for a period equal to the integrity duration
- if it accommodates services and ducts, continue to maintain the barrier to fire and smoke by necessary and sufficient sealing of gaps around such penetrations.

In the event of a fire:



Integrity

1. A compartment floor, exposed to a fire from above or below
(a) must maintain its loadbearing capacity for the designed duration of fire resistance, so that the building's structural stability is not endangered and
(b) it must not, for the design duration, develop holes or cracks which would permit the spread of fire and smoke

That is, it maintains its integrity.

Insulation

2. It must resist the conduction of heat so that, for the designed period of fire resistance
(a) if fire breaks out in the storey below, the heat transmitted to the upper surface will not reach a temperature sufficient to cause fire to spread and
(b) if fire breaks out at the level of the floor then any heat conducted down will not cause flaming on its lower surface (the ceiling below).

That is, it maintains its function of insulation.

3. Where services pass through the wall, the wall must be able to accommodate any necessary and sufficient stopping (see section 11).

Fig. 6.5. Performance features of a compartment floor.

6.7 What are the likely products/materials for compartment floors?

Section 6.8 says that it is necessary to ask a range of questions about passive fire protection products. Figure 6.6 depicts what are potentially the components of a 'built-up'compartment floor – although an alternative choice may be a reinforced concrete slab - and shows that there will be a range of permutations in choosing products/materials about which questions may be posed. For the assembly of a compartment floor – which itself should be assumed to be exposed to a fire from below – thus it is assumed that the ceiling layer is likely to bear the initial effects of fire exposure. The structural supporting element and the insulating materials may become involved at a later stage, if ever, and the upper layer (the flooring which is the upper surface) may not be exposed to the fire, always depending on the intensity of the blaze.

Table 6.1. Elements of a built-up compartment floor.

Upper surface (flooring)	Structural support element	Insulating (infill) material	Lower surface (ceiling)
Timber flooring	Timber	Mineral wool	Gypsum boards with plaster skim
• t&g boards	Concrete	Granular (loose) inert pugging	Lath and plaster
• plain edge boards	Steel	Lightweight concrete/gypsum plaster	Concrete
• sheeting			Proprietary suspended ceiling
Proprietary raised floor system			Timber boards
			Other proprietary boards

In addition, floors including insulating glass can be used as compartment floors, although they are proprietary systems and not built-up systems,

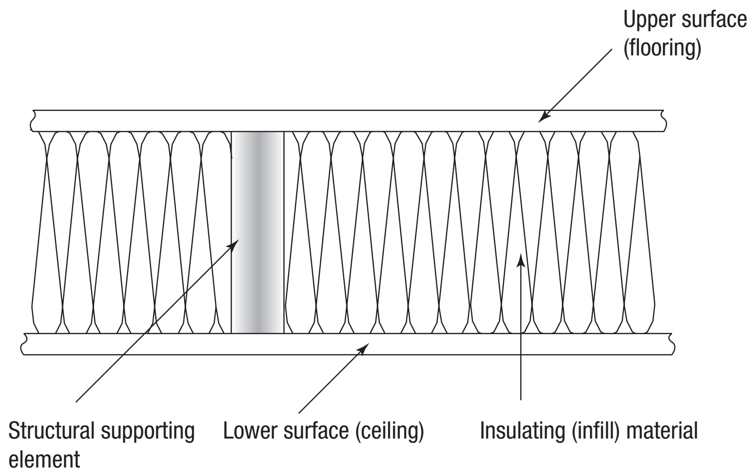


Fig. 6.6. The components of a built-up compartment floor. It may be assembled on site or be delivered as a prefabricated assembly.

6.8 What contribution do the products/materials make to passive fire protection?

The above-mentioned choices available for compartment walls and floors should be considered in the light of the findings of the risk assessment and in any case the following questions should be asked by the designer:

Does the system:

- perform a particular function with respect to passive fire protection?
- contribute to fire growth?
- exhibit good or bad surface spread of flame?
- demonstrate fire resistance (integrity)?
- contribute to the fire load?
- preserve the stability of the structure?
- inhibit/restrict temperature rise (insulation)?
- resist the spread of smoke?
- inhibit deflection of wall and floor elements or the transference of loads?
- accommodate services without detriment to fire protection?
- exhibit durability?

And before any choice is made, is the designer satisfied with the product certification for the item under consideration, and has the test evidence been reviewed?

6.9 How are such products tested in the UK?

Constructional elements which perform a separating function have traditionally been tested in the UK to the requirements of BS 476: Parts 20 to 23. European tests exist within the series of BS EN 1364 and BS EN 1365. See also section 15.

6.10 Certificaton

UKAS accredits Warrington Certification to provide product conformity certification for separating elements and cites as a Standard the CERTIFIRE document Technical Schedule (TS) 49, *Separating elements*. Products listed in Part 12 of this Directory will be certificated against that Technical Schedule.

7. Fire-resisting and/or smoke control doorsets

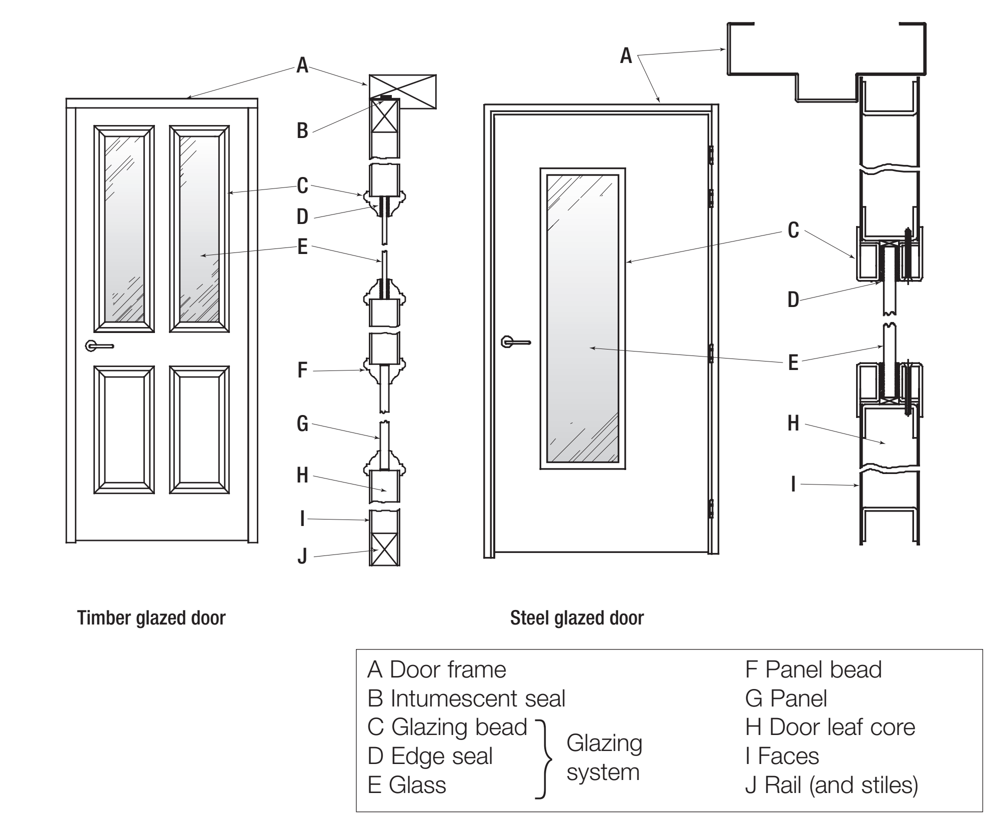


Fig. 7.1 Elements of doorsets.

7.1 General

How do fire-resisting and smoke control doorsets help accomplish the objectives of passive fire protection? They need to perform in such a way as to restrict the passage of heat and hot gases, and the spread of fire and smoke, beyond the compartment of origin of a fire. To do so, a doorset must:

- for integrity – maintain the integrity of any wall in which it is installed for the required design duration;
- for insulation – restrict the rise of temperature transmitted from the fire to the non-fire face of the wall for the required design duration;
- prevent the passage of smoke).

It is vital that the building designer specifies fire-resisting and smoke control doors which are appropriate to their function. In that connection the door leaf is just part of the consideration, because it is the parts of the whole doorset – the frame, leaf, architrave/moulding, seals, hardware and (if any) glazing – which in combination deliver its fire resistance performance (see 7.2). Tests may lead to a doorset being certificated to resist fire (and smoke) for a particular duration. The accompanying certificate will make clear that such a fire resistance duration will result only if the tested combination is replicated exactly in a design, without change of any of the components. Construction companies should be particularly careful not to seek to cut corners in that respect if invited by suppliers to accept something less than the tested combination.

The reason for such caution lies in the principal function of a fire-resisting doorset as distinct from other types of doors, to prevent the spread of fire and/or smoke through the opening which it protects. For the purposes of this account, such doorsets are assumed to be fitted in openings in compartment walls (and such walls may be adjoining protected stairwells or other means of escape). If, for the purposes of passive fire protection in the building under design, it is judged that a wall should have 60 minutes fire resistance, then any doorset protecting an opening in that wall must have at least equal performance. Compartmentation and compartment walls are dealt with in section 6.

This present section applies to the generality of hinged or pivoted doors/doorsets, generally referred to as pedestrian doors. Roller shutters and bigger, heavy duty doors are dealt with in section 9, 'Industrial fire-resisting doors and shutters'.

7.2 Fire-resisting doors, the Building Regulations and test standards

> In the words of Approved Document B,
>
> 'Any test evidence used to substantiate the fire resistance rating of a door or shutter should be carefully checked to ensure that it adequately demonstrates compliance and is applicable to the complete installed assembly. Small differences in detail (such as glazing apertures, intumescent strips, door frames and ironmongery etc) may significantly affect the rating'.

Approved Document B refers to classifications of doors (by their minimum fire resistances) when they have been tested to either BS 476: Part 22 or to the relevant European standard. It will be the integrity of the door which is determined by testing (cited in minutes of fire resistance).

A successful test to British Standard 476: Part 22 will, for example, provide enough evidence to enable a claim to be made of 30 minutes fire resistance (integrity) for a door and such a door is often referred to as FD30; if such a door also restricts smoke leakage at ambient temperatures, when tested in accordance with BS 476: Part 31, then that attribute is indicated by adding the letter 'S' to the coding, FD30S.

In the case of testing to European standards, all fire-resisting doors are to be classified in accordance with BS EN 13501, *Fire classification of construction products and building elements*, Part 2, *Classification using data from fire resistance tests (excluding products for use in ventilation systems)*. They are to be tested to the relevant method from the BS EN 1634 series of standards (see page 17, above). Again, the fire resistance performance is cited in minutes of integrity (indicated by 'E') and any smoke control is indicated by adding 'S_a'. So a 30 minute door which also restricts smoke at ambient temperatures is coded E30S_a.

Table B1 of Appendix B in Volume 2 of Approved Document B is titled 'Provisions for fire doors' and lists, for 10 specified design situations (some of them with subdivisions), the appropriate choice of fire door as evidenced by testing to either BS 476 or to the relevant European standard. The accompanying text in Appendix B draws attention to some considerations of detail and specific application, including the need to fit self-closing devices to most fire-resisting doors.

7.3 Fire-resisting doorsets: the objectives

To summarise the objectives relating to the provision of fire-resisting doorsets:

- in a compartment wall or other separating wall where an opening is necessary to permit the passage of people and goods (it could be an opening in a large cavity barrier), then a fire-resisting doorset acts to maintain the fire protection provided by the wall for the required design duration. These openings may be termed pedestrian doors;
- where a vertical shaft or service duct (examples might be staircases/lifts/hoistways) passes through a compartment floor such shafts will be enclosed by fire-resisting walls - openings in enclosures of that kind shall be protected with fire-resisting doorsets to maintain the fire resistance of the shaft or duct for the design duration;

- if walls which form part of a route which is a means of escape from fire (for example, a corridor or stairway) require to have pedestrian doors, then such door openings shall be protected for the design duration by a doorset of appropriate fire resistance.

If a single door is judged to be not adequate to protect an opening then it may be necessary to install two doors, one on each side of the opening.

It is frequently the case, where an opening of greater width is required, that a fire-resisting doorset involves two leaves, each hung on separate frame jambs.

All fire-resisting doorsets in compartment walls need to be fitted with self-closing devices: see section 8.

7.4 Types of fire-resisting doorsets

Doorsets which fall within the scope of this section may be one of the following types:

- timber;
- timber faced/edged, with mineral board core;
- flush steel ‘pan and lid’ construction;
- steel frames leaves with glass panels;
- proprietary steel frames and leaves with glass panels.

Timber: timber doorsets come in a variety of designs and constructions. For the purposes of passive fire protection, designers should choose doorsets made of timber and/or timber-based materials which have leaves with solid timbers edges/rails. The core materials may range from chipboards to lamels (strips/planks) of solid timber and the facings may be of chipboard, plywood or medium-density fibreboard. The doors will require intumescent edge seals to resist fire spread and smoke seals to provide smoke control.

Timber faced/edged doorsets with mineral board core: doorsets of this type generally have leaves which are timber faced but with cores on mineral boards. Cores of such material may improve a doorset’s performance in terms of integrity and are often used for periods in excess of 60 minutes integrity. These doorsets, just like all-timber assemblies, will require intumescent edge seals to resist fire spread and smoke seals to provide smoke control.

Steel/glass doorsets: such doorsets are frequently used in public buildings (and not in industrial buildings) and come with steel framing and glass panel infills. When heated, steel expands and may distort. Any glass contained within a steel frame will not, in a fire, provide appreciable resistance to distortion, so integrity can be a problem if gaps appear along a door’s edge, for example. That problem may be reduced by appropriate attention to the door hardware and latching system. The steel frame usually lacks insulation (although not always) while the glazing may be non-insulating or insulating. It is clearly necessary to evaluate the components and conditions to which any certification evidence relates when considering steel/glass doorsets.

Flush steel: flush steel doorsets comprise outer leaves of steel sheeting inside which there may be one of a number of door construction systems. The internal construction can be a combination of metal spacers/strips, with infill of mineral wool or even, for example, a paper honeycomb.

Flush steel doors in steel frames can have high fire resistance in terms of integrity. When such doors are fitted with inset glazed panels it is critical to determine what effect that feature has on integrity by reviewing the product’s certification. Most doors of this type will not deliver high levels of insulation in a fire, especially at the leaf edges and along the lines of framing elements, because of the conductivity of the metal. Higher insulation performance requires doors with cores of boards of mineral or other insulating fibre.

Doorset selection

Just as in other sections in this Part of the Technical Directory, the specifier is reminded of the questions to ask when making choices for fire-resisting doorsets. Does the doorset:

- perform a particular function with respect to passive fire protection?
- contribute to fire growth?
- exhibit good or bad surface spread of flame?
- demonstrate fire resistance (integrity)?
- contribute to the fire load?
- preserve the stability of the structure?
- inhibit/restrict temperature rise (insulation)?
- resist the spread of smoke?
- inhibit deflection of wall and floor elements or the transference of loads?
- exhibit durability?
- self-close?

7.5 Doorset installation and door furniture

Door hardware was mentioned above in relation to test evidence and is separately the subject of section 8 (below). It should be said here, however, that the doors considered in this present section may be either hinged or pivoted and that, unless installation is carried out to the highest standard, defects or component shortcomings at the points at which a door swings or latches can have an adverse effect on a doorset's performance in a fire.

The same applies to the installation of the doorset's framework in the wall which accommodates it and particularly to the effective sealing around the edges between the doorset frame and the wall.

Sealing (that is, intumescent strips/smoke seals) at the door edge/frame interface must be of the appropriate type and suitability for the particular doorset, complete and undamaged, and fitted strictly in accordance with manufacturers' directions. Any change from the tested specification must be justified by third-party certification. The opinion of a fire engineer may not be sufficient.

As discussed in 7.2, BS 476: Part 22 provides a regime for testing and evaluating fire-resisting doorsets, in terms of integrity, for a minimum duration, quoted in minutes. British Standard 8214: *Code of practice for fire door assemblies with non-metallic leaves*, gives requirements for their specification, design, construction, installation and maintenance.

7.6 Door sizes

Door leaf size plays a part in the effective fire resistance of a doorset. Whatever the type of door, the heat effect of a fire is liable to cause expansion and distortion of a door leaf. The bigger the door the greater will be the likely deflection. Steel door leaves – which may be what is called for following the risk assessment – may be available in larger sizes than other types and in those larger sizes it is more likely that potential distortion will lessen their integrity rating.

On this topic, general advice and guidance is to be found in BS EN 1634: Part 1: *Fire doors and shutters*.

7.7 Standards and guidance

Subsection 7.2 makes reference to the principal standards relating to fire-resisting doorsets and to the link with the Building Regulations.

While a door is provided to permit the passage of people and goods, and while the attribute of fire resistance is required for passive fire protection of the opening, there may also be special requirements relating to the passage of disabled persons. See Approved Document M to the Building Regulations, *Access to and use of buildings.*

For additional guidance, see:

- a volume in the FPA's Design Guide, *Protection of openings and service penetrations from fire* (ref. 12) (www.thefpa.co.uk);
- the British Woodworking Federation's BWF-CERTIFIRE *Complete guide to fire door assemblies* (ref. 14) (www.bwf.org.uk);
- the Door and Shutter Manufacturers' Association publication, *Code of practice for fire-resisting metal doorsets* (ref. 13) (www.dhfonline.org.uk);
- the Glass and Glazing Federation's publication *A guide to best practice in the specification and use of fire-resistant glaszed systems* (which can be downloaded from www.ggf.co.uk).

7.8 Testing such products in the UK

Fire door assemblies are assessed to the test method regimes of either BS 476: Part 22, *Methods for determination of the fire resistance of non-loadbearing elements of construction* or BS EN 1634, *Fire resistance tests for door and shutter assemblies,* Part 1, *Fire doors and shutters*. Smoke resistance is determined by testing to BS 476: Part 31, *Methods for measuring smoke penetration through doorset and shutter assemblies* or BS EN 1634: Part 3, *Smoke control doors.* And see BS 8214: *Code of practice for fire door assemblies with non-metallic leaves,* a Standard which is being redrafted at the present time.

7.9 Certification

Warrington Certification operates a number of Technical Schedules under their CERTIFIRE brand, on the subject of fire-resisting doorsets as referenced below and on associated hardware as referenced in 8.11. Technical Schedules relating to doorsets are:

- TS10: *Fire-resisting pedestrian-type hinged or pivoted doorsets with non-metallic leaves*;
- TS12: *Hinged or pivoted fire-resisting pedestrian-type doorsets with metallic leaves and frames*;
- TS21: *The contribution of edge seals to the control of smoke leakage via door assemblies*;
- TS35: *The contribution of edge seals to the fire resistance performance of door assemblies*;
- TS42: *Fire-resisting doorsets and openable windows with fire-resisting and/or smoke control characteristics*.

Products listed in Parts 3 and 9 of this Directory will be certificated against those Technical Schedules.

8. Building hardware

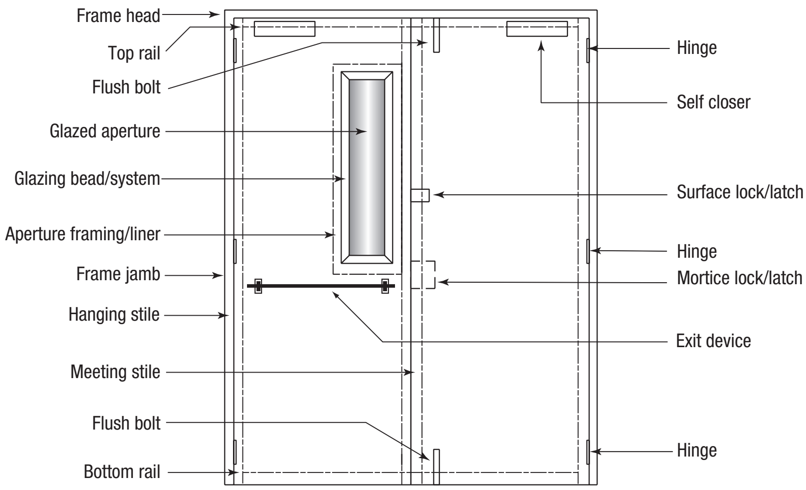


Fig. 8.1. A pair of doors with hardware attached.

8.1 General

The prime function of building hardware (historically also called door furniture) is to effect the reliable opening and secure closing of a door into its frame. In terms of passive fire safety it can be very important that a door which infills an aperture in a wall can be relied upon to default to the closed position after it has been opened. Hardware fitted to fire-resisting doorsets are classed as belonging to one of two categories. Either they are **essential hardware,** which ensure a door returns to its protective position, or they are **non-essential,** items which perform a function while the door is in use but do not contribute to the fire resistance of the doorset.

Figure 8.1 illustrates a number of items that may be found as building hardware components in a generic doorset. Not all items will be found in every doorset. The designer should relay to the building user the advice that it is not advisable to attach to any fire-resisting door any extraneous item which could have an adverse effect upon its minimum period of fire resistance. It is also critical to ensure that the items of hardware chosen are compatible with the doorset. A short list of possible components is as follows:

- lever handles or knobs;
- hinges;
- pivots;
- latch/lock (surface or mortice);
- bolt (surface or mortice);
- self-closing device (door closer);
- emergency or panic exit devices;
- door coordinator devices;
- pull handles/push plates.

Letter plates (see 8.8) may be permitted on external doors, in particular on the front doors of domestic premises, but should be avoided in fire-resisting doors unless tested as suitable.

The following subsections deal with the principal items of building hardware. Whatever special conditions may apply to the testing of particular components, all door furniture should have been tested satisfactorily to BS 476: Part 22 or BS EN 1634-1, on a doorset of the type on which it is proposed to be fitted and would normally be covered by third-party certification for the particular doorset.

8.2. Lever handles/knobs: pull handles/push plates

Lever handles or knobs will be required on doors which are latched, and should comply with BS EN 1906: *Building hardware*. *Lever handles and knobs*. Pull handles should comply with BS 8424: *Building hardware. Pull handles, requirements and test methods.* Some authorities accept the fitting of push plates or kick plates subject to limitations on the size of such items and always on condition that the fitting method does not inhibit or interfere with the fire resistance features of the doorset, such as its intumescent strips. In the absence of test evidence about the suitability of push/kick plates a specifier might seek advice from an accredited third-party certification organisation, so that only suitably approved products are specified.

8.3 Hinges/pivots

From Approved Document B

'Unless shown to be satisfactory when tested as part of a fire door assembly, the essential components of any hinge on which a fire door is hung should be made entirely from materials having a melting point of at least 800°C.'

8.3.1 Hinges/pivots

The hinges or pivots on which a fire-resisting doorset is hung can exert a significant influence on the fire resistance of the doorset. Hinges are an essential component which ensures that a door leaf opens satisfactorily and that it can be returned to its closed position. The same applies to pivots, although it is more likely that pivot fittings will come as essential components of the doorset to which they belong and will be accompanied by the manufacturer's mounting data sheet.

See BS EN 1935: *Building hardware. Single-axis hinges. Requirements and test methods.*

To fit some hinges involves removing part of the door leaf and/or door frame. Such action may lessen the integrity of the doorset, while the conductive nature of the hinge may aggravate that effect. Thus it is important to establish that the fixing method to be employed is precisely that which was tested and included in the certification evidence, including any requirement for additional intumescent protection (material for which may be supplied as standard with a doorset or hardware).

In many instances hinge fixings can have a greater influence on the fire resistance of a doorset than the hinge itself. Although intumescent sealing performs a vital function it will not prevent heat transfer through the hinge and into the hinge fastenings.

Separate test evidence may be required concerning hinges to be used in a non-metallic door leaf hung in a metal door frame. The scope of certification should show that the components – door leaf, hinge, fixing and door frame – are acceptable when in combination with the doorset.

8.4 Latches and locks

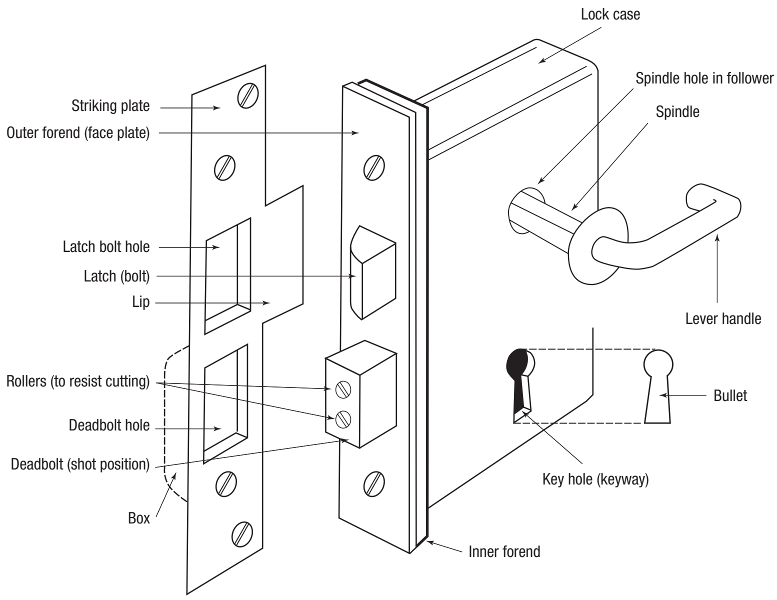


Fig. 8.2. The parts of a lock.

Latch

A latch is a fastener, self-engaging and usually openable from both sides of a component, such as a door, that holds it in a closed position and can be released by hand. Latches normally keep doors closed but not locked.

Lock

A latch is a fastener controlled by a key or similar device that secures a movable component, such as a door within a frame or opening, and combines within its case both a latch operated by a handle and a deadbolt (operated by the key/device).

The specification of locks and latches – particularly when they are to be mortised into a door leaf – can influence the fire resistance of a door assembly in two ways, one beneficial and one not.

- a latch can act to restrain or resist distortion of a door leaf which is exposed to a fire and thus helps to maintain fire resistance for a longer duration than otherwise;
- since the fitting of a mortice latch or lock requires the removal of part of the door leaf and frame, that action can reduce the insulation of the leaf at that location, a disadvantage which may be made worse by the tendency of the hardware to improve the conduction of heat in the event of a fire.

It is often the case that mortice lock/latch cases need to be protected (insulated) with intumescent material and if suppliers' data sheets do not mention this feature then advice should be sought before any product is specified. Intumescent material may also be necessary for use with other items of door hardware, particularly on timber doors.

Fire-resisting doorsets which incorporate smoke seals occasionally require wider leaf-edge-to-frame gaps than normal non-smoke-control doors, in order to accommodate the smoke seals. This can result in a reduced depth of engagement of any latch or deadbolt. A designer may need to take this into account if ever tempted to vary the latch or lock which has been tested satisfactorily with a particular fire-resisting door leaf and frame.

Since latches can prevent a door from fully closing into its frame without the application of adequate force, additional requirements may be imposed upon their performance to establish their suitability for use with fire-resisting doorsets which have the self-closing feature.

British Standard 5872 included test requirements for the mechanism of a heavy-duty latch as well as the mechanism of a mortice deadlock for use as the sole method of keeping a door closed (BS 5872, category B). This standard has now been superseded by BS EN 12209: 2003 which sets out requirements and test methods for locks and latches.

8.5 Bolts

Fire-resisting doorsets may be fitted with either surface mounted bolts or recessed (flush) bolts. Any door bolt, its keep and their fixings should comply with BS EN 12051: 2000: *Building hardware. Door and window hardware. Requirements and test methods*. Doors on escape routes should not be bolted, except possibly on one leaf of a double door assembly if the other leaf is wide enough to satisfy statutory escape requirements. Door bolts are not appropriate for use on emergency exit doors. The responsible person on a premises will ensure that appropriate fire safety measures are in force with respect to whether or not to bolt doors.

8.6 Door closers

A door closer is a spring-operated device which acts to keep a door in its closed position. Its role in passive fire protection is to ensure that fire-resisting doors remain closed at all times (or to close if a fire occurs, in some arrangements), so to restrict the spread of fire and smoke.

Such a device is capable of fully closing from any degree of opening and needs to be effective against any latch fitted to the door. All fire-resisting doors should be fitted with a self-closer, with some exceptions. They are not required on fire doors to cupboards and to service ducts or on fire doors within flats (although they are required on flat entrance doors).

If a self-closing device would present a hindrance to normal passage of traffic through a doorway, for example, in a residential care home, self-closing fire doors may be held open by:

- a fusible link (but only conditionally if the door is an opening provided as a means of escape); or
- an automatic release mechanism linked to an automatic fire detection and alarm system; or
- a door closer delay device.

In the case of an opening protected by two fire doors in ‘air-lock’ style, both should be fitted with self-closers but, subject to detailed conditions, one may be held open on a fusible link.

See BS EN 1154: *Building hardware. Controlled door closing devices. Requirements and test methods* and see also BS EN 1155. *Building hardware. Electrically powered hold-open devices for swing doors. Requirements and test methods.*

8.7 Emergency and panic exit devices

Emergency escape fittings which are quick and easy to operate are needed on fire escape doors. If escape route doors play a role in fire compartmentation of a building then it will be required that any escape hardware fitted to a doorset does not impair the fire-resisting performance of the doorset. The easy operation of final exit doors can be at odds with the security requirements for a particular building and its purpose group or occupancy activity. The risk assessment should take account of any such potential conflict of requirements; management responsibilities need to be clearly defined and design choices will depend on the findings of the risk assessment. Standards BS EN 179 and 1125 (the latter for panic bar devices intended for use by the general public) relate to emergency escape door hardware. If there is doubt about suitability to occupancy, it is recommended by the Door and Hardware Federation (in its *Code of practice: hardware for fire and escape doors*, ref. 15) that a BS EN 1125 device is the one to choose.

8.8 Letter plates

Fitting a letter plate in a door inevitably involves the removal of an area of a door leaf in order to install the slotted plate, and that is not an aid to integrity. Wherever possible, avoid fitting a letter plate to a fire-resisting doorset unless it is known that a suitably certificated product is available.

8.9 Door coordinator devices

Door coordinator devices (historically called door selectors) are fitted on the individual leaves of pairs of doors. Their purpose is to ensure that the paired doors – which will have latches and/or rebated meeting stiles – close in the correct sequence and thus maintain effective closure (and compartmentation) at the aperture. Door coordinators shall be assessed via the methods and requirements of BS EN 1158, *Building hardware. Door coordinators. Requirements and test methods.* The fire performance of such devices shall satisfy the test criteria of BS EN 1634-1.

8.10 Standards and guidance

Any door hardware product which has been a component in a successful fire resistance test to either BS 476: Part 22 or BS EN 1634: Part 1 and so is categorised as having no adverse effect on the performance of the door assembly which has been tested, will be certificated as fire resistant for the test duration on that particular doorset. This does not imply suitability for other types of doorsets.

- Hinges are subject to the requirements and test methods of BS EN 1935: *Building hardware. Single-axis hinges. Requirements and test methods*.
- Lever handles or knobs on latched doors and should comply with BS EN 1906: *Building hardware. Lever handles and knobs.*
- Pull handles should comply with BS 8424: *Building hardware. Pull handles, requirements and test methods.*
- Standard BS EN 12209: 2003: *Building hardware. Locks and latches. Mechanically operated locks, latches and locking plates. Requirements and test methods* (which supersedes BS 5872) establishes a comprehensive classification/coding of the multitude of diverse requirements of the European construction market. Fire and smoke resistance are among the features assessed.
- Any bolts and fixings should comply with BS EN 12051: 2000: *Building hardware. Door and window hardware. Requirements and test methods.*
- For self-closing devices see BS EN 1154: *Building hardware. Controlled door closing devices. Requirements and test methods* and see also BS EN 1155. *Building hardware. Electrically powered hold-open devices for swing doors. Requirements and test methods.*
- Door coordinators shall met the requirements of BS EN 1158: *Building hardware. Door coordinator devices. Requirements and test methods.*

A number of trade associations issue publications giving guidance about door hardware. See the many useful publications of the Door and Hardware Federation, including its *Code of practice: hardware for fire and escape doors* (ref. 15).

8.11 Testing such products in the UK

There are a number of test laboratories accredited by UKAS to perform fire resistance tests on the very wide ranges of items of door hardware, such hardware being included of necessity in tests of complete doorsets.

8.12 Certification

CERTIFIRE certification of hardware for fire doors is supported by a number of long-standing Technical Schedules:

- TS23: *The contribution of mortised locks and latches to the fire resistance of door assemblies*;
- TS24: *The contribution of single axis hinges to the performance of fire-resisting door assemblies*;
- TS26: *The contribution of panic exit devices, operated by a horizontal bar, to the performance of fire-resisting door assemblies*;
- TS31: *The contribution of emergency exit devices, operated by a lever or push pad, to the performance of fire-resisting doorsets*;
- TS32: *The contribution of letterplates and their accessories to fire-resisting and smoke control doorsets with metallic or non-metallic leaves*;
- TS33: *Door coordinator devices*;
- TS34: *Door closing devices and accessories*.

Products listed in Parts 3 and 9 of this Directory will be certificated against those Technical Schedules.

9 Industrial fire-resisting doors and shutters

9.1 General

Section 7 dealt with fire-resisting doorsets suitable for pedestrian traffic. There are, however, many situations in industrial and commercial buildings where larger openings are necessary in compartment walls (or floors, see 9.4) to permit the passage of vehicles or for other purposes. This present section deals with fire-resisting door and shutter assemblies suitable for passive fire protection of such larger openings. There exists a large variety of risks in those kinds of premises and the designer's choice of suitable assembly will, not surprisingly, depend on the outcomes of the fire risk assessment.

9.2 Requirements

The essential fire protection requirements reflect those outlined for pedestrian doorset in section 7:

- to maintain the integrity of any wall (or perhaps floor, 9.4) in which the assembly is installed, for the design duration;
- to restrict the rise in temperature transmitted from the fire face to the non-fire face of the wall (or perhaps floor) for the design duration;
- to prevent the passage of smoke for the same duration as the maintenance of integrity;
- not by itself to contribute significantly to the growth of the fire.

In addition, industrial-type doorsets must be durable and capable of resisting the demands of heavy use, including resistance to impact.

It is generally assumed in this section that the doorset/shutter assembly under discussion will be constructed of steel and does not incorporate timber. Thus it will not of its own material construction contribute to the growth of any fire.

By the same token it may not be insulated so the designer must look closely at the environment in which such an assembly may be required to be installed. In most situations there will exist combustible materials in the premises under design. Where a larger size opening is to be protected by a door or shutter, then the effectiveness of the fire-resisting (compartment) wall can be reduced by the tendency of the door to transfer heat by radiation or conduction. It is important that any combustible materials are not sited closer than a minimum distance in case, for example, radiation causes them to ignite. Guidance on gauging safe distances can be found in subsection 3.1 and Figure 1 of the FPA's publication *Protection of openings and service penetrations from fire* (ref. 12), part of its Design Guide series. Uninsulated doors are acceptable in use, so long as attention is paid to the possible effects of heat transmission.

9.3 Types of industrial doors/shutters

There are five main types, described below.

9.3.1 Roller shutters: vertical or horizontal opening

Such shutters consist of interlocked blades or laths which roll and unroll around a central barrel, like a window blind. Vertical opening shutters have the barrel mounted horizontally while horizontal opening shutters have a vertical barrel. The ends of the blades are contained in and run along guide channels. The curtain formed by the blades, when deployed, provides effective integrity for a period evidenced by test performance, such testing extending to an evaluation of the effectiveness of the components of the assembly and their mechanical operation.

In the absence of insulation in their construction, roller shutters do not control heat transmission to any great extent but their performance is improved if they are used in tandem, to provide a double curtain. The need for movement between the blades, to effect rolling deployment, means that there is considerable scope for smoke leakage. That said, vertically opening shutters may be seen installed in locations such as shopping malls, where, in partly unrolled mode, they can function as smoke curtains to help restrict the spread of smoke through a mall.

Smoke curtains/barriers

It is widely acknowledged that the smoke from a developing fire in a building is as much of a risk to life as the fire itself. One of the most effective ways of dealing with that risk is to incorporate a system of ventilation into a building to deal with the products of combustion. That is not always possible, however, and in such cases or for other reasons it will be necessary to include additional smoke control features.

One example is the type of smoke curtain/barrier which is built into the more extensive modern shopping malls. Usually installed at ceiling height, they comprise fire-resistant ‘curtains’ which span the width of a mall at a particular point. They are often motor-driven curtains linked to smoke sensors. Once smoke is detected the sensors operate the motor and the curtain is lowered into place at a predetermined depth in the mall. The hot smoke reaches the ceiling of the mall and would then roll along horizontally in any unobstructed direction to fill the mall very quickly. The lowering of the smoke curtains stops that movement and creates a smoke reservoir in which the smoke accumulates, certainly long enough for the visitors and staff in a mall to evacuate to a place of safety.

Depending on the location and circumstances it can be necessary to deploy vertical or horizontal curtains/barriers as aids to smoke control.

Relevant standards are BS 7346: Part 3: 1990, *Components for smoke control systems. Specification for smoke barriers* and BS EN 12101: 2006, *Smoke and heat control systems. Specification for smoke barriers,* as well as the generally applicable BS 476: Part 22, *Methods for determination of the fire resistance of non-loadbearing elements of construction*

Their all-steel construction means that roller shutters are durable. Heavy impacts, such as from forklift trucks, can cause damage and it will be a responsibility of management to monitor their condition and likely operational effectiveness. Roller shutters are motor driven, so maintenance routines must extend to inspection and testing of the motor.

Horizontally opening shutters run in horizontal tracks and guides and have maintenance requirements different from vertical shutters. It is vital that the track in the floor does not become blocked by waste materials which could prevent their closing in the event of a fire.

Under no circumstances should goods, materials or vehicles be left in the protected opening, since they will prevent the effective operation of a vertical or horizontal roller shutter.

9.3.2 Metal folding doors

These are not commonly installed nowadays. While they are generally not self closing and can be less than easy to operate they do not take up a lot of floor space. Nevertheless they are no longer a solution of common choice for protecting large openings although, depending on the situation, they may represent an option which offers an advantage in a particular set of circumstances.

In terms of integrity it is possible for them to provide fire resistance for the design duration (certification evidence should be sought), although a disadvantage can be the existence of edge gaps, particularly at the top edge. Such doors are not insulated to any significant extent and the above-mentioned gaps impair their effectiveness in resisting smoke leakage. They are normally robust but the guides and tracks on which they run need to be kept free from waste materials which could cause jamming.

9.3.3 Metal sliding doors

Sliding doors have some of the same disadvantages as folding doors. They have gaps around the edges and are not always easy to operate, although some types are self closing, being deployed either pneumatically or by a system of weights and pulleys. They may be made of thick sheet steel with stiffening struts or are of thinner steel box construction with internal insulation of board or mineral wool.

Sliding doors run on head tracks and foot guides and so can have gaps at the edges which reduce their performance with respect to integrity. In design terms they should be considered to be uninsulated assemblies which do not have the capacity to resist heat or smoke transmission.

9.3.4 Large, hinged, steel doorsets

Large metal doors are very similar to fire-resisting steel doorsets for pedestrian traffic – see section 7 – but are constructed on a larger scale and may require more (or stronger) hinges and more latching points. The doors are likely to be flush steel, encasing insulation of board or mineral wool. The frame and leaf edges are likely to transmit high temperatures in the event of a fire. Any glazing panel may have an adverse effect on its performance since, in a fire, the steel is likely to endure longer than fire-resisting glazing. Much the same can be said about their insulation characteristics; most steel doors have a tendency to transmit heat around the edges/frames and vision panels may impair insulation unless they are of insulating glass. Subject to the choice of material for the encapsulated core, this type of door will make very little or no contribution to fire growth; they are very strong and durable.

9.3.5 Conveyor closures

Conveyors are systems in use in industry for the conveyance of goods and/or materials from one stage to another in a production, storage or dispatch process. Frequently it is necessary for such conveyance to pass from one compartment to another in a premises. A conveyor closure is a device or system which, in the event of a fire, closes automatically by operation of a fire or heat detection system, thus sealing openings in compartment walls or floors through which the conveyor passes. Conveyance may be on a conveyor belt or by means of overhead passage on hooked tracks, for example. Where such a conveyor system passes through and so breaches a compartment wall, for instance, then clearly there needs to be provision for re-establishing compartmentation if fire breaks out, not least because of the possibility of burning goods on a conveyor belt being taken from the site of a fire to other parts of a premises.

Since the conveyor system itself passes through the compartmentation then the protection of such openings needs to be linked to a system of closure which acts to eliminate the various risks involved:

- operating the closure so that it does not shut down on and become impeded by an item on the conveyor;
- being able to effect separation (cutting) of the belt passing through the opening;
- ensuring that any closing barrier (which may be driven up into or down across the opening) is the tightest possible fit.

Conveyor closure is sometimes achieved by using two closure devices close together, in a fire-resisting enclosure, which itself should be constructed from non-combustible materials.

Conveyor closure systems (which will incorporate an intelligent detection and triggering function) will almost certainly need to be purpose made by a supplier with expertise in the field – a roller shutter or sliding door system will not suffice.

9.4 Escalator shutters

It may be necessary to protect openings which have been created in compartment floors for escalator wells. Protection is by the installation of escalator shutters at the floor at the upper end of the escalator. Such shutters are constructed of linked steel blades or laths which will perform like a rolling, fire-resistant curtain. In the event of fire a detection device linked to a motor causes the blades to drive out horizontally from the narrower wall above the deepest part of the escalator well and move along (firstly) horizontal guides and eventually circle down to floor level just beyond the opening of the escalator belt, to effect closure. (There will be smoke leakage protection at the edges.)

- balustrades at the sides of escalator wells need to be insulated to the design duration of the compartment, to restrict heat radiation;
- the ceiling over or above any such escalator closure should be of non-combustible materials, to protect against any radiated heat transmitted upwards;
- combustible materials should not be stored at or near the ‘closing’ end of an escalator shutter.

9.5 Installation considerations

As is the case with virtually every other passive fire protection product or system, it must be emphasised that the performance of a fire-resisting door or shutter assembly depends critically upon the quality of installation. In the case of industrial-type closing assemblies, which can be big and heavy, much also depends on the strength and fire resistance of the structure into which they are fitted.

Roller shutters are an example of heavy equipment and they require appropriate strength in the supporting structure and a strong method of attachment thereto. Evidence of performance in testing will take these requirements into consideration but they must be replicated in real life on the construction site. This is particularly important if assemblies are built-up on site, where special attention must be paid to details of installation, such as minimisation of leaf edge/frame or leaf edge/floor gaps.

Door hardware is equally important for industrial doors as it was for the generality of pedestrian doors (section 7), particularly for the larger sizes of doors and shutters.

Whatever the choice of product or system – and, as always, the designer must be assured of evidence of third-party approval to appropriate standards – they must be installed properly if they are to provide effective passive fire protection.

9.6 Standards and guidance

The fire resistance (integrity and insulation) of a door/shutter assembly shall be demonstrated by satisfactory testing to BS 476: Part 22: *Methods for determination of the fire resistance on non-loadbearing elements of construction* or BS EN 1634: Part 1: *Fire resistance tests for door and shutter assemblies. Fire doors and shutters.*

Smoke resistance evaluation is carried out by testing to BS 476: Part 31: *Methods for measuring smoke penetration through doorsets or shutter assemblies* or by reference to BS EN 1634: Part 3: *Smoke control doors and shutters.*

Conveyor closures should deliver integrity for a period of time to match the design duration of the compartmentation. It is recommended that their insulation performance should be at least 60 minutes per BS 476: Part 22 or BS EN 1634: Part 1: *Fire doors and shutters* or BS EN 1366: Part 7: *Fire resistance tests for service installations. Conveyor systems and their closures.*

The Door and Shutter Manufacturers Association (DSMA, part of the Door and Hardware Federation) publishes two relevant documents, *Code of practice for fire resisting doorsets* (ref. 16) and *Code of practice for fire resisting roller shutters* (ref. 17) (visit www.dhfonline.org.uk).

9.7 Certification

CERTIFIRE certification of related products is supported by Technical Schedule TS30, *Industrial type fire resisting doorsets.* Products listed in Part 10 of this Directory will be certificated against that Technical Schedule.

10. Glass and glazing systems

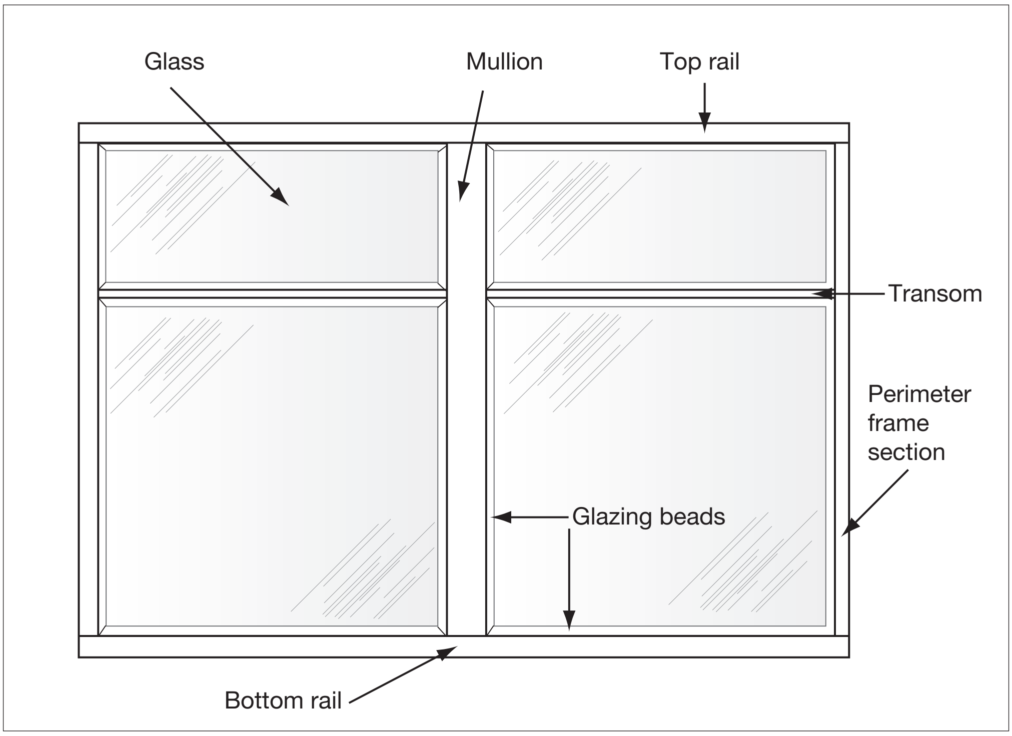


Fig.10.1. Elements of a glazing assembly.

10.1 General

Section 10 deals with fire-resisting glasses and their use in glazing systems or assemblies, usually in compartment walls, to provide a complete range of the fire-resisting characteristics needed for a particular location or use. Designers understand the need to specify glass and glazing products which are appropriate to the fire resistance performance which is required.

What contribution does glass make to passive fire protection? In its everyday, soda lime float monolithic (solid) form, very little. By its nature, glass offers much less resistance to heat than most other construction materials, a characteristic which is evident from a comparison of their thermal conductivities.

Thermal conductivity is the capacity of a material to conduct heat, a measure of the amount of heat energy which can be conducted in 1 second through an area of 1 square metre of the material across a distance of 1 metre when there is a temperature difference of 1 degree (1K) between the two ‘faces’. The symbol k is used for this value.

There is a loose relationship between thermal conductivity and density, insofar as high density materials tend to be good conductors of heat (with high thermal conductivities) while materials of low density tend to be good thermal insulators.

Table 10.1. Comparison of thermal conductivities and densities of common building materials.

Material	Density (kg/m^3)	Thermal conductivity (W/mK)
Cast concrete	2100	1.40
Brickwork	1700	0.84
Glass	1700	1.05
Calcium silicate board	875	0.17
Timber	650	0.14
Mineral wool slab	25	0.035
Polyurethane board	30	0.025

While the great contribution of glass is to provide visibility or illumination through what would otherwise be opaque barriers such as walls and doors, the inclusion of glass as windows and vision panels will necessarily introduce weakness in terms of passive fire protection unless the correct glass and system is used. Technology seeks to counteract that weakness, not just with newer types of glasses but also glasses in combination with specialist framing and glazing systems. All such products and systems need to be tested to establish their optimum performances in relation to fire.

10.2 Consider insulation first

There are two main types of glasses which can provide fire resistance.

10.2.1 Non-insulating glasses

Such glasses, with or without wires, are monolithic (solid) in form and in the event of a fire can conduct heat from the fire side to the unexposed face and then emit appreciable radiant heat from that face. The principal types are:

- Integral wired glass: as the name indicates, this glass has a wire mesh incorporated within its sheet during the manufacturing process, when the glass is molten.
- Non-integral wired glass: two sheets of glass sandwich between them the wire mesh, the sandwich being held together by resin bonding.
- Monolithic (solid, clear) glass: commonly of soda-lime-silica composition and produced by the float glass method (molten glass being run into trays), it can also be composed of borosilicate or clear ceramic and may also be laminated.

10.2.2 Insulating glasses

There are proprietary glasses incorporating thermally activated materials, which have the capacity to reduce significantly the level of heat on and radiating from the unexposed face of the glass during a fire. This may be achieved in one of two ways:

- laminated glasses: such glasses may incorporate clear intumescent layers in their physical make-up as well as safety layers which guard against human impact.
- gel glasses: this category of glasses includes a layer of heat-activated gel encapsulated between two layers of glass.

More will be said in subsection 10.5.1 about the importance of framing for glass panels. It is always the case that certificated, fire-resisting glasses will have been tested in a suitable framing system and that the approval conveyed by the certification requires that the framing is an essential part of the combination. No changes can be made in the framing system unless there is new test evidence to support such variation.

10.3 Performance of glass in a fire

In this subsection there is consideration of broad aspects of performance of glass in the event of fire.

Does glass contribute to fire growth? No, glass does not provide fuel for combustion.

What about surface spread of flame? Monolithic glass is reckoned to be Class 0, while this characteristic will be part of the analysis when laminated glass is being tested.

Does glass demonstrate appreciable fire resistance in terms of integrity? This is one of the principal questions which fire testing helps answer. Topics under consideration when testing (either in line with BS 476: Part 22 or BS EN 1364: Part 1) will be:

- whether single/multiple panes are being tested, and what size of pane;
- what framing system is matched to the glass;
- what glazing system (the method of attaching the glass to the framing, intumescent sealants, channel sections and other components) is proposed.

Any tendency of a glass pane to slump under test could constitute a failure of integrity, depending on the test stage reached. The framing and glazing systems have important influences in this respect in helping to restrain the pane.

What about temperature rise through the glazing? This can only be determined by testing the capacity of the system to limit the conduction of heat from the exposed to the unexposed face of the sheet (BS 476: Part 22 or BS EN 1364: Part 1).

Can glazing restrict the spread of smoke? It depends on the glazing system. Glass is impermeable but smoke may spread if the glazing system is not similarly leakproof.

Can glazing resist deflection? The designer should be looking to specify glass-plus-frame-plus-glazing-materials which have demonstrated, under test, that they provide a combination which will cope with the deflection anticipated in the location where the glazing will be installed.

And what about durability? Even if answers to all other questions are satisfactory, it is still vital that the glazed assembly is sufficiently durable to cope with conditions which are predicted, by risk assessment, to exist in the building under design, whether office or factory or warehouse or something potentially less glass-friendly. The designer will be keen not to site windows and screens in locations where impact damage might be expected.

10.4 Glass in use

From earlier subsections it is evident that the choice of glass in fire-vulnerable circumstances will be linked to its performance in relation to insulation. Approved Document B draws attention to the conditions under which the fire resistance of glass (for both insulation and integrity) is acceptable for glazed elements in fire-resisting enclosures and doors (Approved Document B, Volume 2, 5.4, 5.7 to 5.9, 8.38 and Diagram 32). Table A4 of the Approved Document specifies limitations on the use of uninsulated glazed elements on escape routes, noting that limitations do not apply to glazed elements which meet the insulation criterion (and see its Table A1).

10.4.1 Impact resistance

It was previously desirable to ensure the glass had been tested and marked to the requirements given in BS 6206 but with the commencement of CE marking for certain safety glasses on 1 September 2006 any reference/marking to BS 6206 shall cease.

To comply with regulatory requirements regarding glazing in hazardous locations, however, the installed glazing must continue to be marked. British Standard 6262. *Glazing for buildings:* Part 4: *Code of practice for safety related to human impact:* 2005, clauses 7.1 and 7.2, requires that the installed safety glass should be indelibly marked so that the marking be visible after installation.

The following information is specific to meet the requirement for accidental human impact:

- the name or trade mark of the manufacturer, merchant or installer;
- the identifier of the product standard to which the safety glass conforms; examples are BS EN 12150; BS EN 14179; BS EN 14449;
- the classification according to BS EN 12600.

10.5 The importance of a compatible glazing combination

To be effective in resisting the effects of fire a glazed assembly must comprise a fully compatible combination of glass, framing system and glazing (sealing) system. The range of permutations is partly indicated by Table 10.2, although it should be noted that not all possible permutations from the table are compatible: check the test certification evidence.

Table 10.2. Possible permutations to produce a glazed assembly.

Glasses	Framing systems	Glazing systems
Non-insulating	**Timber**	**Intumescent**
Monolithic glass	• hardwood	• mastic-type sealants
• soda-lime	• softwood	• prefabricated strips
• borosilicate	**Mineral boards sections**	- high pressure
• ceramic	**Metal**	- low pressure
Integral wired glass	• aluminium	**Channel sections**
Non-integral wired glass	• steel	**Tapes**
Insulating glass		• ceramic fibre
• laminated glasses		• elastomeric foam
• glass/gel/glass sheet		**All-in-one system**

Edge cover

The term used to describe the need to provide cover around the edge of a pane in order to achieve a cool edge, which will help maintain the fire resistance duration of a glazing assembly. Any glazing (edge) system must act to secure the glass in position for an appropriate duration. This can be detrimental to some toughened glasses if it is over the acceptable edge cover limits.

10.5.1 Framing systems

Fire-resisting glasses may have unique characteristics which need to be matched by the framing system. The passive fire protection questions are essentially the same as those posed (above) for fire-resisting glass.

Timber framing: may comprise softwood or hardwood frames with angled beads and an appropriate depth of glass edge cover on all edges. With respect to fire resistance, hardwood normally chars at a slower rate than softwood, although it may be appropriate to use deeper edge cover and a frame liner may be a requirement of the glazing system.

Metal framing: aluminium is sometimes used but not for applications where high fire ratings are required. Steel is the method of choice for most fire-resisting glazed assemblies. Its high thermal conductivity does mean that it will need protection to achieve higher ratings for insulation. Since steel expands appreciably when heated, the fixing system needs to cope with that effect.

10.5.2 Glazing (edge) systems

The range of glazing systems, used to secure the edges of glass sheets, is broadly as follows:

Intumescent

- Mastic-type sealants (intumescent/fire-resisting formulations) which also provide high/low pressure effects at the edge of the sheet;
- Prefabricated strips (high/low pressure and high/low expansion)

It is often necessary to employ liners when sealants or prefabricated strips are used with timber framing.

Channel sections

There are two main types

- elastomeric channels;
- u-shaped pvc channels with intumescent integral strips.

Either type is suitable for use with timber framing and the elastomeric channels are also used with some metal framing systems.

Tapes

Ceramic fibre tapes provide high integrity ratings when used with ceramic glass, delivering both a perimeter clamping force as well as a cool edge. They are not usually used in timber framing systems.

Elastomeric foam tapes provide the room for expansion demanded by insulating glasses and are best used with timber or lower-rated steel framing systems. They are not for use with non-insulating glasses.

10.6 Installation

The assembly and installation of fire-resisting glazing is a specialist business and must be undertaken by an experienced organisation which can provide evidence of its capabilities, preferably in the form of certification by FIRAS or similar. The process calls for a thorough understanding of the parts played by the different components of framing and glazing systems in relation to the glass types with which they are in combination.

10.7 Standards and guidance

It was mentioned elsewhere that the integrity of glasses is tested in accordance with BS 476: Part 22 or BS EN 1364: Part 1 (see Table 1.3). Test evidence via the same standards will demonstrate the ability of framing and glazing systems to restrict the rise of temperature through a glazed assembly (insulation). The propensity of such an assembly (including any laminating compounds) to support surface spread of flame shall be Class 1 and the glass surface shall be Class 0 rated. The safety characteristics of glass are determined in accordance with the relevant product standard of the glass type, see 10.4.1.

Specifiers seeking detailed guidance about glass and glazing systems should refer to the Glass and Glazing Federation's publication, *A guide to best practice in the specification and use of fire-resistant glazed systems* (ref. 18, and go to www.ggf.co.uk).

10.8 Testing in the UK

Testing of glass and glazing components is carried out in line with the requirements of the standards mentioned in 10.7.

10.9 Certification

Warrington Certification issues, as part of the documentation for a CERTIFIRE product certification scheme, its Technical Schedule 25, *Fire resistant glass, glazing systems and glazing materials.* Its technical provisions have been adopted as a common basis for certification and incorporate criteria to ensure that a glazed element will provide the necessary fire resistance when correctly fitted with other CERTIFIRE approved components or tested/appraised elements.

Products listed in Parts 5, 8 and 9 of this Directory will be certificated against that Technical Schedule.

11. Voids and cavity barriers

11.1 General

Cavities and voids exist in some form in most buildings; usually they are not visible and are often the incidental result of construction work rather than created intentionally. (Some cavities are functional, such as vertical or horizontal shafts which accommodate building services. The passive fire protection issues associated with functional shafts are dealt with in section 14.)

Among the cavities which commonly occur are:

- between the constructed wall of a building and external cladding panels;
- between the external wall and an internal lining;
- within double-skinned corrugated or profiled roof sheeting;
- between ceilings and the floors above them, where the voids owe their existence to separations caused by joists, for example;
- between a true ceiling and a false ceiling installed beneath it;
- roof voids of all shapes and causes;
- other cavities created during construction, sometimes as a result of boarding across inconveniently shaped corners to square up a space.

The hazards associated with voids are that:

- a fire can start unseen in a void and grow appreciably before being noticed;
- voids can form channels for the transmission of fire and smoke from the point of origin to other locations in a building;
- it is frequently the case that firefighters find it difficult to gain access to such spaces.

It is necessary to consider the installation of one or more cavity barriers to aid passive fire protection against the hazards represented by such concealed spaces.

11.2 Action on voids

11.2.1 Cavity barrier by choice

The prime recommendation is that designers should attempt to eliminate entirely, at the planning stage, any cavities such as those listed in 11.1. In places where that may not be possible, it is necessary to install a cavity barrier.

Cavity barrier

A fire-resisting barrier, usually not less than 100mm high (see also linear gaps sealing in 12.4), which is installed in a void in a ceiling or floor or in a roof space, to provide the necessary restriction on the passage of heat and smoke for the design duration appropriate to that place in the building. (See *FPA Design Guide* 2000, section 4.1.3.5 (ref. 1).)

In its *Protection of openings and service penetrations from fire* (ref.12) the FPA's *Design Guide* specifies that a *large cavity* is one that is more than 600mm high or deep and that for such a cavity and also for any that extend more than 20m in any direction (including around corners), a cavity barrier would be required. See *FPA Design Guide, Protection of openings and service penetrations from fire,* page 53 (ref.12). See also Approved Document B, Volume 2, section 9. In cases of narrow cavities then fire stopping or the installation of linear gaps seals may be a better solution, although, whatever choice is then made, the fire-resisting barrier should be able to cope with any movement created by general use or induced in the event of a fire.

Cavity barriers should have been certificated to resist fire following successful testing to the requirements of BS 476: Part 22: *Methods for determination of the fire resistance of non-loadbearing elements of construction* or BS EN 1634: Part 1: *Fire resistance tests for non-loadbearing elements. Walls.* Test evidence should cover such attributes as:

- fixing system, appropriate for use with the anticipated surrounding construction;
- jointing systems for horizontal or vertical joints;
- the size and proposed orientation of the chosen barrier;
- requirements of the chosen product to permit the passage of services (i.e. methods of sealing round openings);
- compatibility for use against (but not above) a compartment wall.

Both faces of a cavity barrier should be Class 0 rated.

If a cavity barrier was intended for use in a size or orientation not supported by the certification test evidence then it would be necessary to seek to establish its suitability for that application by other means, such as a field of extended application assessment. The Passive Fire Protection Federation (PFPF), the representative body for the passive fire protection industry in the UK, publishes its *Guide to undertaking assessments in lieu of fire tests* (ref. 19) to help explain how such engineering assessments may be recruited to evaluate the effect which, say, a modest increase in size (or some other minor variation from test circumstance) is likely to have on the fire performance of a product or system.

11.2.2 Cavity barrier in use

- Where cavity barriers are being used to effect subdivision of a void in a roof then they should, if possible, be installed to coincide with any fire-resisting partitions in the compartment beneath the roof.
- Similarly, if subdividing a void beneath a floor, cavity barriers should be placed to coincide with any fire-resisting partitions in the compartment above the floor.

  These measures will help extend the line of vertical fire protection and it is recommended that the cavity barriers be installed in that manner even if the result is that they are located closer together than might otherwise be necessary if the fire-resisting partitions were not present.
- If a large vertical void starts beneath the level of the topmost ceiling and extends into roof space then a cavity barrier should be used to cap the void at roof level to aid protection of the roof.

It is recommended in many places in this publication that compartment walls should be built right up to the underside of a roof. **Under no circumstances should a cavity barrier be used to extend a compartment wall to roof height** – the wall should be completed in the appropriate constructional material up to the roof.

11.3 Cavity barriers and barrier materials

The principal materials for cavity barriers are:

Boards/other rigid barriers

- calcium silicate board;
- cement-based board;
- cement boarding, steel faced, fibre reinforced;

- gypsum board (reinforced or unreinforced);
- vermiculite sprayed mesh.

Other materials

- mineral wool quilt;
- mineral wool slab (semi-rigid);
- glass-fibre-based curtaining.

The size and placement of the cavity which requires protecting with a cavity barrier will dictate the choice from the available materials, always dependent on the required design duration at the site of barrier placement.

11.4 Standards and official guidance

For fire resistance performance a cavity barrier – which to fulfill its function should in any event be designed to resist fire and smoke – should comply with the requirements of BS 476: Part 22: *Methods for determination of the fire resistance of non-loadbearing elements of construction* or BS EN 1634: Part 1: *Fire resistance tests for non-loadbearing elements. Walls.* The surfaces of cavity barriers should be rated Class 0 for surface spread of flame.

In section 9 of Approved Document B, ‘Concealed spaces’, there is a full account of the need to use cavity barriers to block pathways around fire-separating elements of construction, Table 13 sets out maximum sizes for undivided concealed spaces and Diagrams 33 to 36 illustrate where and how cavity barriers might need to be deployed.

Summary data about the types of cavity barrier materials (mostly types of boards but including mineral wool quilt) and their comparative performance attributes are given in the *FPA Design Guide for the fire protection of buildings 2000*, page 180 (ref. 1).

11.5 Testing in the United Kingdom

Fire tests on materials, products or systems which comprise cavity barriers, to national and international standards, are conventionally provided by most accredited test laboratories in the UK.

11.6 Certification

Certification by Warrington Certification is supported by CERTIFIRE Technical Schedule TS39, *Cavity barriers.* Products listed in Part 6 of this Directory will be certificated against that Technical Schedule.

12. Sealing of services and linear gaps

Approved Document B

'If a fire-separating element is to be effective, every joint or imperfection of fit, or opening to allow services to pass through, should be adequately protected by sealing or fire-stopping so that the fire resistance of the element is not impaired.'

12.1 General

The term building services applies to the multitude of pipes, ducts and cables which convey water, gas, electricity, communications, heating and the like through a building. The passage of building services conduits through compartment walls and floors is never a tidy process and can impair their fire protection performance: there are usually gaps which need to be sealed. Gaps also exist at junctions and similar situations in buildings and they must be fire-stopped to avert any possibility of the spread of fire and smoke through such openings. All such sealing is essential.

There is a variety of sealing products and systems available and they fall into three broad categories:

- those for sealing the imperfect fit around small penetrations;
- those where larger openings are necessary to accommodate services, resulting in wider gaps to be sealed;
- those for sealing 'linear 'gaps (see 12.4).

This section deals with those types of sealing requirements. The passive fire protection aspects of protected shafts and larger ducts are dealt with in section 14.

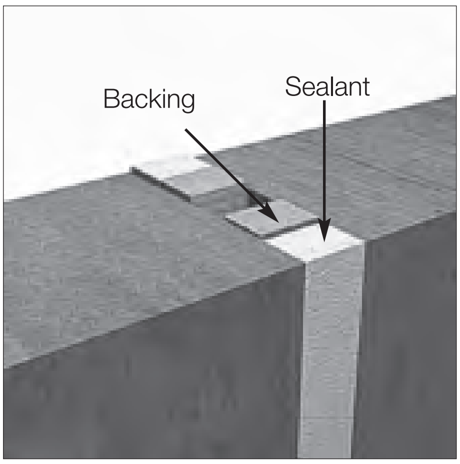


Fig. 12.1. Typical installation of linear joint sealing system (shown with backing in this example).

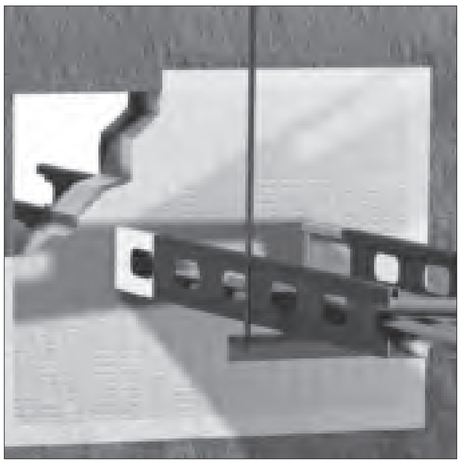


Fig. 12.2. Typical example of sealing of services penetrating a wall.

12.2 Essentials of service sealing

The principal objective of sealing around service openings is to maintain the fire resistance of the separating element of construction (wall or floor or cavity barrier) in which the opening has been made for the required design duration. The aim is to fill the gap, whatever its size, by a material or product which will restore the fire resistance to its previous level. However that is achieved, the performance functions of sealing (which resemble those for the passive protection attributes of compartmentation) include the following:

- to maintain the integrity of the penetrated element for the required design duration;
- to restrict the transfer of heat (the insulation requirement) to the non-fire side of the element in which the opening was made;
- to help prevent the conduction of heat by the service pipe or ductwork itself;
- to restrict the passage of smoke for the design duration;
- in the case of a large penetration seal of the barrier type (see 12.3.2), not to promote the spread of flame on the surface of the seal;
- in general use, as well as in the event of a fire, not to react adversely to vibrations or movements in the surrounding construction and to retain the sealing property.

In general terms, sealing materials and products shall comply with the test requirements of BS 476: Part 22: *Methods for determination of the fire resistance of non-loadbearing elements of construction* or BS EN 1366-3: *Penetration seals* and 1366-4: *Linear joint seals.*

12.3 Surveying the available materials/products

The choice of a sealing product or system is complicated by the fact that there is an enormous variation in the types and sizes of gaps that require sealing.

12.3.1 Small openings

The gaps around small openings for the passage of single pipes, for example, are generally sealed by choosing from among the following products:

- ***Intumescent/mastic-type sealants:*** good for filling small gaps but it will be necessary to select a fire-resistant product, which will normally incorporate intumescence in its reaction to heat. Check on the manufacturers' data sheet with respect to statements about fire testing approvals.
- ***Mineral fibre fire stopping: mineral*** (rock or stone) wool is used to stuff/fill gaps around services. It is important that the fibre is stuffed tightly for the full depth of the gap.
- ***Cement-type compounds:*** sand/cement mixtures or plaster can be used to fill gaps and inhibit fire spread. They set hard and, although they may not cope with distortive movements, in a fire they may resist failure until any fire is well advanced.
- ***Polymeric foamed gaskets:*** very good for filling gaps but may not perform well when exposed to high temperatures. If mixed with intumescent materials the intumescents can act to restore the barrier if the foam has been depleted by the fire.

12.3.2 Larger openings around services

To cope with a large opening to accommodate, say, multiple services, it is common practice to use a barrier slab or bulkhead to fill most of the aperture. The services are arranged to pass through the slab and it is then necessary to seal the gaps at the place where the services traverse the slab. At that point the method of sealing will be as for a small penetration, care being taken that the sealant is not incompatible with the material of the bulkhead barrier.

The following materials are used in sealing large openings for services:

- ***Cement-type slabs:*** these can be made by spraying an appropriate cement- or plaster-based material onto a metal mesh, using the mesh-reinforced slab as the basic barrier and respraying around any gaps once the slab has been cut and the services passed through it.

- ***Fire-resistant boards:*** there is a wide variety of boards available (gypsum, cement based, calcium silicate). Check carefully on their suitability and consult as necessary about evidence of their fire resistant properties.
- ***Composite steel/cement boards:*** these perforated fire protection boards come in a range of thicknesses and are very suitable where there is a need for high resistance to impact as well as fire resistance. They are non-combustible.
- ***Mineral fibre slabs:*** usually incorporating rock or stone wool, these slabs readily accept services and are easy to work.

Bulkhead barriers are to satisfy BS: 476: Part 7: *Method of test to determine the classification of the surface spread of flame of products* for Class 1 surface spread of flame and have Class 0 performance rating in terms of the different national versions of Building Regulations in the UK.

12.3.3 Low melting point services

It may be necessary to choose a special sealing system when it is required to protect a plastic pipe (or other service which softens when exposed to heat) where it passes through a fire-resisting construction. The principal choices are:

- ***Metal-cased pipe collars:*** essentially a length of steel tubing with a lip or collar at its outer end and with pressure-delivering intumescent material on its face.
- ***Pipe wraps:*** these depend on the surrounding construction to help restrict its integral intumescent material and it is recommended that its likely site of application is assessed to establish that a pipe wrap is a suitable option.

12.4 Linear gap seals

Linear gap (or linear joint) seals are used to stop gaps which are of fairly consistent narrow width but proportionately long (according to some authorities a ratio of length to width of about 10:1 and not wider than 150mm). A 'functional' linear gap is one of appropriate dimensions which exists for a particular purpose, such as a movement joint. A 'non-functional' linear gap is an imperfection in fit which requires stopping.

Broadly, the types and materials of linear gap seals are:

- functional
  - intumescent mastic-type seals
  - non-intumescent mastics
  - gaskets of combined foam/intumescent formulation
- non-functional
  - mineral stopping fibre
  - cementicious compounds.

Designers/specifiers should satisfy themselves of the ability of linear gap seals to perform at least as well, in terms of passive fire protection, as the construction features abutting the gap that requires sealing. Test evidence should confirm the capacity of a linear seal to accommodate in-service movement and not shift or shake loose. There should be confidence that, in the event of a fire, the sealed gap will remain impervious to fire and smoke for the design duration, certainly in terms of integrity and preferably insulation, too. British Standard EN 1366: Part 4: *Linear gap seals* is the standard of relevance.

12.5 Aspects of the sealing process

No choice of sealing product or system is possible without an understanding of the practicalities of the process. Questions may need to be asked about:

- the width and depth of a gap;
- the nature of the construction in the neighbourhood of the gap (for example, are there substrates?);
- the nature of the service;
- what depth of sealing product or system will deliver the necessary fire resistance;
- whether it is a horizontal or vertical gap in a horizontal or vertical element, or if there are any other orientations to be taken into account;
- if the seal is preformed, if there is then a requirement for jointing;
- if there are any special requirements related to environmental conditions (such as high humidity or heavy vibrations in the vicinity).

Whatever choices are made, it should be understood that the prime function of a sealing product or system is to fill a gap **so that the gap stays filled**. So an important consideration, for example, is its ability to accommodate any movements which may be imposed upon it. If it is known that a seal may be exposed to movement in use then it may be advisable to choose a product which retains a degree of flexibility rather than a sealant which sets hard. Similar analysis should be applied to other factors which may affect the choice.

Finally, it should be understood that, even when the best choice is made in all the circumstances, the efficiency of the resulting seal depends entirely upon the care and skill exercised in its installation.

12.6 Standards and guidance

Section 10 of Approved Document B: Volume 2, deals generally with the protection of openings in fire-separating elements of construction. The Association of Specialist Fire Protection has published its 'Red Book', *Fire stopping and penetration seals for the construction industry* (ref. 20), freely available via the ASFP's website, www.asfp.org.uk. See also BS EN 1366-3, *Fire resistance tests for service installations. Penetration seals* and BS EN 1366: Part 4: *Linear gap seals.*

In the United Kingdom, testing of service sealing materials and products will be carried out in accordance with the methods of BS 476: Part 22: *Methods for determination of the fire resistance of non-loadbearing elements of construction* or BS EN 1364: Part 1: *Fire resistance tests: General requirements.* Bulkhead barriers shall exhibit surface spread of flame Class 1 (BS 476: Part 7: *Method of test to determine the classification of the surface spread of flame of products)* and have Class 0 performance rating in Building Regulations' terms.

12.7 Certification

Warrington Certificaton provide a CERTIFIRE scheme document TS 40: *Linear gap seals,* which elaborates upon the test requirements for linear gap products if certification by Warrington Certification is to be achieved. See also TS 03: *Fire-resisting penetration sealing systems.* Products listed in Part 6 of this Directory will be certificated against those Technical Schedules.

13. Air-handling ductwork systems

13.1 General

This section deals principally with ductwork which is to be installed in a building for one of the following purposes:

- an air ventilation system;
- a smoke extraction system
- a dual ventilation/smoke extract system.

It is rarely the case that the ductwork of one of those systems does not penetrate a compartment wall and/or floor. Unless other measures are taken, first among them being the choice of fire-resisting ducting, the presence of the system will not simply impair one of the building's key passive fire prevention features (compartmentation) but, even worse, can also provide a conduit for the rapid conveyance of heat and smoke throughout a building if fire breaks out.

Choice of ductwork system (see also 13.2) will depend on the functional requirements and on the outcome of the fire risk assessment. The designer will need to be familiar with the guidance provided in BS 5588: Part 9: 1999: *Code of practice for ventilation and air conditioning ductwork*. See 13.5 for additional references to guidance produced by trade associations and other bodies. Subsections in 13.2 cite appropriate test standards for ductwork – testing must extend to the evaluation of support methods and the types of sealings used where ducts pass through openings in walls and floors. Ducts need to satisfy tests for the effects of both internal and external fires.

13.2 Types of ductwork

Ductwork needs to be considered as a complete system. There are two main types of systems of fire-resisting ductwork (see below) and each will need to have dampers installed. Dampers and their link to active fire protection systems are dealt with in 13.3.

13.2.1 Steel ductwork

There are many proprietary systems of steel ductwork which will effect the **movement of air** around buildings. Systems may incorporate fire protection features (usually for external insulation of the steel ducting) so that the cladding/protection plus ductwork will meet both integrity and insulation requirements for the design duration. Among the fire protection features may be:

- rock fibre mineral wool;
- fire-resistant lining boards (for example, calcium silicate);
- sprayed fire-resistant coatings;

or a combination of such products.

The whole assembly needs to be tested and certificated by an accredited, third-party testing organisation to BS 476: Part 24: *Method for determination of the fire resistance of ventilation ducts* or BS EN 1366: Part 1: *Fire resistance tests for service installations. Ducts.*

Ductwork which is intended for use for **smoke extraction** will also need to demonstrate compliance with the provisions of BS EN 1366-8: 2004: *Fire resistance tests for service installations. Smoke extraction ducts.*

The Standards cited above relate only to the performance of the systems of ductwork; they do not provide evidence of the efficiency of the air-handling or smoke extract system as a whole.

13.2.2 Self-supporting board/casing

Fire-resistant ductwork can be installed in the form of self-supporting enclosures constructed from fire protection boards of calcium silicate or cement-based products. It is important to specify the fixing system appropriate to the rating of the board; choices of fixings/hangers/stiffeners are critical, as is their installation at the appropriate centres. The choice of adhesive may depend on the design pressure of the enclosure being constructed. A complete, self-supporting ductwork system must be assessed to BS 476: Part 24 or BS EN 1366: Part 1.

13.3 Dampers

It is evident that ductwork, to perform its design function, may pass through a compartment wall or floor or through a cavity barrier, any one of which may well have a particular design duration in terms of integrity and insulation. In order that the ductwork possesses no less fire resistance (integrity) than the separating element through which it passes it will be necessary (except for situations covered in 13.4) to fit fire dampers in the ductwork to ensure that separation is maintained.

A damper is a device which is fitted in ductwork, where the ducting passes through a separating element of construction, and in the event of fire breaking into the duct will close to prevent the passage of fire (and, for some types, smoke too). Dampers are also often fitted in fire rated ductwork, not to maintain the fire resistance of the duct but to ‘zone’ the building for smoke control; for example, some dampers in fire ducts are designed to open in the event of fire to allow smoke extraction from the building.

There are three main types of dampers:

- curtain fire dampers;
- multi-blade dampers (combined fire/smoke dampers)
- intumescent dampers.

In **curtain fire dampers** the ‘curtain’ feature consists of a set of interlocking blades which, when deployed to operate vertically (the blades being horizontal), are held at the top of the damper’s aperture by a fusible link. When exposed to its operational design temperature the fusible link melts and the stack of blades falls to effect a closure of the ducting. In horizontal mode (the array of blades is held vertically) the fusible link holds the curtain in place against the force of springs pulling on the leading blade, the springs acting to pull the curtain into place when the temperature of a fire melts the link. Curtain-type dampers will effectively resist the passage of fire but are often overlooked as a choice for smoke control dampers due to their lower performance as smoke dampers.

In **multi-blade dampers** the closure mechanism consists of a series of single blades, each of which rotates on an axis which is bearing mounted. In general use the blades are in the open position to permit air flow in ducting; when closed, each blade overlaps the next to effect closure of the duct. Such dampers can be operated (a) by springs which, on melting of a fusible link, cause the blades to rotate to the closed position, or (b) by the closing of a heat-activated switch which in turn operates an electric or pneumatic actuator to drive the blades into their closed position.

Intumescent dampers may be either louvred or honeycomb in structure. They operate when the passage of hot gases through them reaches the activation temperature of the intumescent materials of which they are constructed, at which stage the intumescents expand as designed and close the ducting. They are often regarded as very reliable since there are no moving parts in their construction.

In its *Design guide for the fire protection of buildings* (ref. 1) the Fire Protection Association recommends that 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. It also proposes that suitable heat/smoke detectors are to be fitted within the ductwork, in pairs, one on each side of the damper, and suggests that dampers that rely only on a fusible link to close are not acceptable for its guidance purposes.

13.3.1 Test standards for dampers

Traditionally the methods of BS 476: Part 20: *Method for determination of the fire resistance of elements of construction (general principles)*, have been used to evaluate the fire resistance of dampers; the European standards are BS EN 1366-2: *Fire resistance tests for service installations. Fire dampers* and BS ISO 10294: *Fire resistance tests. Fire dampers for air distribution systems,* Part 1: 1996: *Test method* and Part 5: 2005: *Intumescent fire dampers.*

13.3.2 Damper installation

Dampers must be installed within (in line with) the wall, floor or other separating element through which the ductwork is passing. Installation must be in accordance with manufacturers' instructions and all penetration gaps around dampers must be sealed in appropriate manner (see section 12). It is necessary to provide access as appropriate to dampers, both mechanical and intumescent, so that regular inspection is possible.

13.4 Exceptions to the damper rule

Car parks and catering kitchens, by the polluted nature of the gases which may need to be extracted from them, are special cases when it comes to the installation of ductwork and dampers. For both such premises it is required that they should have separate extraction systems, independent of any others that exist for their buildings, and BS 5588: Part 9 recommends that, where the ductwork of such systems penetrates compartment walls or floors it must be fire resisting and not fitted with dampers.

Kitchen ductwork is a problem because it conveys combustion gases which carry and deposit combustible materials such as grease within the ducting. Prudent management will institute routines for the regular cleaning of the ducts but it is an acknowledged hazard and, if fire were to break out in a compartment along the route of the extract ductwork, it could result in a fire which, since there are no dampers in the ducting, could endanger kitchen occupants. British Standard 476: Part 24 requires that, as a precaution against the effects of an external fire, the internal surface of that ductwork must meet additional insulation criteria. The ducts must have access points for cleaning at distances not greater than 3m.

13.5 Standards and guidance

General guidance is contained in BS 5588: Part 9: 1999: *Code of practice for ventilation and air conditioning*. Designers should specify ductwork which has been tested and certificated by an accredited, third-party testing organisation to BS 476: Part 24: *Method for determination of the fire resistance of ventilation ducts* or BS EN 1366: Part 1: *Fire resistance tests for service installations. Ducts.* Ductwork will have been tested to the 476 criteria for external fires (duct A) and internal fires (duct B). Smoke extract ductwork needs to comply with BS EN 1366-8: 2004: *Fire resistance tests for service installations. Smoke extraction ducts.*

The fire resistance of dampers is demonstrated by successful testing to the provisions of BS 476: Part 20: *Method for determination of the fire resistance of elements of construction (general principles),* while the European standards are BS EN 1366-2: *Fire resistance tests for service installations. Fire dampers* and BS ISO 10294: *Fire resistance tests. Fire dampers for air distribution systems,* Part 1: 1996: *Test method* and Part 5: 2005: *Intumescent fire dampers.*

British Standard ISO 10294: Part 2: 1999: *Classification, criteria and field of application test results,* uses the suffixes E (integrity), I (insulation) and S (smoke leakage) to denote the suitability of dampers with respect to those attributes, so EIS indicates a damper which delivers integrity, insulation and resistance to the passage of smoke. Approved Document B, Volume 2, proposes that a fire damper should have an E classification of not less than 60 minutes and a fire-and-smoke damper should have an ES classification of not less than 60 minutes.

Guidance on the design and installation of mechanical ventilation and air conditioning equipment, a topic outside the scope of this book, is given in BS 5720: 1979: *Code of practice for mechanical ventilation and air conditioning in buildings.*

The Association of Specialist Fire Protection is a good source of information on the choice and design of ductwork. It publishes *Fire rated and smoke outlet ductwork* (ref. 21) and *An industry guide to the design for installation of fire and smoke resisting dampers* (ref. 22), documents which are freely downloadable from the ASFP website, www.asfp.org.uk.

The Fire Protection Association publishes its RC44: *Recommendations for fire risk assessment of catering extract ventilation* (ref. 23), which, in addition to providing basic advice (including guidance on potential design hazards), contains a risk assessment pro forma.

14. Service shafts

14.1 General

Section 12 dealt with the topic of service sealing, the efficient sealing of openings around service pipework or cabling where they pass through fire-resisting elements of construction, and section 13 covered air-handling ductwork systems. These topics interact in this section, because it can be necessary to incorporate, in the design of a building, a service shaft (or duct) to accommodate in one enclosure a multitude of services such as water, gas and electrical and other cabling, quite apart from the types of air-handling systems dealt with in section 13. Service shafts or ducts, which almost certainly penetrate compartment floors or walls, need careful design consideration in the interests of passive fire safety.

14.2 Design considerations

The drawback of service shafts is that they usually introduce penetrations in compartment walls or floors or other separating elements of construction. Compartmentation (section 6) has one ruling principle, which is that compartment walls and floors must resist the passage of fire and smoke across their complete areas and for the design duration. Any penetrations of those walls and floors must be protected in a manner which ensures that the passive fire protection performance of the walls and floors is not impaired. This principle must be applied to the design and construction of service shafts. In summary:

- any enclosure to a floor (or wall) opening and any door in such an enclosure shall have the same fire performance, in terms of integrity and insulation, as the floor (or wall) through which it passes. (In this context an enclosure is taken to be a service shaft for the accommodation of pipes and/or multiple cabling.)

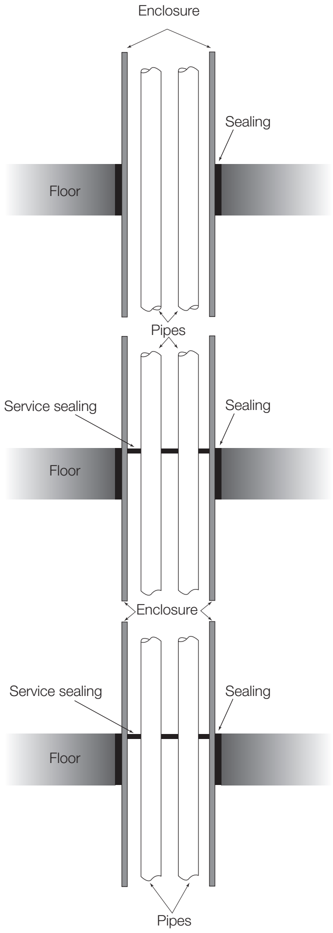
If the designer opts to contain service pipework and cabling within steel ductwork of the kind described in section 13 (‘Air-handling ductwork systems’) then it is also necessary to identify the suitability of such ductwork with respect to fire resistance by establishing whether or not it complies with the requirements of BS EN 1366: Part 5: *Fire resistance tests for service installations. Service ducts and shafts.*

Figure 14.1 depicts some related examples of a vertical enclosure. Assuming that (in the example) the compartment floor has a design duration of T, in minutes, then the task of the designer is to specify the construction of the enclosure so that, in the event of fire starting in compartment A, then it cannot penetrate the enclosure and subsequently break into compartment B in less than T minutes, which means that the aggregate of fire resistance of the enclosure and any fire resistance measures within it must be not less than T.

14.3 Fire resistance of service shafts

Service shaft enclosures should be constructed of materials which have been satisfactorily tested to BS EN 1366: Part 5: *Fire resistance tests for service installations. Service ducts and shafts.* Depending on the choice made for any enclosure it may be necessary to incorporate sealing around the assorted pipework or cabling within an enclosure; Figure 14.1 illustrates alternative scenarios and explains the need for sealing around services in some cases.

Construction | **Details/fire resistance requirements**



If the fire performance of the shaft enclosure is not less than that of the compartment floor in this example, then it is not necessary to incorporate sealing around any pipework or cabling within the shaft. See section 14.2.

If the design duration of the compartment floor is T (in minutes) and if the fire performance of the shaft enclosure approaches (but is not less than) 50% of T, then there should be service sealing around the pipework/cabling in the shaft, at floor level, of not less than 50% of T so that in aggregate the enclosure and the service sealing have fire resistance of not less than T.

If the shaft enclosure has no fire resistance then service sealing needs to be installed around the pipework within the shaft, at floor level, the sealing to have fire resistance equal to that of the design duration of the compartment floor. Some authorities recommend that there should be insulation applied to the services' pipework/cabling for a distance of 500mm above the service sealing and 100mm below, as an extra safeguard.

Fig. 14.1. Examples of service sealing requirements in shaft enclosure.

It is possible to specify service shafts without their own fire resistance, as long as sealing around the enclosed services matches the fire resistance of the compartment floor (or wall) through which the enclosure passes, but this is not so in the special case of pipes which contain volatile liquids or combustible gases. In that circumstance, as well as the need to incorporate service sealing within the enclosure to the same design duration as the element of construction which is penetrated, the enclosure itself should have a fire resistance of at least 60 minutes (integrity and insulation) or more than that if it needs to match a compartment design duration which exceeds 60 minutes.

If service shafts do contain pipework which conveys volatile fluids or combustible gases, ventilation shall be provided to such shafts.

14.4 Standards and guidance

The principal standard is BS EN 1366: Part 5: *Fire resistance tests for service installations. Service ducts and shafts.*

15. Guidance on fire tests

In the United Kingdom it is expected that a range of tests to European standards which is being introduced to harmonise the fire performance classifications of construction products (see Table 1.3) will eventually replace the traditional, well-tried series of BS 476 tests. Some of the European test standards are still under development, although most are complete and all are listed in Table 1.3. It was felt useful to survey at this point the major BS 476 tests in order to provide the reader with an assessment of their overall coverage and purpose.

15.1 Who does the testing?

The reaction-to-fire performance of a passive fire protection material or the fire resistance of a passive fire protection product or system should be established by testing to an appropriate national or international standard. In the United Kingdom, testing will be performed by laboratories accredited by the United Kingdom Accreditation Service (UKAS).

15.2 Testing to what standards?

European test standards are increasingly those which apply in the fire performance arena. At the time of writing the first edition of this publication, BS 476: *Fire tests on building materials and structures* continues in use, while a growing suite of European standards are in assembly to supersede the BS 476 tests. Manufacturers of passive fire protection products are increasingly seeking to have their products tested to EN standards – and the specific requirements thereof – in order to remain competitive in the European (and UK) marketplace. Table 1.3 (page 16) shows the most recent state of development of the European standards and the subject is dealt with in 15.4. Subsection 15.3 summarises some of the most-used Parts of the BS 476 series. Changes are being introduced into Approved Document B to embrace the EN standards and classes.

15.3 British Standard 476: Fire tests on building materials and structures

Part 3: Classification and methods of test for external exposure to roofs

Test specimens are exposed to heat conditions (a test fire) representing a nearby fire which is in progress ‘outside’ the roof samples. The samples are exposed to a test flame to replicate the deposit of burning brands and to a gradual, measured increase of radiant heat. This test is not intended to demonstrate the effect of the roof samples being exposed to a fire which occurs within a building.

Part 4: Non-combustibility test for materials

The attribute of non-combustibility is tested by placing small samples of the material in question in a furnace at 750°C. If the test specimen does not flame for more than 10 seconds or show any appreciable tendency to self heating then it is regarded as non-combustible.

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

The heat emission from building materials is tested by inserting samples of the material(s) into a furnace at a temperature of 750C.

Part 12: Method of test for ignitability of products by direct flame impingement

The test method uses a choice of seven flaming ignition sources for a variety of flame application times (from 1 to 180 seconds) on the test material(s).

Part 13: Method of measuring the ignitability of products subjected to thermal irradiance

Combustible materials are tested to establish comparative classification of their propensity to ignite. In the test a flame is applied to a sample of the material. Materials are classified as:

- ‘Easily ignitable’ (with a performance letter X)
- ‘Not easily ignitable’ (with a performance letter P).

Part 6: Method of test for fire propagation for products

Part 6 provides a means of comparing the contributions which different materials might make to the development (growth) of fires. In the test a specimen is subjected to heat in an enclosed space under specified conditions and the amount and rate of heat produced is measured. Materials on which such a test is performed are given a performance index with the letter X or P as in the ignitability test (see Part 13).

Part 7: Method of test to determine the classification of the surface spread of flame of products

Samples of a test material are mounted at right angles to a gas-heated radiant panel, the heat output of the panel thus affecting the specimen with graduated intensity. The distance and rate of flame spread are observed and the specimen materials are classified as follows:

- Class 1. Surface of very low flame spread
- Class 2. Surface of low flame spread
- Class 3. Surface of medium flame spread
- Class 4. Surface of rapid flame spread.

The Building Regulations makes reference to Class 0 as the highest national (UK) product performance classification for lining materials (see Approved Document B, volume 2, Appendix A, paragraph A13). Class 0 is not a classification identified in any British Standard test. See page 34.

Parts 20 to 23: Fire resistance tests for elements of construction

Fire resistance is a measure of the ability of a structure to perform its normal functions under standard fire conditions. It is generally expressed as a duration (in minutes) for which the structure can withstand the fire conditions. It should be understood that fire resistance is a property of a complete structural element and not of individual materials or components. Tests are carried out by exposing elements of construction to radiant heat in a furnace which is designed to deliver increases in temperature at a measured rate.

Elements which perform a separation function, such as walls, floors, ceilings, doors, are tested to determine if they can prevent the passage of fire from one side to the other. If any of the following circumstances occur within the chosen test period …

- loss of stability leading to collapse
- loss of integrity – cracks or holes form through which flames and smoke can pass or flaming on the ‘protected’ side

- heat is conducted from the fire to the non-fire side of the structure at such a temperature as to lead to the ignition of combustible materials in contact with the farther face

… then the element is deemed to have failed.

Loadbearing elements of construction (Part 21 test methods) are tested under loads calculated to produce the maximum design stresses or a given design load.

Fire tests to established, national British Standards will conclude with test reports which include:

- details of the test specimen, whether material or assembled product;
- an explanation of the test procedure;
- full account of the measurements which were made; and
- the results of the test.

The evidence contained in the test reports form the basis for approval to the material or product under the BS fire test methods. It does not convey approval of any variation of the samples, so a sample that is of different size or in an alternative orientation is not certificated by extrapolation from the original test results.

15.4 European test regimes

An important difference between existing British and the new European tests is that the European standards express product performances in terms of classifications, one set of classifications for reaction to fire and another for fire resistance. For either set, a classification report will be produced in accordance with the requirements and methods of the appropriate part of BS EN 13501.

For reaction to fire, the system exposes a product to a variety of reaction to fire tests and determines its performance as one of seven 'Euroclasses', from A1 to F (A1 is the best and F the worst) or for floor coverings Afl to Ffl. There are other coded properties, for example, classifications for the production of smoke (s) and the production of droplets (d).

For fire resistance, the performance of the element being tested is expressed as an assessment against the time taken for its failure judged against its three principal criteria: loadbearing capacity (R), integrity (E) and insulation (I).

A full explanation of the distinction between the British national and European systems is given in the Passive Fire Protection Federation's *Guide to demonstrating the performance of passive fire protection products* (ref. 24).

15.5 Testing in Europe

There is a European Group of Official Laboratories for Fire-testing (EGOLF), comprising approximately 50 laboratories in 22 countries across Europe. Membership is open to all independent, official, nationally accredited laboratories that test materials, components and products in support of legislation in Europe. Among their aims are:

- to facilitate the mutual acceptance of fire test reports among European countries;
- to contribute to the unification of fire test methods and reports, their assessment and their application;
- to define a unified quality level for fire testing equipment, methods and expertise;
- to promote research and development within the field of fire testing.

Bodycote Warringtonfire is a founder member of EGOLF and fire testing services at Bodycote Warringtonfire include those carried out to a large number of national and international standards. For more information visit www.warringtonfire.net.

Appendix: Warrington Certification Technical Schedules

It was mentioned in section 2 that third-party product certification which is provided by Warrington Certification is supported by a number of types of documents. Of prime importance is the set of Technical Schedules, embodying technical requirements which have been established with industry through the involvement of formal liaison panels.

Technical Schedules normally include provisions for evaluations to ensure that the fire performance of a product, which has been established by testing and assessment, will be maintained for a duration deemed to be equivalent to the length of a reasonable working life. Such evaluations may take the form of durability tests, weathering tests and/or tests to examine the effect of exposure to other climatic conditions.

The following table contains the current list of Technical Schedules (November 2007), including some which are in draft form. The letters TS against a document title indicates that it relates to fire performance attributes, while the letters WCL indicate documents which relate to non-fire products.

Technical Schedule	Title
TS00	General requirements for CERTIFIRE certification of passive fire protection products/systems
TS03	Fire-resisting penetration sealing systems
TS10	Fire-resisting pedestrian-type hinged or pivoted doorsets with non-metallic leaves
TS12	Hinged or pivoted fire-resisting pedestrian-type doorsets with metallic leaves and frames
TS14	Passive fire protection materials used to provide fire protection to structural steelwork
TS15	Intumescent coatings used to provide fire protection to structural steelwork
TS16	Natural smoke and heat ventilators
TS19	The reaction-to-fire properties of exposed surfaces. Class 0/Class 1
TS21	The contribution of edge seals to the control of smoke leakage via door assemblies
TS23	The contribution of mortised locks and latches to the fire resistance of door assemblies
TS24	The contribution of single axis hinges to the performance of fire-resisting door assemblies
TS25	Fire-resisting glass, glazing systems and glazing materials
TS26	The contribution of panic exit devices, operated by a horizontal bar, to the performance of fire-resisting door assemblies
TS30	Industrial type fire-resisting doorsets
TS31	The contribution of emergency exit devices, operated by a lever or push pad, to the performance of fire-resisting doorsets

Technical Schedule	Title
TS32	The contribution of letterplates and their accessories to fire-resisting and smoke control doorsets with metallic or non-metallic leaves
TS33	Door coordinator devices
TS34	Door closing devices and accessories
TS 35	Intumescent fire seals
TS39	Cavity barriers
TS40	Linear gap seals
TS41	Signal-activated uncontrolled door closers
TS42	Fire-resisting doorsets and openable windows with fire-resisting and/or smoke control characteristics
TS43	Reactive coatings
TS44	Renderings
TS45	Boards
TS46	The reaction-to-fire properties of exposed surfaces. Class 0/Class 1 (EN version)
TS47	Air transfer grills
TS48	Smoke control and fire-resisting ductwork systems
TS49	Separating elements
TS50	Smoke and toxicity
TS52	Powered head and smoke exhaust ventilators
TS53	Natural heat and smoke exhaust ventilators
TS54	External walls including sandwich panels
TS55	Ceilings
TS56	Fire-resisting lift landing doors
TS57	Intumescent structural members
TS58	Fire protection systems for tunnel linings
WCL0	General requirements for certification of enhanced security of doors, windows, grilles, shutters and curtain walling.
WCL1	Enhanced security requirements for doorsets and door assemblies for dwellings to satisfy the requirements of PAS23 and PAS24
WCL2	Requirements for burglary resistance of hinged, pivoted, folding or sliding doorsets, windows, curtain walling, security grilles, garage doors and shutters
WCL3	Requirements for burglary resistance pedestrian door sets, windows, curtain walling, grilles and shutters to European standards

References

This publication contains many references to Approved Documents (which support the Building Regulations) and also to British, European and American Standards and Warrington Certification's Technical Schedules. Readers can find information about the Approved Documents in Table 1.1. Table 1.3 lists the principal British and European Standards relating to the fire performance of construction elements. For up-to-date details of other Standards mentioned in the text, visit the British Standards Institution's website, www.bsi-global.com and search the catalogue of standards. Warrington's Technical Schedules are listed in the Appendix to this volume, page 78.

Other publications cited in the text are listed below, by reference number.

1. Fire Protection Association, *Design Guide for the fire protection of buildings 2000,* FPA, 1999. That book is being replaced by a series of publications on particular topics, some of them specific to types of premises being designed. Visit www.thefpa.co.uk for more information.
2. Fire Protection Association *Design Guide, Essential principles,* FPA, 2003.
3. Building Regulations 2000: Approved Document B: *Fire safety,* Volume 1: *Dwellinghouses*, Volume 2: *Buildings other than dwellinghouses,* The Stationery Office, 2006.
4. Scottish Building Standards Agency, Technical Handbooks: *Domestic handbook* (2007), section 2, *Fire; Non-domestic handbook* (2007), section 2, Fire. The Stationery Office.
5. Department of Finance and Personnel, Northern Ireland, Technical Booklets: Technical booklet E, *Fire safety* (2005). The Stationery Office.
6. Department for Communities and Local Government, *Building Regulations and fire safety: procedural guidance,* DCLG, 2006.
7. Institution of Structural Engineers, *Manual for the design of plain masonry in building structures,* 2nd edition, 2005.
8. Association of Specialist Fire Protection, *Fire protection for structural steel in buildings,* 4th edition, 2007.
9. Fire Protection Association, *Design Guide, The protected zone,* FPA, 2004.
10. Building Research Establishment, BR187, *External fire spread: building separation and boundary distances,* 1991.
11. Fire Research Station, DG294, *Fire risks from combustible cavity insulation,* 1985.
12. Fire Protection Association *Design Guide, Protection of openings and service penetrations from fire,* FPA, 2005.
13. Door and Shutter Manufacturers' Association, *Code of practice for fire resisting metal doorsets.*
14. British Woodworking Federation, *Complete guide to fire door assemblies* (comes with Fire Door DVD), BWF, 2007.
15. Door and Hardware Federation/Guild of Architectural Ironmongers, *Code of practice: hardware for fire escape doors,* D&HF, 2006.
16. Door and Shutter Manufacturers' Association, *Code of practice for fire resisting doorsets,* DSMA.
17. Door and Shutter Manufacturers' Association, *Code of practice for fire resisting roller shutters,* DSMA.
18. Glass and Glazing Federation, *A guide to best practice in the specification and use of fire-resistant glazed systems,* GGF.
19. Passive Fire Protection Federation, *Guide to undertaking assessments in lieu of fire tests,* PFPF, 2000.
20. Association of Specialist Fire Protection, *Fire stopping and penetration seals for the construction industry,* 2nd edition, ASFP, 2004.
21. Association of Specialist Fire Protection, *Fire rated and smoke outlet ductwork,* ASFP, 2000.
22. Association of Specialist Fire Protection, *An industry guide to the design for installation of fire and smoke resisting dampers,* ASFP, 2005.
23. Fire Protection Association, *Recommendations for fire risk assessment of catering extract ventilation,* RC44, FPA, 2007.
24. Passive Fire Protection Federation, *Guide to demonstrating the performance of passive fire protection products,* PFPF, 2004.

Published in 2008 by Warrington Certification Limited

ISBN 978-1-906575-00-7

Important notice

While Warrington Certification Limited has tried to ensure the accuracy of this publication it cannot accept any liability for any loss or damage of any kind that may arise or result from any errors, omissions, mis-statements or mistakes of whatever nature. Any listed company or other recipient of this publication who becomes aware of any such matters is requested to notify Warrington Certification Limited. Warrington Certification Limited will endeavour to include any appropriate amendment in the subsequent issue of this publication.

Printed in Great Britain by St Ives Blackburn Limited. 3.0/0208

HEAD OFFICE
Holmesfield Road, Warrington, Cheshire UK WA1 2DS
Tel:+44(0)1925 646 777 Fax:+44(0)1925 646 667
Email: certification@warringtonfire.net www.warringtonfire.net

A Bodycote engineering & technology company.

ISBN 978-1-906575-00-7