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# Fire Resistance of Buildings: In-depth

## Summary

Fire protection measures are classified as either active or passive. Active fire protection measures respond to the presence of a fire and include fire alarm systems and are covered in other fire topics. This topic advises on passive fire protection measures, which give protection and resistance to the elements of the building structure and the compartments of a building to prevent the spread of fire.

## Employers' Duties

* Under the [Health and Safety at Work, etc Act 1974](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/health-and-safety-work-etc-act-1974-5#DCAM-234835), as amended, and the [Management of Health and Safety at Work Regulations 1999](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/management-health-and-safety-work#DCAM-234814) , employers have a general duty of care to provide a safe working environment in relation to fire safety.
* Under the [Regulatory Reform (Fire Safety) Order 2005](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/regulatory-reform-fire-safety-order-2005#DCAM-944502), the responsible person must take general fire precautions, which include measures to mitigate the spread of fire.
* In Scotland, this requirement is in the Fire (Scotland) Act 2005 / Fire Safety (Scotland) Regulations 2006.
* In Northern Ireland, this requirement is in the Fire and Rescue Services (Northern Ireland) Order 2006 and the Fire Safety Regulations (Northern Ireland) 2010.

## Employees' Duties

Under the [Health and Safety at Work, etc Act 1974](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/health-and-safety-work-etc-act-1974-5#DCAM-234835), as amended, employees have a duty to take reasonable care of their own health and safety and that of other people who may be affected by their activities at work.

Under the relevant UK fire safety legislation, employees have a duty to co-operate with their employer to enable the employer to comply with health and safety duties and must bring to their employer's attention any defects or shortcomings in their employer's fire protection arrangements of which they become aware.

## In Practice

### Building Regulations and Passive Fire Protection

To reduce the risk to people and property if there is a fire, it is necessary to consider how to control or restrict the spread of that fire to maintain the fire resistance of the building.

Good design features can ensure that only limited damage will result if fire breaks out.

Passive fire protection measures can be defined as products that are built in to the fabric of the building “to restrict the growth and spread of fire and smoke”. They do this by providing resistance to help prevent the spread of fire:

* through concealed spaces in a buildings structure
* over wall surface finishes in rooms and on escape routes
* between buildings.

Passive fire safety covers all those aspects of fire protection that are involved in the design of a building, the building materials and the structural maintenance. Features that might be categorised as passive measures are those that control the spread of a fire, such as:

* [fire barriers and fire doors](https://app.croneri.co.uk/topics/fire-resistance-buildings/indepth#DCAM-240216)
* thermal insulation
* applied coatings
* intumescent seals
* [fire-resistant glazing](https://app.croneri.co.uk/topics/fire-resistance-buildings/indepth#DCAM-240219)
* [fire-proof ducts or cabling](https://app.croneri.co.uk/topics/fire-resistance-buildings/indepth#DCAM-240220).

The Building Regulations 2010 require buildings to be separated from each other and sub-divided internally by the use of fire-resisting materials. The extent of the fire-resisting construction and the standard of fire resistance to be achieved are indicated in section B3 of *Approved Document B: Fire Safety*.

In Scotland and Northern Ireland the following legislation applies.

* Building (Scotland) Act 2003.
* Building (Scotland) Regulations 2004.
* Building Regulations (Northern Ireland) 2012.

### Fire Compartmentation

Compartmentation has two objectives.

1. To prevent rapid fire spread that could trap occupants of the building.
2. To reduce the chances of fires becoming large, on the basis that large fires are more dangerous.

Compartmentation is defined in BS 4422: 2005 *Fire. Vocabulary* as “the division of a building into fire-tight compartments by fire resisting elements of building construction in order to contain a fire within the compartment of origin.”

Through the application of UK Building Regulations, compartmentation is seen as an integral design feature of a building so as to protect life in the event of a fire.

The design of the compartment effectively suppresses the fire by:

* limiting the material available as fuel to the contents of the compartment alone
* preventing additional air (oxygen) from entering the compartment to assist in the development of the fire.

Where this approach is successful, the fire will eventually extinguish itself owing to lack of both fuel and oxygen. See the topic on [Fire Science and Combustion](https://app.croneri.co.uk/topics/science-fire-and-suppression/quickfacts#DCAM-3034581).

Almost all buildings require some compartmentation, in the form of fire-resisting walls, doors, floors, ceilings and other structural elements. Generally, however, the compartment will suppress the spread of fire only for a limited period: most compartments in buildings will resist fire for only 30 minutes to 1 hour.

Early failure of a compartment may occur due to one or more of the following:

* poor workmanship during installation of the fire-resisting element at initial build or refurbishment
* use of inappropriate materials/elements for passive fire protection purposes at initial build or refurbishment
* removal of all substrate leaving excessive penetrations with no fire stopping (eg during installation of new cabling)
* poor replacement of elements or use of inappropriate products following direct repairs or alterations to those elements
* damage/removal of elements during indirect repairs of alteration works within the premises
* damage to elements during maintenance and/or inspection of that element.

### Fire Doors

Fire doors are used to minimise the spread of fire and smoke and to aid escape. For those specifying fire doors, either for new builds, refurbishments or replacement works, there is normally the option to specify for a doorset or a door assembly. The *UK Fire Door and Doorset Industry Group*, which represents a cross-section of the fire door industry, have developed the following definitions.

* A doorset is a frame, finished door leaf or leaves, glazed where required, and its necessary hardware, fully machined needing no further site work other than possible re-assembly of factory-prepared component parts, and all placed on the market by one legal entity, for fixing in position in an opening in a wall.
* A door assembly is a frame, door leaf or leaves and its necessary hardware, supplied as individual component parts, usually unmachined, and placed on the market by more than one legal entity, for incorporating into an opening in a wall.

All fire-resisting doors are rated by their performance when tested to an appropriate standard. The level of protection provided by the door is measured, primarily by determining the time taken for a fire to breach the integrity of the door assembly, together with its resistance to the passage of hot gases and flame.

Fire doors should be designed, installed and maintained to the requirements of BS 8214:2016 *Timber-based Fire Door Assemblies. Code of Practice*.

#### Fire Door Requirements

The provision of fire doors is set out in detail in Appendix B to Approved Document B of the Building Regulations 2010 or its equivalent in Scotland and Northern Ireland.

The performance criteria required will normally be determined by reference to Building Regulation codes of practice as detailed above and other standards such as BS9999.

A doors performance criteria will normally be identified by the prefix FD on the door followed by the required integrity rating expressed in minutes, e.g. FD30, a fire-resisting door able to resist integrity failure for 30 min. Certain doors are also required to restrict the spread of ambient temperature smoke. These doors are identified by the suffix S, eg FD30S.

Doors installed to original standards may differ from the requirements of more modern standards. It is an inherent part of the risk assessment process to determine whether departures from current guidance, including guidance that supports the relevant fire safety legislation, create sufficient risk to warrant upgrading of fire doors to current standards.

There are many grey areas including the fitting of strips and seals to fire doors. The fire risk assessor should be taking into consideration factors such as the extent of fire detection and alarm systems, other passive protection measures and the length of time to evacuate when determining if upgrades are necessary.

Where upgrading is not deemed reasonably practicable, “it is appropriate to acknowledge the departure from current standards, so that at some future time the current standard can be adopted”.

Fire door performance can be confirmed through meeting performance requirements stipulated in relevant standards or through third-party certification.

Whatever route a specifier selects, a fire doorset or assembly will only be as good as the quality of the installation workmanship. Installation of fire doors is one of the most important roles in the fire door supply chain and the role that is least monitored. A poorly or incorrectly installed doorset/assembly rated for 30 minutes may provide only 5–10 minutes of fire resistance.

In respect of installation, BS 8214 notes that Approved Document B of the Building Regulations “recommends that the installation of fire-resisting products be covered by product conformity certification or by independent registered installer schemes, where such schemes are available”.

#### Specific Features of Fire Doors

The prime function of door hardware (also called door furniture or ironmongery) is to affect the correct and reliable performance of the fire door. Hardware fitted as essential items include:

* pivots or hinges that attach the door onto the frame and may also help to stop the door bowing
* door closing and hold-open devices, typically an overhead door closer or floor spring that ensures the door closes reliably and stays shut
* a latch or lock that is used to secure the door to prevent unauthorised use.

Selection of poor quality or unsuitable products can prevent doors from performing correctly with hardware malfunctions being commonplace. It can often be the case that cost and aesthetics are given precedence over practicality and reliability.

##### Self-closers

Fire-resisting doors serve their function only if they are closed at the time of a fire. They must, therefore, be self-closing. All doors should be fitted with an automatic self-closing device (except for fire doors to cupboards and service ducts that are normally kept locked shut) capable of closing the door from any angle of swing. Self-closing devices must meet the requirements of BS EN 1154:1997 *Building Hardware. Controlled Door Closing Devices*.

##### Hold-open Devices

To be effective, fire-resisting doors must be closed but in premises such as hotels, care homes and hospitals they can be inconvenient for the people using such establishments. Fire doors should not be fixed open in such a way that they will not close in the event of a fire. To remove this problem, electrically-operated devices may be fitted near fire doors that will hold the door open magnetically, releasing it in the event of the fire alarm sounding. These hold-open devices must be tested at least weekly and should be released at night.

##### Door Seals

All doors need a small gap between the door itself and the frame in order for it to open and close properly. However, this gap must not undermine the fire-resistance and smoke resistance of the door, and therefore some form of seal is needed. Modern seals are made from intumescent materials, which expand when heated and therefore form an effective seal. BS 8214:2016 contains requirements for such seals.

##### Door Signs

All fire-resisting and fire-stop doors must be fitted with signs which comply with BS ISO 3864 *Graphical Symbols. Safety Colours and Safety Signs*.

##### Glazing

All aspects of the glazing detail are crucial, including glass type, intumescent specification, quality of timber for glazing beads and method of installation. Incorporating apertures and glass into fire doors can reduce performance and this should never be performed on a certified and tested fire door.

##### Hinges

Hinges have an important role in ensuring the integrity of the fire door. BS EN 1935: 2002 *Building Hardware. Single Axis Hinges* is the current European standard for single axis hinges.

The Building Regulations set out the circumstances in which rising butts may be used, although these are not recommended.

##### Locks and Latches

In fitting locks or latches to fire-resisting doorsets, the potential fire performance of a doorset can be reduced. Where mortise locks are provided, the cut-out in the door should be the minimum necessary to prevent any voids which fire can penetrate. After the edges, the mortise lock and latch areas represent the next zone of weakness. Filling the voids in the cut-out with intumescent paste will markedly lessen the weakness in this area.

### Maintenance and Inspection

All fire doors and associated hardware must remain in efficient working order at all times. For this reason, it is important that they are inspected regularly and are repaired where necessary to a satisfactory standard. The frequency of inspection may vary, depending on the type and day-to-day use of a door. The inspection process should include some or all of the following checks.

* Self-closing devices operate properly.
* Hold-open devices release when the fire alarm operates.
* Glazed panels are intact and undamaged.
* Warning signs are in place. All fire-resisting and fire stop doors must be fitted with signs that comply with BS ISO 3864 or the Health and Safety (Safety Signs and Signals) Regulations 1996.
* Doors open and close freely and there is no physical damage to the door.
* There is no distortion or warping of the door or frame.
* No unauthorised modifications have taken place as these may greatly affect the door's integrity.
* The push bar or other panic release mechanism on final exit doors work properly and secure the door when it is in the closed position.
* Seals and smoke strips where fitted are not damaged.
* Hinges and locks are properly lubricated.

Any repair work done must be of a standard to allow the fire doors or exits to continue to meet the criteria laid out in the relevant British Standard.

### Fire-resistant Glazing

Fire-resistant glazing can be used within buildings in order to maintain high levels of separation between areas and maintain protection to escape routes where glass is required (eg sight panels in fire doors) or for architectural effect.

Fire-resistant glass can be based on a number of different glass technologies. Each glass type has its own characteristics, which can give rise to significant differences in behaviour.

Fire performance depends on the glass type and the fire-resistant glazed system design and construction. Also, the approved fenestration layout and glass pane sizes generally vary according to the particular approved glazed system being considered.

Further guidance is available in *A Guide to Best Practice in the Specification and Use of Fire-resistant Glazed Systems* (Glass and Glazing Federation, 2005) and the British Standard PD 6512–3: 1987 *Use of Elements of Structural Fire Protection with Particular Reference to the Recommendations given in BS 5588 'Fire Precautions in the Design and Construction of Buildings'. Guide to the Fire Performance of Glass*. (Note: BS 5588 series has been replaced and consolidated into BS 9999:2017).

Installation is just as important as the correct selection of the right combination of frame, glass, glazing seal, beads and fixings. Any number of tests and assessments conducted on the system are completely undermined if the installation is sub-standard.

Best practice suggests that all installation should be undertaken by an appropriately third-party certificated organisation, eg to the Fire Accreditation Scheme (FIRAS).

Glazing will have a permanent stamp that indicates, as a minimum, product name and manufacturer/supplier, and possibly the fire performance rating as well. The stamp must be visible and readable.

### Cables and Ductwork

The provision of fire-resisting walls, ceilings and floors is most commonly compromised by the installation of what is known as ‘penetrating services’ (pipes, cables, air handing equipment etc.). As this often occurs after any handover of premises, it often goes unnoticed.

The presence of any holes where cables are inserted through fire resistance elements is not acceptable as this will compromise fire resistance. These should be made good with a propriety material that is compatible with the existing structure.

There are a variety of propriety materials and products that can be utilised. This includes intumescent collars and wraps, fire-resisting mortars, coated-mineral fibre batts, fire-resisting pillows, etc.

Ductwork should also be assessed for fire resistance and some buildings have special ductwork that can aid passive fire safety compartments. In short, the ductwork should be capable of the same level of fire resistance as the walls, floor and doors. This will typically be with the use of dampers or fire-resistant closures.

Any ductwork that has special fire applications should be rated and assessed for fire safety. Typical methods for protecting ductwork include the use of fire dampers, fire-resistant enclosures and fire-resisting ductwork.

The Association for Specialist Fire Protection publication *Guide to Inspecting Passive Fire Protection for Fire Risk Assessors* contains useful information.

### External Fire Spread

Fire spread to or from a building can have the potential to threaten life and cause considerable damage. As such, external fire exposure risks to or from neighbouring properties should be considered as part of the fire risk assessment process so as to eliminate or reduce the risks by implementing reasonable control measures and to enable pre-planning measures to be implemented in the event of a fire.

The Building Regulations contain a number of requirements relating to the design and construction of premises and the requirement to reduce the external spread of fire. This will include compartmentation and separation distances.

Fire spread from building to building by radiation will be dependent upon a number of factors, not least the size and severity of the fire, which will determine the actual amount of radiative energy emitted. Other factors will include:

* distance between and orientation of the building of origin and the neighbouring structure
* extent of the building surface capable of transmitting heat
* intensity (emissive power) of the source radiation.

Control of external fire spread can be achieved by:

* a fire-resisting external envelope to the building so as to protect against fire spread
* installation of automatic sprinkler protection or deluge systems
* sufficient separation distances between buildings
* good standards of fire safety management and housekeeping.

## List of Relevant Legislation

* Localism Act 2011
* Fire (Scotland) Act 2005
* [Health and Safety at Work, etc Act 1974](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/health-and-safety-work-etc-act-1974-5#DCAM-234835)
* [Construction (Design and Management) Regulations 2015](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/construction-design-and-management-1#WKID-201412161228480000-16203718)
* [Building Regulations (Northern Ireland) 2012](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/building-regulations-northern-ireland-2012-0#WKID-201205281158160371-80417866)
* [Fire (Scotland) Act 2005 (Relevant Premises) Regulations 2012](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/fire-scotland-act-2005-relevant-premises#WKID-201212061213210821-83739042)
* [Building Regulations 2010](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/building-regulations-2010#DCAM-4867084)
* [Fire Safety (Employees’ Capabilities) (England) Regulations 2010](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/fire-safety-employees-capabilities-england#DCAM-4560304)
* [Fire Safety Regulations (Northern Ireland) 2010](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/fire-safety-regulations-northern-ireland#DCAM-4930203)
* [Fire Safety (Scotland) Amendment Regulations 2010](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/fire-safety-scotland-amendment-regulations#DCAM-4969302)
* Fire Safety (Scotland) Regulations 2006
* Building (Scotland) Regulations 2004
* Fire and Rescue Services (Northern Ireland) Order 2006
* [Regulatory Reform (Fire Safety) Order 2005](https://app.croneri.co.uk/reference-articles/law-and-guidance/legislation-tracker/regulatory-reform-fire-safety-order-2005#DCAM-944502)

## Further Information

### Publications

### British Standards

The following are available from the [BSI Shop](http://shop.bsigroup.com).

* BS 476-22:1987 *Fire Tests on Building Materials and Structures. Methods for Determination of the Fire Resistance of Non-loading Elements of Construction*
* BS EN 1363-1:2012 *Fire Resistance Tests. General Requirements*
* BS EN 1364 *Fire Resistance Tests for Non-loadbearing Elements*
* BS EN 1365 *Fire Resistance Tests for Loadbearing Elements*
* BS EN 1634-3:2004 *Fire Resistance and Smoke Control Tests for Door and Shutter Assemblies, Openable Windows and Elements of Building Hardware. Smoke Control Test for Door and Shutter Assemblies*

### Home Office Publications

The following are available from [www.gov.uk](https://www.gov.uk/government/organisations/department-for-communities-and-local-government).

* [*Approved Document B: Fire Safety: Volume 1: Dwellinghouses* (2006) (revised 2010 and 2013)](https://app.croneri.co.uk/file/13573/download)
* [Approved Document B *Fire Safety: Volume 2 — Buildings Other than Dwellinghouses* (2006) (revised 2010 and 2013)](https://app.croneri.co.uk/file/13574/download)

### Scottish Government Publications

The following is available from the FireLaw section of [www.scotland.gov.uk](http://www.scotland.gov.uk).

* *Technical Standards for Compliance with the Building Standards (Scotland) Regulations 1990*

### Organisations

* **Association for Specialist Fire Protection (ASFP)**
* <http://www.asfp.org.uk>
* The ASFP was established in 1975 to represent and support the activities of the fire industry in relation to all forms of “built in” fire protection. It produces a range of guidance documents relating to initial design/build and assessment of compartmentation elements.
* **Fire Industry Association (FIA)**
* <http://www.fia.uk.com>
* The FIA is a trade association formed by the merger of two leading associations within the fire protection industry — Fire Extinguishing Trades Association, the trade association of companies responsible for the manufacture and maintenance of portable fire-fighting equipment, and British Fire Protection Systems Association established, the co-ordinating body for the UK fire systems industry.
* **Fire Protection Association (FPA)**
* <http://www.thefpa.co.uk>
* The FPA is the UK’s national fire safety organisation. It provides a range of fire safety audit and fire risk assessment services.
* **Institution of Fire Engineers (IFE)**
* <http://www.ife.org.uk>
* The IFE is the international qualifying organisation for fire engineering and fire safety professionals. It was founded in 1918 to promote, encourage and improve the science and practice of fire extinction, fire prevention and fire engineering. The IFE maintains a register of fire risk assessors.

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