BS 9999:2008

BSI British Standards

Code of practice for fire safety in the design, management and use of buildings

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British Standards

Publishing and copyright information

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to xv, a blank page, pages 1 to 439 and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 6 October 2008. It was prepared by Technical Committee FSH/14, *Fire precautions in buildings*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes the following publications, which will be withdrawn on 6 April 2009:

- BS 5588-0:1996;
- BS 5588-5:2004;
- BS 5588-6:1991;
- BS 5588-7:1997;
- BS 5588-8:1999;
- BS 5588-9:1999;
- BS 5588-10:1991;
- BS 5588-11:1997;
- BS 5588-12:2004;
- DD 9999:2005.

BS 5588-1 is not being superseded by BS 9999 but is expected to be revised in due course and issued with a new identifier.

Information about this document

DD 9999 contained a number of important changes from the guidance in the BS 5588 series, particularly in the approach for design of means of escape, and in the guidance on construction which introduced a number of new features. It also introduced the concept of the risk profile.

This document converts DD 9999 into a full British Standard, and incorporates the following changes from the Draft for Development.

- The text from BS 5588-5 (access and facilities for fire-fighting) and BS 5588-12 (management) is now included in the appropriate places as indicated in the Draft for Development.
- Account has been taken of public comments received on the Draft for Development.
- The recommendations have been updated to take into account changes to legislation and the publication of new standards and legislative guidance documents.
- The title has changed to reflect the content more accurately.
- The recommendations specifically relating to fire-fighting have been updated to take into account the findings of the Building Disaster Assessment Group (available at http://www.communities.gov.uk/fire/fireandresiliencestatisticsandre/fireresearch/buildingdisasterassessment).
- The document has been restructured into sections and the contents list expanded.

The concept behind the development of BS 9999 and BS 7974 is that technical guidance on fire safety is provided at three different levels. This permits a design approach to be adopted that corresponds to the complexity of the building and to the degree of flexibility required. The three levels are as follows.

a) *General approach*. This level is applicable to a majority of building work undertaken within the UK. In this case the fire precautions designed into the building usually follow the guidance contained in the documents published by the relevant government departments to support legislative requirements.

b) *Advanced approach*. This is the level for which BS 9999 is provided. Guidance provided in this document gives a more transparent and flexible approach to fire safety design through use of a structured approach to risk-based design where designers can take account of varying physical and human factors. Much of the guidance in BS 9999 is based on fire safety engineering principles, although it is not intended as a guide to fire safety engineering.

c) *Fire safety engineering*. This is the level for which BS 7974 is provided. This level provides an alternative approach to fire safety and can be the only practical way to achieve a satisfactory standard of fire safety in some large and complex buildings, and in buildings containing different uses.

There might be circumstances where it is necessary to use one publication to supplement another, but care needs to be taken when using a "pick-and-mix" approach as it is essential to ensure that an integrated approach is used in any one building.

Whilst primarily intended for designers, fire engineers and fire safety managers, it is expected that BS 9999 will also be of use to:

- specifiers, contractors, site supervisors and site safety officers;
- owners, tenants, occupants, facility managers, safety officers and security staff;
- regulators and enforcers, including building control bodies, fire authorities, health and safety inspectors, environmental health officers, and environmental agencies.

BS 9999 is designed as a co-ordinated package covering the four main areas that influence fire safety measures, namely:

- fire safety management;
- the provisions of means of escape;
- the structural protection of escape facilities and the structural stability of the building in the event of a fire;
- the provision of access and facilities for fire-fighting.

Individual recommendations of this British Standard applied in isolation might give little or no benefit, and might even reduce the level of fire safety. Although the basic principles and recommendations for escape from floor areas are described in Section **5**, the most conscientious application of these recommendations could be undermined unless supported by other necessary measures.

Whatever fire safety provisions are made, they can be seriously compromised by a lack of management of fire safety (see Sections **4** and **9**); inadequate facilities for fire-fighting (see Section **6**); or a lack of appropriate related measures on construction of the building (see Section **7**).

It is important therefore that all those involved in either designing or approving the package of fire safety measures appreciate these interactions and influences. In addition it is important that a record is made of the basis for any package of fire safety measures proposed and approved, whether at the initial design stage or at any subsequent alteration to the building and/or its occupancy.

In developing this British Standard, cognizance has been taken of the guidelines given in CEN Guide 6.

These issues will also form essential components of the overall fire safety strategy adopted in the occupied building to ensure compliance with relevant fire safety legislation.

Assessed capability. *Users of this British Standard are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.*

Further information

Advice is available from a number of bodies, depending on whether they have a direct responsibility for the enforcement of fire safety in the building concerned. The bodies concerned include:

- local authorities;
- fire and rescue authorities;
- the Health and Safety Executive;
- building control bodies;
- environmental health departments;
- social services;
- education authorities;
- health authorities;
- the Environment Agency;
- consumer protection departments;
- petroleum licensing authorities.

Advice is also available in books and documents published by:

- Communities and Local Government (for planning and building construction matters and compliance with fire safety in occupied buildings) (http://www.communities.gov.uk);
- the Health and Safety Executive (for general and specific health and safety matters concerned with work activities) (http://www.hse.gov.uk);
- Scottish Government Building Standards (http://www.sbsa.gov.uk);
- the Department of Finance and Personnel (http://www.dfpni.gov.uk) and the Department of Health, Social Services and Public Safety (http://www.dhsspsni.gov.uk) in Northern Ireland.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations. Some variation from the recommendations might be necessary for certain specialist buildings or areas of buildings, e.g. areas of lawful detention.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word "should" is used to express recommendations of this standard. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Contractual and legal considerations

NOTE References are made throughout this British Standard to legislation and guidance applicable in the UK. However, it is recognized that the standard might be used outside the UK, and in such circumstances, readers of the standard need to be aware of the legislative requirements and sources of further information applicable in their own countries.

Broadly speaking, fire safety legislation in the UK sets out fire safety objectives for various types of premises and their associated activities, and specifies who is responsible for ensuring that they are met. Individual items of legislation generally refer to, and give legal force to, named sets of regulations that are more detailed than the parent legislation. They either specify how certain activities are to be performed, and duties discharged, or they state functional requirements, i.e. they describe the outcome(s) required. When functional requirements are given, the regulations usually refer to other technical guidance and/or standards, including British Standards. Reference is made throughout the text to legislative material of which users of this British Standard need to be aware.

Attention is particularly drawn to regulatory requirements in respect of the following principal stages in the lifetime of a building:

a) *planning* – type, size, use, appearance, access and location of a proposed building;

b) *construction* – materials, methods, nature and extent of both structural and installed fire safety features, internal and external arrangements for access, and proximity to other buildings;

c) *use* – occupants' activities including storage and use of materials, provision of first aid fire-fighting equipment and fire safety training for occupants, and maintaining means of escape;

d) *maintenance* – maintenance of fire safety systems and equipment in occupied and unoccupied buildings;

e) *alterations and extensions* – changes in fire risk or fire safety provisions; fire safety arrangements during construction work;

f) *change of use* – changes in fire risk or fire safety provisions;

g) *demolition* – fire safety arrangements during demolition work;

h) *when empty* – empty buildings are particularly vulnerable to arson.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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Section 1: General

0 Introduction

0.1 General principles

The design of buildings for fire safety relies upon an understanding of the sources of fire, materials and systems likely to be involved in fire, and the likely spread of fire.

The recommendations and guidance given in this British Standard are based on the assumption that under normal circumstances (i.e. except in the case of arson) a fire is unlikely to start in two different places in a building. Further information on the spread of fire is given in **4.1**.

The recommendations given in this British Standard are general, and all fire safety protection measures, procedures, etc., need to take into account the particular circumstances of the individual building or complex concerned. The same recommendations generally apply to both existing and new buildings, but existing buildings, especially historic buildings, often pose problems which are unlikely to arise in new buildings. In assessing the fire safety management needs of an existing building which is being modified, it is essential to have a full understanding of the existing structure and any fire safety provisions incorporated, and to take into account all of the following:

a) any change in use of the premises which could affect the fire risk profile (e.g. increased fire load and process risks, introducing the public, changes to sleeping risk, seasonal changes);

b) how the necessary fire safety levels can be practicably achieved in the existing premises and whether they are appropriate;

c) historic and environmental aspects of the premises and to what extent they need to be disturbed;

d) legislation and guidance introduced since the premises were originally constructed, or last altered, or since their fire safety was last assessed;

e) the interrelationship between life safety and measures to protect property/contents;

f) business continuity.

Historic buildings present particular challenges, as many are listed, and permitted alterations are limited without the agreement of the appropriate authorities. The advice of consultative bodies, such as English Heritage, should be sought in the early stages of design. The appropriate authorities sometimes agree to limited modifications to improve life safety where, in turn, there will be added long-term protection and preservation of the original building fabric. Specific issues relating to historic buildings can be divided into four areas:

1) the preservation of the ambience and important features of the building such as timber linings to accommodation stairs and slender cast iron structure, both of which can sometimes conflict with the desired fire safety construction but can be accommodated with suitable compensating features;

2) the existing construction of the building, including hidden features such as the extent of cavities through which fire could spread and the quality of walls, partitions and floors the fire resistance of which might be unknown or questionable. Life safety can often be addressed by the use of suitable compensating features, but these do not always cover property protection and business interests;

3) the fire performance of the building structure. Although modern construction standards seldom apply to historic buildings, action to improve the level of fire and life safety might be necessary based on change of use or due to the need to reduce the fire risk and potential for loss of the structure and/or interior in any other context;

4) the sensitivity of historic structures and interiors (finishes and contents) to fire and smoke damage.

In both new construction and upgrading existing buildings, the various aspects of fire precautions are interrelated and weaknesses in some areas can be compensated for by strengths in others. A higher standard under one of the areas might be of benefit in respect of one or more of the other areas. BS 9999 provides a level of flexibility that allows the fire protection measures and the risks to be assessed to enable reasonable practical solutions to be designed.

Fire precautions in all premises – however old – need to be seen as a whole, a package aimed at achieving an acceptable standard of fire safety. In modifying existing structures, if the new work can be shown not to have a negative impact on the remainder, it is expected that no work will be needed on the remainder, although it might be possible to offer improvement as good practice.

The principles and recommendations in this British Standard apply straightforwardly where premises have a single main use and are contained in a single, separate building. However, complications might arise where a building comprises two or more different main uses. In such cases it is important to consider the effect of one risk on another. A fire in a shop or unattended office could have serious consequences on, for example, a residential or hotel use in the same building. Similarly, a high fire risk in one part of a building could seriously affect other areas in another part of that building.

Amongst the factors that need to be taken into account in establishing a minimum package of fire protection measures are:

i) the potential users of the building;

ii) the hazard posed by one occupancy to another;

iii) provision for giving warning in case of fire, including any automatic fire detection;

iv) the provision of automatic fire suppression systems and smoke control arrangements;

v) the overall management and control of the building or development, from a fire safety point of view.

BS 9999 provides guidance on the provision of measures to control or mitigate the effects of fire. The primary objective is to ensure that an adequate standard of life safety can be achieved in the event of fire in the building. This can also have the effect of assisting the fire and rescue service and/or of providing some property and environmental protection. There are references throughout the standard to occupant safety, fire-fighter safety and property protection, to draw attention to the different considerations these could raise.

Section **2** is very important as it sets out the principles behind the guidance and introduces the concept of the risk profile. The guidance on the provision of means of escape and on construction has been developed to reflect the nature of the occupants and the use of the buildings as well as the likely fire growth and resulting risks associated with that use – the risk profile.

0.2 Management of fire safety

It is a fundamental assumption that features described in BS 9999 will require management and maintenance throughout the life of the building.

Managing fire safety is the whole process throughout the life of a building, starting with the initial design, which is intended both to minimize the incidence of fire and to ensure that, when a fire does occur, appropriate fire safety systems (including active, passive, and procedural systems) are in place and are fully functional. The management of fire safety is thus an essential element in averting disaster in the event of a fire. Although many buildings will never have a serious life-threatening fire, it is essential for fire safety procedures to be planned for every building. Often, the one common element in multi-fatality fires is that, when fire is discovered or when the alarm is raised, the occupants of premises, be they staff or members of the public, react and respond in ways which are different from those assumed or expected by the building designer. There are a number of stages by which people react to a fire alarm. Initially they tend to seek information regarding the validity of the warning, possibly by asking colleagues. They then gather belongings or seek associates or family. Only then do they seek to travel to a place of ultimate safety. The management of fire safety is intended to increase awareness and increase the probability of appropriate behaviour, to minimize the threat from the fire.

There have been numerous fire incidents, both large and small, where there have been lives lost or put at risk as a result of the safety systems provided being inappropriate or not being used effectively. In some occupancies (such as football grounds), fire is not always seen as the biggest safety problem and care is needed to avoid it becoming a neglected issue.

It is now widely acknowledged that the design and engineering put into a building for life safety can only do its job properly if it can be managed, maintained and tested over the whole life of the building, and if the staff are trained to handle incidents and operate effective and tested emergency plans.

Once the designer or engineer has handed over the building, then good management of fire safety becomes the key element to fire safety for the life of the building.

Effective management of fire safety can contribute to the protection of the building occupants in many ways:

- by working to prevent fires occurring in the first place;
- by monitoring the fire risks on an ongoing basis and taking appropriate action to eliminate or reduce the risk;
- by being aware of the types of people in the building (such as disabled people, elderly people, children, pregnant women, etc.) and any special risks or needs;
- by ensuring that all of the fire safety measures in the building are kept in working order, and in particular that the means of escape are always available;
- by training staff and organizing the evacuation plan, to ensure that occupants leave quickly if a fire occurs;
- by taking command in the event of a fire until the fire and rescue service arrives.

These tasks differ in detail depending on the occupancy of the building.

1 Scope

This British Standard gives recommendations and guidance on the design, management and use of buildings to achieve reasonable standards of fire safety for all people in and around buildings. It is not applicable to individual dwelling-houses, and might have only limited applicability to certain specialist buildings and areas of buildings (e.g. areas of lawful detention).

*NOTE The sections on fire safety management (Section **4** and Section **9**) are not applicable to buildings under construction (i.e. new build prior to partial occupation).*

This British Standard is applicable to the design of new buildings, and to alterations, extensions and changes of use of an existing building. It also provides guidance on the ongoing management of fire safety in a building throughout the entire life cycle of the building, including guidance for designers to ensure that the overall design of a building assists and enhances the management of fire safety. It can be used as a tool for assessing existing buildings, although fundamental change in line with the guidelines might well be limited or not practicable.

The recommendations and guidance given in this British Standard are intended to safeguard the lives of building occupants and fire-fighters. Whilst some of the recommendations and guidance might also assist in the achievement of other fire safety objectives – such as protection of property, the environment, communities and business/service viability – additional measures might be necessary which are outside the scope of this British Standard.

This British Standard does not cover fire safety design strategies for extreme events such as terrorist actions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 476 (all parts), *Fire tests on building materials and structures*

BS 799-5, *Oil burning equipment – Part 5: Specification for oil storage tanks*

BS 1635, *Recommendations for graphic symbols and abbreviations for fire protection drawings*

BS 3251, *Specification – Indicator plates for fire hydrants and emergency water supplies*

BS 4533 (all parts), *Luminaires*

BS 4790, *Method for determination of the effects of a small source of ignition on textile floor coverings (hot metal nut method)*

BS 5234 (both parts), *Partitions (including matching linings)*

BS 5266-1, *Emergency lighting – Part 1: Code of practice for the emergency lighting of premises*

BS 5266-7 (BS EN 1838), *Lighting applications – Emergency lighting*

BS 5306-0, *Fire extinguishing installations and equipment on premises – Part 0: Guide for the selection of installed systems and other fire equipment*

BS 5306-1, *Code of practice for fire extinguishing installations and equipment on premises – Part 1: Hose reels and foam inlets*

BS 5306-2, *Fire extinguishing installations and equipment on premises – Part 2: Specification for sprinkler systems*

BS 5306-3, *Fire extinguishing installations and equipment on premises – Part 3: Code of practice for the inspection and maintenance of portable fire extinguishers*

BS 5306-4, *Fire extinguishing installations and equipment on premises – Part 4: Specification for carbon dioxide systems*

BS 5306-5 (all sections), *Code of practice for fire extinguishing installations and equipment on premises – Part 5: Halon systems*

BS 5306-6 (all sections), *Fire extinguishing installations and equipment on premises – Part 6: Foam systems*

BS 5306-8, *Fire extinguishing installations and equipment on premises – Part 8: Selection and installation of portable fire extinguishers – Code of practice*

BS 5395-1, *Stairs, ladders and walkways – Part 1: Code of practice for the design, construction and maintenance of straight stairs and winders*

BS 5395-2, *Stairs, ladders and walkways – Part 2: Code of practice for the design of helical and spiral stairs*

BS 5410-1, *Code of practice for oil firing – Part 1: Installations up to 45 kW output capacity for space heating and hot water supply purposes*

BS 5410-2, *Code of practice for oil firing – Part 2: Installations of 45 kW and above output capacity for space heating, hot water and steam supply services*

BS 5438:1989+A2:1994, *Methods of test for flammability of textile fabrics when subjected to a small igniting flame applied to the face or bottom edge of vertically oriented specimens*

BS 5499 (all parts), *Graphical symbols and signs – Safety signs, including fire safety signs*

BS 5651, *Method for cleansing and wetting procedures for use in the assessment of the effect of cleansing and wetting on the flammability of textile fabrics and fabric assemblies*

BS 5655-6, *Lifts and service lifts – Part 6: Code of practice for the selection and installation of new lifts*

BS 5656-1, *Safety rules for the construction and installation of escalators and passenger conveyors – Part 1: Specification and proformas for test and examination of new installations*

BS 5656-2, *Escalator and moving walks – Safety rules for the construction and installation of escalators and moving walks – Part 2: Code of practice for the selection, installation and location of new escalators and moving walks*

BS 5839-1:2002+A2:2008, *Fire detection and alarm systems for buildings – Part 1: Code of practice for system design, installation, commissioning and maintenance*

BS 5839-3, *Fire detection and alarm systems for buildings – Part 3: Specification for automatic release mechanisms for certain fire protection equipment*

BS 5839-9:2003, *Fire detection and alarm systems for buildings – Part 9: Code of practice for the design, installation, commissioning and maintenance of emergency voice communication systems*

BS 5852:2006, *Methods of test for assessment of the ignitability of upholstered seating by smouldering and flaming ignition sources*

BS 5867-2:2008, *Fabrics for curtains, drapes and window blinds – Part 2: Flammability requirements – Specification*

BS 5906, *Waste management in buildings – Code of practice*

BS 6180, *Barriers in and about buildings – Code of practice*

BS 6262-4, *Glazing for buildings – Part 4: Code of practice for safety related to human impact*

BS 6263-2, *Care and maintenance of floor surfaces – Part 2: Code of practice for resilient sheet and tile flooring*

BS 6644, *Specification for installation of gas-fired hot water boilers of rated inputs between 70 kW (net) and 1.8 MW (net) (2nd and 3rd family gases)*

BS 6798, *Specification for installation of gas-fired boilers of rated input not exceeding 70 kW net*

BS 7036 (all parts), *Code of practice for safety at powered doors for pedestrian use*

BS 7157:1989, *Method of test for ignitability of fabrics used in the construction of large tented structures*

BS 7176, *Specification for resistance to ignition of upholstered furniture for non-domestic seating by testing composites*

BS 7273-4, *Code of practice for the operation of fire protection measures – Part 4: Actuation of release mechanisms for doors*

BS 7346-3, *Components for smoke and heat control systems – Part 3: Specification for smoke curtains*

BS 7346-4, *Components for smoke and heat control systems – Part 4: Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing steady-state design fires – Code of practice*

BS 7346-6, *Components for smoke and heat control systems – Part 6: Specifications for cable systems*

BS 7346-7:2006, *Components for smoke and heat control systems – Part 7: Code of practice on functional recommendations and calculation methods for smoke and heat control systems for covered car parks*

BS 7671, *Requirements for electrical installations – IEE Wiring Regulations – Seventeenth edition*

BS 7807, *Code of practice for design, installation and servicing of integrated systems incorporating fire detection and alarm systems and/or other security systems for buildings other than dwellings*

BS 8214, *Code of practice for fire door assemblies with non-metallic leaves*

BS 8300, *Design of buildings and their approaches to meet the needs of disabled people – Code of practice*

BS 8313, *Code of practice for accommodation of building services in ducts*

BS 8414-1, *Fire performance of external cladding systems – Part 1: Test methods for non-loadbearing external cladding systems applied to the face of a building*

BS 8414-2, *Fire performance of external cladding systems – Part 2: Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame*

BS 8486-1, *Examination and test of new lifts before putting into service – Specification for means of determining compliance with BS EN 81 – Part 1: Electric lifts*

BS 8486-2, *Examination and test of new lifts before putting into service – Specification for means of determining compliance with BS EN 81 – Part 2: Hydraulic lifts*

BS 8491, *Method for assessment of fire integrity of large diameter power cables for use as components for smoke and heat control systems and certain other active fire safety systems*

BS 9251, *Sprinkler systems for residential and domestic occupancies – Code of practice*

BS 9990, *Code of practice for non-automatic fire-fighting systems in buildings*

BS EN 54-7, *Fire detection and fire alarm systems – Part 7: Smoke detectors – Point detectors using scattered light, transmitted light or ionization*

BS EN 54-11:2001+A1:2006, *Fire detection and fire alarm systems – Part 11: Manual call points*

BS EN 81 (all parts), *Safety rules for the construction and installation of lifts*

BS EN 115, *Safety rules for the construction and installation of escalators and passenger conveyors*

BS EN 378 (all parts), *Refrigerating systems and heat pumps – Safety and environmental requirements*

BS EN 671 (all parts), *Fixed fire fighting systems – Hose systems*

BS EN 1125, *Building hardware – Panic exit devices operated by a horizontal bar – Requirements and test methods*

BS EN 1154, *Building hardware – Controlled door closing devices – Requirements and test methods*

BS EN 1155, *Building hardware – Electrically powered hold-open devices for swing doors – Requirements and test methods*

BS EN 1363 (all parts), *Fire resistance tests*

BS EN 1364 (all parts), *Fire resistance tests for non-loadbearing elements*

BS EN 1365 (all parts), *Fire resistance tests for loadbearing elements*

BS EN 1366 (all parts), *Fire resistance tests for service installations*

BS EN 1634-1, *Fire resistance tests for door and shutter assemblies – Part 1: Fire doors and shutters*

BS EN 1634-3, *Fire resistance tests for door and shutter assemblies – Part 3: Smoke control doors and shutters*

BS EN 12101 (all parts), *Smoke and heat control systems*

BS EN 12150-1, *Glass in building – Thermally toughened soda lime silicate safety glass – Part 1: Definition and description*

BS EN 12416-2, *Fixed firefighting systems – Powder systems – Part 2: Design, construction and maintenance*

BS EN 12845, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*

BS EN 13501 (all parts), *Fire classification of construction products and building elements*

BS EN 13823, *Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item*

BS EN 14179-1, *Glass in building – Heat-soaked thermally-toughened soda lime silicate safety glass – Part 1: Definition and description*

BS EN 60702-1, *Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V – Part 1: Cables*

BS EN 60702-2, *Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V – Part 2: Terminations*

BS EN ISO 306, *Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)*

BS EN ISO 1182, *Reaction to fire tests for building products – Non-combustibility test*

BS EN ISO 1716, *Reaction to fire tests for building products – Determination of the heat of combustion*

BS EN ISO 12543-2, *Glass in building – Laminated glass and laminated safety glass – Part 2: Laminated safety glass*

BS EN ISO 14122-4, *Safety of machinery – Permanent means of access to machinery – Part 4: Fixed ladders*

BS ISO 10294-5, *Fire-resistance tests – Part 5: Fire dampers for air distribution systems. Intumescent fire dampers*

BS ISO 14520 (all parts), *Gaseous fire-extinguishing systems – Physical properties and system design*

ISO 834-1, *Fire-resistance tests – Elements of building construction – Part 1: General requirements*

Other publications

COLWELL, S. and MARTIN, B. *Fire performance of external thermal insulation for walls of multi-storey buildings*. BR 135. Second edition. Watford: Building Research Establishment, 2003.

HARRISON, R. and MILES, S. *Smoke shafts protecting fire shafts; their performance and design*. BRE Project Report 79204. Garston, Watford: Building Research Establishment, 2002.

MORGAN, H.P. and GARDNER, J.P. *Design principles for smoke ventilation in enclosed shopping centres*. BR 186. Watford: Building Research Establishment, 1990.

MORGAN, H.P., GHOSH, B.K., GARRAD, G., et al. *Design methodologies for smoke and heat exhaust ventilation*. BR 368. Watford: Building Research Establishment, 1999.

3 Terms and definitions

For the purposes of this British Standard the following definitions apply.

3.1 access panel

panel used to gain access to service ducts and shafts

NOTE An access panel might or might not be fire-resistant.

3.2 access room

room that forms the only escape route from an inner room (**3.68**)

3.3 access statement

explanation of philosophy and approach to inclusive design adopted in the design and construction of a building

3.4 accommodation stair

stair, additional to that or those required for escape purposes, provided for the convenience of occupants

3.5 air handling void

duct which forms part of either the supply or the return air distribution system

NOTE This is usually a ceiling or floor void and is usually known as a plenum.

3.6 air transfer grille

fixed grille not connected to the ductwork system allowing the free transfer of air between adjacent rooms and/or spaces

3.7 alternative format

information provided through an accessible medium

NOTE Examples include the provision of information electronically instead of in printed format, or in British Sign Language instead of through ordinary speech.

3.8 ancillary accommodation
all parts of a building that are ancillary to the main use of the building and under the control of the management of the overall premises

NOTE Examples of ancillary accommodation include rooms associated with engineering services, service areas and refuse rooms.

3.9 associated floor area
floor area in an atrium building not separated from the atrium by construction having a fire resistance equal to that required for the elements of the structure of the building

NOTE The area of the atrium base should be included in the calculation of the associated floor area.

3.10 atrium (plural: atria)
space within a building, not necessarily vertically aligned, passing through one or more floors

NOTE Enclosed lift wells, enclosed escalator structural openings, building services ducts and stairways are not classified as atria.

3.11 atrium base
plan area of the lowest floor level, bounded by lines projected down from the edge of the floor slab immediately above the lowest floor level within the atrium

3.12 available safe escape time
calculated time available between the ignition of a fire and the time at which the conditions for escape become untenable to the occupants

3.13 basement
storey with a floor which at some point is more than 1.2 m below the highest level of ground adjacent to the outside walls

3.14 boundary
edge of the land belonging to a building, or, where the land abuts a road, railway, canal or river, the centreline of that road, railway, canal or river

3.15 bridgehead
part of a building, usually the floor below the fire (floor above in the case of basements), from which fire-fighting teams can be safely committed to attack a fire

3.16 building control body
any one of a number of different bodies including the Local Authority and Approved Inspectors (in England and Wales), and Verifiers (in Scotland)

3.17 canopy
horizontal structure projecting into a void

NOTE An example is the soffit of an upper level walkway, which is not fully stepped back from the level below.

3.18 car control station
control panel in a lift car for the use of passengers

3.19 cavity barrier
construction provided to close a concealed space against penetration of smoke or flame, or provided to restrict the movement of smoke or flame within such a space

3.20 ceiling void
cavity between a structural floor or roof and the suspended ceiling below, through which building services may pass

3.21 Class 0 material or surface
material or surface that is either:

a) of limited combustibility throughout; or

b) classified as Class 1 when tested in accordance with BS 476-7, which has a fire propagation index *I* of not more than 12, and a subindex i_1 of not more than 6, when tested in accordance with BS 476-6

NOTE Class 0 is not identified in any British Standard test.

3.22 compartment wall or floor
fire-resisting wall or floor used in the separation of one fire compartment from another

3.23 competent person
person, suitably trained and qualified by knowledge and practical experience, and provided with the necessary instructions, to enable the required task(s) to be carried out correctly

3.24 concealed space or cavity
space enclosed by elements of a building (including a suspended ceiling) or contained within an element, but not a room, cupboard, circulation space, protected shaft or space within a flue, chute, duct, pipe or conduit

3.25 control equipment
electrical switches, door interlocks and apparatus associated with the operation and programming of a lift service

3.26 controlled fire load
fire load that is limited by means of management controls on the quantities of combustible material that are present on the atrium base or where the fire load is limited by an effective automatic suppression system

3.27 dampers

3.27.1 fire damper
mechanical device that is operated automatically or manually and is designed to prevent the passage of fire and which, together with its frame, is capable of meeting for a stated period of time the fire resistance criterion for integrity

3.27.2 smoke damper
mechanical device which, when closed, restricts smoke passing through an aperture within a duct or structure

NOTE The device may be open or closed in its normal position and may be automatically or manually operated.

3.27.3 fire/smoke damper
combined fire damper and smoke damper

3.28 dead end
place from which escape is possible in one direction only, or in directions less than 45° apart that are not separated by fire-resisting construction

3.29 depth
distance of the lowest point of the floor of the lowest storey of a building to the fire and rescue service access level measured at the centre of that face of the building where the distance is greatest

3.30 ductwork
system of enclosures of any cross-sectional shape for the distribution or extraction of air and/or smoke

3.31 element of structure
member forming part of the structural frame of a building or any other beam or column

NOTE An element of structure can be a load-bearing wall or load-bearing part of a wall; a floor; a gallery; an external wall; or a compartment wall (including a wall common to two or more buildings).

3.32 emergency action
action to be taken in the event of a fire or other emergency

3.33 emergency lighting
lighting provided for use when the supply to the normal lighting fails

3.34 escape route
route forming part of the means of escape from any point in a building to a final exit

3.35 final exit
termination of an escape route from a building giving direct access to a street, passageway, walkway or open space, and sited to enable the rapid dispersal of persons from the vicinity of a building so that they are no longer in danger from fire and/or smoke

3.36 fire compartment
enclosed space, which may be subdivided, separated from adjoining spaces within the building by elements of construction having a specified fire resistance

3.37 fire doors

3.37.1 fire door
door or shutter provided for the passage of persons, air or objects which, together with its frame and furniture as installed in a building, is intended (when closed) to resist the passage of fire and/or gaseous products of combustion, and is capable of meeting specified performance criteria to those ends

NOTE 1 A fire door may have one or more leaves, and the term includes a cover or other form of protection to an opening in a fire-resisting wall or floor or in a structure surrounding a protected shaft.

NOTE 2 For the purposes of this British Standard, the term "fire door" includes:

- *side-hung or pivoted fire doors;*
- *shutter assemblies;*
- *access hatches that are fixed or hinged.*

3.37.2 self-closing fire door
fire door fitted with a device which fully closes the door from any angle, overriding the resistance of any latch and/or seal but not including rising butts

3.38 fire and rescue service access level
level at which there is suitable entry to a building and to a fire-fighting shaft from an area to which fire and rescue service appliances have access

3.39 fire-fighting lift
lift with fire protection measures, including controls that enable it to be used under the direct control of the fire and rescue service in fighting a fire

3.40 fire-fighting lobby
protected lobby provided within a fire-fighting shaft giving access from a fire-fighting stair to an accommodation area, and normally to any associated fire-fighting lift and fire main

3.41 fire-fighting shaft
protected enclosure containing a fire-fighting stair, fire-fighting lobbies, a fire main and, if provided, a fire-fighting lift together with any machinery space

3.42 fire-fighting stair
protected stairway communicating with an accommodation area only through a fire-fighting lobby

3.43 fire growth rate
characteristic rate at which a fire is assumed to grow

3.44 fire load
quantity of heat that would be released by the complete combustion of all the combustible materials in a volume, including the facings of all bounding surfaces

NOTE The fire load is expressed in joules.

3.45 fire main
water supply pipe, fitted with an outlet and control valve at specified points, installed in a building for fire-fighting purposes

3.46 fire protection measure
passive or active measure taken within a building to increase the level of protection to the occupants

3.47 fire resistance
ability of a component or construction of a building to meet for a stated period of time some or all of the appropriate criteria specified in the relevant part of BS 476 or BS EN 13501

NOTE These criteria include one or more of the following: load-bearing capacity; integrity; and insulation.

3.48 fire safety engineer
person qualified and experienced in fire safety engineering

3.49 fire safety manager
nominated person carrying out the job of management of fire safety

3.50 fire safety manual
record of all design, procedural and management issues and events that relate to the fire safety of a building

3.51 fire-stopping
sealing or closing an imperfection of fit between elements, components or construction of a building, or any joint, so as to restrict penetration of smoke and flame through the imperfection or joint

3.52 first-aid fire-fighting equipment

equipment for use by the occupants of a building to fight a fire

NOTE These include hose reels and portable fire extinguishers.

3.53 flashover

transition from localized burning to full room involvement in a fire

3.54 flat

separate and self-contained premises constructed or adapted for use for residential purposes and forming part of a building from some other part of which it is divided horizontally

NOTE This includes premises described as maisonettes.

3.55 floor area

area enclosed by the inner surfaces of a wall, including internal walls

3.56 floor void

cavity between a structural floor and a platform above, through which building services can pass

3.57 flow rate

number of persons passing a point in a unit of time on a path having a specific width

3.58 fly gallery

narrow balcony or gantry, usually running from front to back of the stage on one or both sides and occasionally continuing across the back wall, used for securing suspension lines, loading counterweights and operating suspension lines, and occasionally for rigging lighting equipment

3.59 fuel load

total amount of combustible material expressed either in megajoules (MJ) or as an equivalent mass of wood

3.60 fuel load density

fuel load per unit area, expressed in megajoules per square metre (MJ/m^2)

3.61 fusible link

device that releases a component such as a fire damper or fire shutter at a set temperature

NOTE This incorporates either a solder link or a frangible glass bulb.

3.62 grid

open framework of beams over the stage which is used (primarily) for the suspension of scenery and lighting equipment or to provide a platform for access to the pulleys for such suspension systems

3.63 grille

security or protective mesh positioned over the opening to a duct or in a door to allow air discharge into a room or space

3.64 height (of an atrium)

level of the surface of the highest point of the floor of the highest storey adjacent to the atrium measured from the level of the atrium base

3.65 height (of a building)

distance of the surface of the highest point of the floor of the highest storey (excluding any such storey consisting exclusively of plant rooms) to the fire and rescue service access level measured at the centre of that face of the building where the distance is greatest

3.66 holding capacity
ability of a stair to hold a specified number of people during an escape

3.67 hot work
operations requiring the use of open flames or the local application of heat or friction
[BS 4422]

3.68 inner room
room from which the only escape route is through another room

*NOTE The room that provides the escape route from an inner room is known as an access room (**3.2**).*

3.69 integrity
ability of a separating element when exposed to fire on one side, to prevent the passage of flames and hot gases or the occurrence of flames on the unexposed side, for a stated period of time in a standard fire resistance test (i.e. the relevant part of BS 476 or BS EN 13501)

NOTE This may be expressed as integrity criterion "E" (see BS EN ISO 13943).

3.70 lifts

3.70.1 dual-entry fire-fighting lift
fire-fighting lift provided with two sets of doors, one used for normal operations and the other in the fire-fighting mode

3.70.2 evacuation lift
lift used as part of the evacuation sequence for people requiring assistance, which has appropriate structural, electrical and fire protection and is capable of being taken under control by an authorized person

3.70.3 lift landing
floor space from which a lift car is normally entered at each level

3.70.4 lift landing door
hinged or sliding portion of a lift well enclosure at each landing that gives access to a lift car when open

NOTE This is separate from the lift car door.

3.70.5 lift machine
unit, including the motor, which drives and stops a lift

3.70.6 lift well
space in which the lift car, the counterweight or the balancing weight travels

NOTE This space is usually bounded by the bottom of the pit, the walls and the ceiling of the well.

3.71 limited combustibility
material performance specification that includes non-combustible materials and for which the relevant test criteria are:

a) (national classes) by reference to the method specified in BS 476-11; or
b) (European classes) in terms of performance when classified as class A2-s3, d2 in accordance with BS EN 13501-1:2007, when tested to BS EN ISO 1182 or BS EN ISO 1716 and BS EN 13823

3.72 mall exit
final exit from a mall, or storey exit, or exit from a mall that leads directly to a storey exit or final exit by way of a protected corridor/passageway

3.73 mall section
length of a mall between two mall exits

3.74 management of fire safety
task(s) carried out by a defined individual or individuals with appropriate powers and resources to ensure that the fire safety systems, passive, active and procedural, within the building are working properly at all times

3.75 material of limited combustibility
either:

a) a non-combustible material; or

b) any material of density 300 kg/m^3 or more which, when tested in accordance with BS 476-11, does not flame and has a rise in temperature on the furnace thermocouple of not more than 20 °C; or

c) any material with a non-combustible facing (on one or both sides) not more than 0.5 mm thick

3.76 means of escape
means whereby a safe route or routes in the event of fire is or are provided for persons to travel from any point in a building to a place of ultimate safety

3.77 mezzanine floor
floor that is ancillary to the main use of the building, does not exceed 20% of the floor area of the lower floor or 500 m^2, whichever is less, is compartmented from the lower storey, and has a means of escape that is independent of the lower storey

3.78 non-combustible
not capable of undergoing combustion under specified conditions [BS EN ISO 13943]

3.79 open-sided car park
car park that:

a) is not a basement storey;

b) has natural ventilation not less than 5% of the floor area at that level of which at least half is in two opposing walls;

c) is separated from the rest of the building if the building is also used for any other purpose

3.80 open spatial planning
internal arrangement of a building in which more than one storey or level is contained in one undivided volume

NOTE Split-level floors are an example of open spatial planning.

3.81 overcladding
addition of an external cladding to an existing building, usually to improve thermal protection or weather protection

3.82 phased evacuation
system of evacuation in which different parts of a premises are evacuated in a controlled sequence of phases, those parts of the premises expected to be at greatest risk being evacuated first

NOTE This is usually the floor containing the fire and the floor above. The remaining floors are evacuated at later stages if required.

3.83 place of relative safety
place in which there is no immediate danger, but in which there could be future danger, from the effects of a fire

3.84 place of ultimate safety
place in which there is no immediate or future danger from fire or from the effects of a fire

3.85 pre-movement time
interval between the time at which a warning of fire is given and the time at which the first move is made towards an exit

3.86 pressure differential system
system of fans, ducts and vents provided for the purpose of creating a pressure differential between a fire zone and a protected space

3.87 pressurization
method of protecting spaces against the ingress of smoke by maintaining a positive air pressure difference between the protected spaces and adjoining accommodation
[BS 4422]

3.88 protected
enclosed (other than any part which is an external wall of a building) with fire-resisting construction

3.89 protected corridor/lobby
circulation area consisting of a lobby or corridor enclosed with fire-resisting construction (other than any part that is any external wall of a building)

3.90 protected shaft
stairway, lift, escalator, chute, duct or other shaft of fire-resisting construction which enables persons, objects or air to pass from one fire compartment to another

3.91 protected stairway
stair discharging through a final exit to a place of ultimate safety (including any exit passageway between the foot of the stair and the final exit) that is protected from fire elsewhere in the building by fire-resisting construction

3.92 protected zone
area in a building that is protected from the effects of fire and smoke

3.93 radial gangway
gangway at an angle to the rows of seating or a stepped gangway in tiered seating

3.94 refuge
area that is both separated from a fire by fire-resisting construction and provided with a safe route to a storey exit, thus constituting a temporarily safe space

3.95 risk profile
means of categorizing the risks for a range of occupancies based on the occupancy characteristic and the fire growth rate

3.96 seatway
distance between adjacent rows of seats

3.97 shopping complexes

3.97.1 shopping complex
structural combination of a number of commercial premises that includes areas providing common access for the public, principally for shopping purposes

3.97.2 covered shopping complex
shopping complex that includes a covered mall, i.e. any mall section (**3.73**) in which:

a) more than 15 m of the length of the mall is covered by a bridge or roof; or

b) (where the mall has an open slot above it, formed for example by projecting continuous canopies) more than 50% of its plan area is obscured; or

c) (in any other case) at least 25% of its plan the area is obscured by a roof or by floors, bridges, galleries or canopies

3.97.3 uncovered shopping complex
shopping complex that does not include a covered mall

3.98 shunt system
system in which branch ductwork turns through an angle and runs parallel to the main ductwork for a specific distance before turning into and connecting with the main ductwork

3.99 smoke clearance system
smoke control system designed to remove the products of combustion following a fire and used at the discretion of the fire and rescue service to assist fire-fighting operations

3.100 smoke control
technique used to control the movement of smoky gases within a building in order to protect the structure, the contents, the means of escape, or to assist fire-fighting operations

3.101 smoke dilution
smoke control achieved by mixing the smoky gases with enough clean air to achieve less hazardous conditions

3.102 smoke exhaust ventilation system
smoke control system designed to remove a sufficient volume of smoke to minimize the possibility of inter-connected spaces becoming untenable as a result of the spread of smoke

3.103 smoke-retarding construction
construction intended to retard the passage of smoke

3.104 smoke shaft
enclosed space in a building provided for venting smoke from a fire-fighting stair or one or more fire-fighting lobbies

3.105 sprinkler
thermosensitive device designed to react at a predetermined temperature by automatically releasing a stream of water and distributing it in a specified pattern and quantity over a designated area

3.106 sprinkler installation
part of sprinkler system comprising a control valve set, the associated downstream pipes and sprinklers

3.107 sprinkler system
entire means of providing sprinkler protection in premises, comprising one or more sprinkler installations, the pipework to the installations, and the water supply or supplies except town mains and bodies of water such as lakes or canals

3.108 structural element

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

NOTE A structural element can be a load-bearing wall or load-bearing part of a wall; a floor; a gallery; an external wall; or a fire compartment wall (including a wall common to two or more buildings).

3.109 temperature control system

heat control system using the principles of smoke exhaust ventilation, sufficient to reduce gas temperatures in the smoke layer formed within the atrium to permit the use of construction/glazing systems in the atrium façade which, whilst capable of preventing the passage of smoke, are not fire-resisting

NOTE Examples of such construction/glazing systems include float and other annealed glasses, tempered glass, etc.

3.110 *t*-equivalent

exposure time in a fire resistance test which gives the same heating effect on a structure as a given compartment fire

3.111 transverse gangway

flat gangway parallel to the rows of seating

3.112 travel distance

actual distance a person needs to travel from any point within a building to the nearest storey exit, having regard to the layout of walls, partitions and fittings

3.113 travel time

time needed, once movement towards an exit has begun, for all the occupants of a specified part of a building to reach a place of safety

3.114 vent

device that is permanently open or can be opened to permit the passage of air or smoke between a part of a building and the external air

NOTE Examples include windows, roof lights, doors, louvres and grilles.

3.115 vitiated air

air in which the oxygen content has been reduced

NOTE In a fire, this is produced by combustion.

3.116 working fly gallery

fly gallery, usually the lowest if more than one gallery is provided, which is likely to be occupied during performances by staff operating suspension lines

4 General recommendations and background

4.1 Spread of fire and smoke

A common basis for designing fire safety measures lies in the identification of the possible causes and/or sources of fire and the evaluation of the manner in which it is likely to develop and spread through a building.

The recommendations and guidance given in this British Standard are based on the assumption that under normal circumstances (i.e. except in the case of arson) a fire is unlikely to start in two different places in a building.

Initially, a fire creates a hazard only in the part of the building in which it starts and is unlikely to involve a large area, although it can subsequently spread to other parts of the building. Fire is less likely to spread if passages, corridors, lobbies or stairways intended for use only for access or means of escape are kept clear of combustible materials.

It is unlikely that fire will originate in the building structure itself. Outbreak of fire is more likely to occur in furnishings, decorations, finished goods, raw materials and/or chemicals, equipment, electrical services, process plant or service plant in the building. The point of origin is therefore likely to be in display areas, factory areas, storerooms, bedrooms, kitchens, living rooms or offices, or possibly in the service installations.

When a fire occurs in an enclosed space, hot smoke-laden gases rise to form a layer, which at first has a tendency to flow under the ceiling and then deepens to fill the whole space. The fire tends to grow in area, the flames spreading to nearby combustible furnishings, fittings, exposed papers, etc. The flames increase in height until they reach the ceiling where they are deflected horizontally and, radiating downwards, accelerate fire growth. If the ceiling is combustible, it can ignite and add to the volume of flame and speed of fire growth. If the space has insufficient openings to provide a continuing air supply, the burning rate of the fire diminishes as it draws on increasingly vitiated air, but the gases generated are then extremely toxic.

Once ignited, combustible products give off hot smoke-laden and toxic gases. Convection and radiation also occur rapidly and, because of the extremely high temperature of the gases, other combustible materials and products within the area of the fire will ignite more easily, further accelerating the progress of the fire. It cannot be assumed that the effects of the fire will be confined to the space in which it originated. If the enclosing walls have no fire resistance or do not form a fire-tight joint with a fire-resisting floor (or ceiling) above, the fire will soon penetrate at ceiling level, where the attack from the flames or hot gases is most severe, to the adjoining space. Even with fire-resisting construction, the buoyancy and expansion of the fire gases can cause them to be driven out of the space to affect other parts of the building.

If the fire gases penetrate into a vertical shaft, such as a stairwell, lift well or duct, they will rise rapidly, attacking the top of the shaft and spreading elsewhere if there are any openings in the shaft. In such circumstances, if a substantial flow of air reaches the fire through an aperture such as a window or door, the vertical shaft can act as a chimney and can greatly accelerate fire growth.

A fire occurring anywhere within a compartment of a building has, therefore, to be regarded as presenting a hazard to all occupants within that compartment, even though in the initial stages of fire development it might seem that the hazard is small and people are in no immediate danger. There is also likely to be a risk to persons in other parts of the building.

In the early stages of a fire, the most significant effects are usually those of smoke and other products of combustion. Smoke is often the first evidence of fire and is thus likely to be the first cause of alarm. When smoke extends down to head height it produces difficulty in breathing and impairs visibility, which interferes with the efforts of occupants to find their way towards the exits. People who are prevented from escaping by dense smoke, or who are unduly delayed from escaping by it, can suffer from the toxic effects of the products of combustion that accompany the smoke. The asphyxiating effect caused by lack of oxygen or by the intense heat of the gases making up the smoke can cause intoxication, disorientation, incapacity, unconsciousness and, in the worst scenario, death.

The speed at which a space becomes untenable is mainly dependent on its volume and the fire growth rate. For higher and larger spaces the time taken to fill with smoke takes longer and so there is more time for escape and longer travel distances are possible.

These considerations are particularly important when dealing with large numbers of persons, some of whom might be unfamiliar with their surroundings, and who might also vary widely in age and degree of mobility.

To facilitate escape it is thus necessary:

a) to ensure that protected escape routes are provided and that they are adequately safeguarded against the ingress of smoke;

b) to limit the time people have to travel before they reach a protected route and/or a final exit;

c) to consider reverse flows that might occur as a result of a particular exit route being unavailable or as a feature of an evacuation plan for disabled people.

A means of smoke ventilation might be necessary to assist the fire and rescue service and, if operated automatically, can also assist escape from the building.

After the outbreak of fire there might only be a short time during which the actions necessary for ensuring the safety of occupants can be carried out. This time will be sufficient only if all provisions for the safety from fire of people, property, business viability and the environment are planned and managed so as to be effective when the occasion arises.

4.2 Variation of guidance

The guidance on means of escape in Section **5** permits variations to be made to travel distances and door and/or stair widths on the basis that the level of risk can be reduced by the provision of additional fire protection measures. Such measures include an increased level of management of fire safety, the provision of an automatic sprinkler system, the provision of a smoke management system or the provision of an additional level of automatic fire detection.

Equally, the guidance on designing the building structure in Section **7** permits certain variations when such measures as an automatic sprinkler system are provided.

NOTE A fire safety engineering approach as detailed in BS 7974 gives greater flexibility and might be more appropriate in the design of complex buildings and spaces.

Designers, occupiers and approving authorities are thus able to allow a degree of flexibility in the provision of fire safety measures as part of the overall design package. However, there are limits on the extent of variation permitted within the scope of this British Standard.

4.3 Property and business continuity protection

The guidance and recommendations in this British Standard are primarily concerned with the protection of life. The provision of fire safety systems for life safety does not necessarily give adequate protection to property or to the continuity of the business carried out in the building.

It is therefore recommended that the potential for property and business loss is assessed so that such risks are understood and addressed. Such assessment should be carried out in accordance with Annex A. Advice and guidance on the provision of fire precautions for the protection of property and the continuity of the business can also be found in Annex A (see also **44.8**).

4.4 Environment

Many fires or emissions from combustion processes damage the environment. The contents of, and activities within, any building catching fire are likely to pollute to a greater extent than products used in the fabric of the building itself.

NOTE Deliberate fires might require additional measures to be taken which are outside the scope of this British Standard.

This British Standard is concerned largely with accidental fires, and the main area for consideration of the environmental impact of such fires is the loss of control of pollutants as a consequence.

Appropriate steps at the design stage of any building can minimize the impact of accidental fire on the environment and, whist the emphasis is likely to be on the potential contents of the building, it would be responsible to consider the effects of using combustible materials in the building specification.

4.5 Additional recommendations for specific building types/occupancies

In addition to the general guidance given in Sections **4** to **9**, specific recommendations for particular building types/occupancies are given in a series of annexes:

NOTE Exemplars are given in Annex C.

a) atria should meet the recommendations given in Annex B;

b) theatres, cinemas and similar venues should meet the recommendations given in Annex D;

c) shopping complexes should meet the recommendations given in Annex E;

d) process plant and structures should meet the recommendations given in Annex F;

e) refuges should meet the recommendations given in Annex G.

4.6 Inclusive design

Accessible means of escape, and the associated fire safety strategy, should be considered as an integral part of the design process, and not as a separate issue. Where a building is designed and managed inclusively to provide access for all users, the facilities provided should where appropriate be used to improve egress arrangements.

Fire safety for disabled people is included within this document; this includes consideration of all disabilities, and is not restricted to guidance for assisting wheelchair users. Specific guidance on means of escape for disabled people is given in **17.7** and **18.8**; general guidance on fire safety procedures for people at particular risk is given in **44.3**; and measures to aid the evacuation of disabled people are described in Clause **46**.

Disabled people can be at particular risk in the event of a fire and need appropriate protection facilities. These might include relevant provisions for those requiring assistance, such as:

- appropriate means for giving warning in the event of fire;
- management planning;
- appropriate fire instructions in alternative formats;
- appropriate wayfinding systems;
- evacuation lifts or protected refuge areas and devices for taking people down or up stairs.

Special management procedures might be required where it is reasonably foreseeable that the proportion of disabled users in a building will be relatively high, or where the use of the premises is likely to result in groups of wheelchair users being present (e.g. some types of sporting, entertainment, transport or public assembly buildings). See Sections **4** and **9** for guidance on building management.

NOTE 1 Attention is drawn to the Disability Discrimination Act 1995 [1], which places duties on all employers and providers of services not to discriminate against disabled people, and to make adjustments to their policies, practices, procedures or physical features of their premises, to ensure that disabled people are not discriminated against by the organization. It is vital to ensure therefore, when making plans for the fire safety and management of buildings, that the requirements of disabled people are properly taken into account at all times. Attention is also drawn to the Regulatory Reform (Fire Safety) Order 2005 [2], which requires suitable means of escape to be provided for all occupants, to the Fire (Scotland) Act 2005 [3] as amended, and to the Fire Safety (Scotland) Regulations 2006 [4]. (Northern Ireland has its own legislation, on which work is ongoing at the time of publication of BS 9999.)

NOTE 2 Attention is drawn to the Disability Equality Duty [5], which requires public authorities to take steps to promote equality for disabled people. With regard to fire evacuation issues, the DED might require authorities subject to the duty to ensure that due regard is paid to making provision for the safe egress of disabled people from all types of buildings under their jurisdiction, in a way that is inclusive and that does not compromise equality of access to those buildings.

Section 2: Risk profiles and assessing risk

5 Assessing risk

An assessment should be carried out in order to determine the risk profile, i.e. the potential for fire risks to people, property and business continuity. This should account for the fire safety provisions in the building and the level of fire prevention management (see Clause **8**). The risk assessments for property protection, business continuity and environmental damage can be undertaken as an extension to that carried out for life safety.

By carrying out a risk assessment, the consequences of fire on people, property, business and the environment can be highlighted to the owner, occupier, operator, tenant, designers and insurers. It should then be clear what fire safety systems are required, what function they have in relation to the protection of people, property, business and the environment, and what management responsibilities are required to maintain and operate these systems.

NOTE 1 This assessment of risk is not designed to satisfy the fire risk assessment requirements of any fire safety-related legislation. Information on fire risk assessment is provided in a series of guides published by Communities and Local Government [6–16], and in guidance published by the Justice Department of the Scottish Government, available from www.infoscotland.com/firelaw. Generic information, mainly related to health and safety risk assessment, is given in INDG 163 [17]. Information on quantitative risk assessments for fire safety design is given in PD 7974-7. Recommendations for business continuity are given in BS 25999-1.

NOTE 2 The statutory fire risk assessment can be extended to cover the needs for protection of buildings and their contents as well the prevention of environmental damage and also for business continuity.

Factors that should be taken into account in assessing the fire risk for both new construction and existing premises include:

a) the anticipated likelihood of a fire occurring;

b) the anticipated severity and potential spread of any fire;

c) the ability of the structure to resist the spread of fire and smoke;

d) the consequential danger to people in and around the building; and

e) the need to address property and contents protection, business interests and the environment.

The basic factors that should be taken into account during such an assessment are shown in Table 1, which also gives cross-references to the relevant sections of this British Standard.

Table 1 **Basic factors in assessing fire risks**

Factor	**Comments**
Adequacy of means to prevent fire	The assessment should identify the scope for fire prevention measures, and indicate the associated management systems needed.
Early fire warning by an automatic detection and warning system	This provision can lead to "first aid" or fire and rescue service fire-fighting in the early stages of fire development. Modern systems can be unobtrusive (aspirating), addressable (by which a fire location and development can be identified), and can reduce unwanted alarms.
The standard of means of escape	See Section **5** and Section **7** (for which structural enclosure and separation would be a part).
Provision of smoke control	See Sections **5**, **6** and **7**.
Control of the rate of fire growth	This item particularly includes spread of flame over surfaces and behind linings, and within contents. See Section **7**.
Adequacy of the structure to resist the effects of fire	See Section **7**.
Degree of fire containment	Includes containment by sub-compartmentation, cavity barriers, and fire-stopping. See Section **7**.
Fire separation between buildings or parts of a building	See Section **7**.
Standard of active measures for fire extinguishment or control	See Section **7**.
Facilities to assist the fire and rescue service	See Section **6**.
Quality of premises management	See Sections **4** and **9**.
Provisions for staff training and ongoing controls	See Section **9**.
Occupancy characteristics and risk profiles	See Clause **6**.

6 Risk profiles

6.1 General

A risk profile should be established for each building in order to determine the appropriate means of escape (Section **5**) and the appropriate design features of the building for life safety (Section **7**).

The risk profile should reflect the occupancy characteristic (**6.2** and Table 2) and fire growth rate (**6.3** and Table 3) for a building, and should be expressed as a value combining these two elements (**6.4**, Table 4 and Table 5).

Account should be taken of the fact that different uses within the same building can have different fire load densities and occupancy characteristics.

There is a minimum package of fire protection measures and management levels associated with each of the risk profiles. These are identified throughout this British Standard.

6.2 Occupancy characteristic

The occupancy characteristic is principally determined according to whether the occupants are familiar or unfamiliar with the building and whether they are likely to be awake or asleep. Occupancy characteristics should be determined in accordance with Table 2.

NOTE It is recognized that within each of these categories there will be persons with a range of capabilities present. In some cases these will be known to the premises management. Further guidance is given in Clause ***46****.*

Table 2 **Occupancy characteristics**

Occupancy characteristic	Description	Examples
A	Occupants who are awake and familiar with the building	Office and industrial premises
B	Occupants who are awake and unfamiliar with the building	Shops, exhibitions, museums, leisure centres, other assembly buildings, etc.
C	Occupants who are likely to be asleep:	
Ci	• Long-term individual occupancy	Individual flats without 24 h maintenance and management control on site
Cii	• Long-term managed occupancy	Serviced flats, halls of residence, sleeping areas or boarding schools
Ciii	• Short-term occupancy	Hotels
D [A)]	Occupants receiving medical care	Hospitals, residential care facilities [B)]
E [C)]	Occupants in transit	Railway stations, airports

A) Currently occupancy characteristic D, medical care, is dealt with in other documentation and is outside the scope of this British Standard.
B) Under some circumstances, residential care facilities may be classified as occupancy characteristic Cii.
C) This occupancy characteristic is included for completeness within this table but is not referred to elsewhere in this British Standard.

6.3 Fire growth rate

The fire growth rate is the rate at which it is estimated that a fire will grow. Fire growth rates should be categorized in accordance with Table 3.

NOTE A building with a high fire load density will not necessarily have a rapid fire growth rate, and low fire load density will not necessarily have a slow fire growth rate.

Table 3 **Fire growth rates**

Category	Fire growth rate	Examples	Fire growth parameter [A)] kJ/s^3
1	Slow	Banking hall, limited combustible materials	0.002 9
2	Medium	Stacked cardboard boxes, wooden pallets	0.012
3	Fast	Baled thermoplastic chips, stacked plastic products, baled clothing	0.047
4	Ultra-fast	Flammable liquids, expanded cellular plastics and foam	0.188

A) This is discussed in PD 7974-1.

6.4 Creating the risk profile

Risk profiles are given as a combination of occupancy characteristic and fire growth rate, as shown in Table 4. Examples of typical risk profiles are given in Table 5.

The examples in Table 5 are indicative only, and risk profiles for specific premises should be determined in accordance with **6.2** and **6.3**.

Where a number of risk profiles apply within one building, the higher risk profile should be used.

NOTE As risk profile assessments are carried out on a case-by-case basis, it is possible that there might be, for example, A1 or A3 offices or a B2 shop. However, the potential for a very fast growing fire is deemed to be unacceptable (i.e. A4, B4 and C4) unless an effective localized suppression system (see Clause ***39****) or sprinklers are added, in which case the risk profiles become A3, B3 and C3 respectively. Where sprinklers are used to change the risk profile, only those installed in accordance with BS EN 12845 (new systems) or BS 5306-2 (existing systems) can be used to adjust the fire resistance periods given in Tables 25 and 26.*

Table 4 **Risk profiles**

Occupancy characteristic (from Table 2)	**Fire growth rate**		**Risk profile**
A (Occupants who are awake and familiar with the building)	1	Slow	A1
	2	Medium	A2
	3	Fast	A3
	4	Ultra-fast	A4 A)
B (Occupants who are awake and unfamiliar with the building)	1	Slow	B1
	2	Medium	B2
	3	Fast	B3
	4	Ultra-fast	B4 A)
C (Occupants who are likely to be asleep)	1	Slow	C1 B)
	2	Medium	C2 B)
	3	Fast	C3 B), C)
	4	Ultra-fast	C4 A), B)

A) These categories are unacceptable within the scope of BS 9999. Addition of an effective localized suppression system or sprinklers will reduce the fire growth rate and consequently change the category (see **6.5**).

B) Risk profile C may be divided into sub-categories, viz. Ci1, Cii1, Ciii1, etc.

C) Risk profile C3 will be unacceptable under many circumstances unless special precautions are taken.

Table 5 **Examples of typical risk profiles**

Occupancy	Risk profile	Occupancy	Risk profile
Administration office	A2	Indoor games/training rooms in schools	B2
Amusement arcade	B2	Kitchen	A3
Archive/library reading area	B3	Licensed betting office (public area)	B1
Art gallery	B1/B2	Lobbies	B1
Assembly hall	B2	Lounge (other than dwelling)	B2
Banking hall	B1	Machine/printing room	A3
Bar	B2	Mechanical plant room	A4 [A)]
Bazaar	B2/B3	Meeting room	B2
Bedroom/study bedroom	Cii2	Museum	B2
Bed-sitting room	Cii2	Office (closed-plan or office less than 60 m^2)	B2
Billiards or snooker room	B2	Office (open-plan exceeding 60 m^2)	A2
Bingo hall	B2	Reading room	B2
Bowling alley	B2	Reception area	B1
Business centre	B2	Restaurant	B2
Canteen	A2	Shop sales area [B)]	B3
Classroom	A2	Shop sales area [C)]	B3
Club	B2	Showrooms	B3
Committee room	A2	Skating rink	B1
Common room	A2	Stadia and grandstands	B1
Computer room	B2	Staff room	A2
Concourse or shopping mall	B2	Storage and warehousing	A2/A3/A4 [A)]
Conference room	B2	Studio (radio, television, film, recording), non-public	A2
Crush hall	B2	Studio (radio, television, film, recording), public	B2
Dance area	B2	Teaching laboratories	A3
Deposit/strong room	A2/A3	Theatre/cinema/concert hall auditoria	B2
Design studio/drafting office	A2	Theatre stages	A2/A3
Dining room	B1	Trading floor	B2
Dormitory	Cii2	Trading gallery	B2
Exhibition areas	B2/B3	Venue for pop concerts	B1
Factory production area	A2/A3	Waiting area/visitors lounge	B1
Filing room/store	A3	Waiting room	B1
Foyers	B1	Workshop	A3
Gymnasium/leisure centre	B2		

A) See Table 4. Risk profile A4 is unacceptable unless a sprinkler system or another appropriate fire suppression system is installed.

B) Excluding those in covered shopping complexes and excluding department stores but including those that trade predominantly in furniture, floor coverings, cycles, prams, large domestic appliances, or other bulky goods, or cash and carry shops.

C) Including supermarkets, department stores, shops for personal services like hairdressing, shops for the delivery and collection of goods for cleaning/repair/treatment or for members of the public themselves carrying out such cleaning/repair/treatment.

6.5 Variation of risk profile

Automatic sprinkler systems can provide an efficient means of fire control within a building compartment. Such provision restricts fire growth, prevents fire spread, limits heat and smoke generation, and can extinguish the fire. This means that if sprinkler systems are installed, the fire growth rate can be reduced by one level in Table 4, Table 12 and Table 13. These tables outline the variations permissible but are subject to defined limits. Where only part of a building is provided with sprinkler coverage, the reduction to the risk profile should apply only to the sprinklered rooms. Corridors and linking spaces associated with the sprinklered rooms should also have sprinkler coverage, or be separated from the sprinklered rooms by fire-resisting construction.

EXAMPLE The provision of an automatic sprinklered installation permits a reduction in fire growth rate, allowing larger travel distances, smaller doors, larger compartments, reduced fire resistance periods and other provisions recommended in this standard. An unsprinklered shop with a risk profile of B3 would become B2 when sprinklered and an unsprinklered office with a risk profile of A2 would become A1 when sprinklered. Also the addition of sprinklers would have the effect of reducing a not allowable B4 risk profile to an acceptable B3.

Where it is proposed to modify the risk profile by using a fire suppression system other than a sprinkler system, it will need to be demonstrated that this system achieves the equivalent standard of fire protection and reliability.

Sprinkler systems should be designed and installed in accordance with BS EN 12845, BS 5306-2 or BS 9251. However, where sprinklers are used to change the risk profile, only those installed in accordance with BS EN 12845 (new systems) or BS 5306-2 (existing systems) can be used to adjust the fire resistance periods given in Tables 25 and 26.

Section 3: Ensuring effective fire protection

7 Ensuring effective fire protection

7.1 General

This British Standard provides guidance to ensure the fire safety of a building over its lifetime, and this requires the correct installation and maintenance of all fire safety provisions.

The design methodology offered here can lead to innovative and unusual fire safety solutions but which, in the event of a fire, are likely to depend for their success upon the proper performance and/or operation and/or interaction of a number of passive and/or active fire protection systems, all of which depend to a degree on human factors. It has been found in practice that designs can frequently be compromised due to incorrect or poor installation, substituted materials or products, missing materials or products, lack of integration of active systems, inadequate inspection, lack of full commissioning, abuse during normal use of the building, inadequate maintenance and/or testing, and problems resulting from inadequate management documentation and training.

All the passive and active elements of fire safety that comprise the building design should be carefully designed, properly constructed or implemented, and should be regularly and appropriately maintained and tested.

7.2 The design stage

The basic fire safety strategy should be decided at the outset of the design process, so that all sectors of the ensuing process can be coordinated.

It is important that the designer understands, and takes account of, the construction process and does not produce a design or designs that cannot physically be built or installed.

The designer should consider the method(s) of procurement, construction, installation, integration, and commissioning, and seek to ensure that the various elements can be properly inspected and tested, and maintained and repaired, that they can (as far as possible) be protected from abuse during normal use of the building, and that there is sufficient management documentation.

Products specified should be of a type appropriate for the actual use of the building, e.g. a fragile lining might not be a good idea if trolleys are going to impact it. Any structural fire protection systems in the plane of a fire compartment wall or floor should not compromise the broader and different fire resistance criteria needed for the compartment wall/floor itself.

The selection of fire protection systems by designers should take account of:

- life cycle cost considerations and how frequently the system or its components will need to be replaced;
- maintenance needs to ensure that the recommended performance (e.g. fire rating) has not been compromised;
- access for periodic inspection and replacements during the lifetime of the building;
- durability issues – wetting, freeze-thaw, movement and aggressive environments – which can reduce performance over a period of time.

Product certification. *Users of this British Standard are advised to consider the desirability of third-party product and installation approval schemes.*

It is important that:

- the material or product specified is appropriate for its end use;
- the material or product specified has appropriate field of application reports showing it to be fit for the intended application. Test reports are inadequate for this purpose;
- the correct construction or installation of the material or product is described and is not compromised by inadequate understanding or knowledge of the contractor or sub-contractors;
- all systems can be adequately commissioned and tested.

NOTE Attention is drawn to the Construction (Design and Management) Regulations 2007 [18], the Building Regulations 2000 [19] and the Building (Scotland) Regulations 2004, as amended [20] in respect of the requirement to provide documentation concerned with communication of information.

The designer should ensure that:

- contractor(s) and sub-contractor(s) understand what the systems are expected to do and how to construct or install them;
- where a lot of different people are likely to be responsible for the construction, installation or maintenance of different parts of the fire safety system, there is adequate management co-ordination;
- managers understand what the systems do, and how to test or evaluate the installation.

7.3 The construction stage

Product installation. *Users of this British Standard are advised to consider the desirability of installation by third-party accredited contractors who understand the fire safety issues for the relevant trades.*

The construction management is responsible for quality monitoring during construction. Where there are a variety of different trades working on a building there might be serious interference by a later tradesperson. For example, a ventilation engineer might compromise previously installed structural passive fire protection which obstructs a new ducting system. Where it might not be reasonable to expect all contractors to understand the needs of the fire safety strategy or take responsibility for them, it might be necessary to develop procedures to integrate different trades and to allocate responsibility and accountability, or appoint an independent supervisor.

It is important that:

- the passive fire protection products constructed or installed are those specified (and not substitutes);
- the passive fire protection is located and fixed properly in accordance with the manufacturer's instructions (e.g. cavity barriers);
- the specified fire resistance periods can be achieved (e.g. by providing an appropriate number of layers of plasterboard);
- the active systems installed are those specified (and not substitutes);
- the active systems are installed properly and in accordance with the manufacturer's instructions;
- actuation equipment is properly installed and tested and cause-and-effect tables are fully tested;
- all systems are adequately commissioned and tested.

NOTE Detailed guidance on passive fire protection in buildings is given in the ASFP publication Ensuring best practice for passive fire protection in buildings *[21]. This document is the output from a DTI Research project to monitor and assess the quality of installed passive fire protection system in buildings.*

7.4 The maintenance stage

Fire protection systems might not provide for the continuity of the fire safety strategy if they are not regularly and properly inspected, tested or maintained. Continued reliability is essential.

NOTE Attention is drawn to the Regulatory Reform (Fire Safety) Order 2005 [2] in respect of the need for responsible persons to make and maintain a fire risk assessment. This task cannot be completed unless fire safety provisions are routinely monitored and are ready for use in an emergency. Attention is also drawn to the Fire (Scotland) Act 2005 [3] as amended, and to the Fire Safety (Scotland) Regulations 2006 [3]. (Northern Ireland has its own legislation, on which work is ongoing at the time of publication of BS 9999.)

There might well be a threat to fire protection systems if subsequent trades cause damage to these systems, or change the construction features such that the intended operation cannot be provided or achieved. The later installation of electrical and IT cable systems, building service pipe work, for example, often causes significant damage to the usefulness of fire compartments in buildings, and work should not be signed off until the passive fire protection measures have been checked for continued functionality. Such cold work checking can be as important as control of hot-work permits for work on buildings.

Product installation. *Users of this British Standard are advised to consider the desirability of using third-party accredited installation contractors for making changes in buildings.*

Changes to the construction or use of a building need to taken into account any impact on the available fire safety systems (active and passive). The maintenance of all fire compartment boundaries is crucial to the fire safety strategy in buildings.

Effective maintenance is equally important externally and internally to the building. A building designed for fire safety should not be compromised by the addition of combustible products or by removal or damage to existing systems. The risk of spread of fire externally over a building should be taken into account. Materials used for repair or modification should not impair the fire safety strategy.

The key actions can be summarized as:

- consider building life issues;
- ensure that building services aid the fire safety strategy; not obstruct it;
- consider the use of hot (see **48.2**) and cold work permits of work;
- maintain, monitor and record the well-being of all fire safety facilities;
- ensure that those responsible are appropriately empowered.

The maintenance requirements should be detailed in the fire safety manual for the building (see Clause **9** and Annex H).

Section 4: Managing fire safety

*COMMENTARY ON SECTION **4***
*This section is concerned with the management of fire safety, and provides guidance for building designers and fire safety managers (in smaller premises, the fire safety manager is likely to be the owner of the building), addressing the issues that need to be considered during the design process. Clauses **8** and **9** deal with general issues and are of relevance to both building designers and fire safety managers. Clause **10** deals with design issues and is mostly of relevance to building designers. Guidance on managing occupied buildings is given in Section **9**.*

This British Standard covers premises of all sizes and complexity and in consequence some material is only applicable to certain sizes or types of premises. Where reference is made to the acceptability or otherwise of management levels in fulfilling legislative requirements, this is taken to be in a United Kingdom context. However, it is recognized that where this standard is used outside the United Kingdom, different legislative regimes might apply. Users of this British Standard should use only those clauses applicable to the premises with which they are dealing.

The guidance in this section takes into account all aspects of building management during the design process, including:

- *effective management planning and control;*
- *protection of escape routes from any area that could be threatened by fire;*
- *fire resistance in the building structure, surface finishings, carpets and furnishings;*
- *segregation of high fire risk/hazard areas;*
- *fire warning systems and, where appropriate, systems for the automatic detection of fire;*
- *automatic fire extinguishing systems to limit the growth of fire;*
- *smoke control measures to maintain the effectiveness of escape routes and to assist fire-fighters;*
- *fire safety manuals;*
- *fire-fighting equipment, whether for use by the staff in containing fire in its early stages, or by way of assistance to the fire and rescue service;*
- *reasonable access to the building for the fire and rescue service, including facilities for the safe and rapid extinction of fire by the fire and rescue service and for the safety of the fire and rescue service personnel when fire-fighting.*

8 Establishing management levels

8.1 Management of the fire safety strategy

Where the designer is aware of the management systems that will be adopted in the premises upon occupation, this may be taken into account as part of the development of the fire safety strategy. Where the management systems that will be adopted are not known, the designer will need to specify the management level that is appropriate for the design.

During the life of a building, any changes to the standard or quality of management, use of the building, or alterations proposed will need to be assessed to identify their effect upon the overall fire safety strategy. For example, where reductions in management levels from those adopted within the original design strategy are proposed, there will be a need to re-evaluate the fire safety strategy for its continued viability. Likewise, changes to the building layout might require changes to the management procedures.

The crucial factor is knowledge of the management systems that will be in place, since this factor influences all of the others. Some buildings are so limited in the options for their use that the management systems required may be assumed for the lifetime of the building. Other buildings can be expected to change use, but with limited changes to management systems, whilst in yet other buildings the use, or management, can be expected to change many times in the lifetime of the building.

In all cases a minimum level of fire safety management will be required (see **8.2**), and a record of the assumptions of how the building will be managed should be specified in the fire safety manual (see Clause **9** and Annex H).

8.2 Management levels

The standard or quality of management is referred to here as the management level. There are three management levels, with level 1 giving the highest level of management, level 2 giving a normally acceptable level of management, and level 3 giving a very basic level of management. Table 6 sets out the likely minimum acceptable management levels for different combinations of fire growth rate and occupancy risk profile. However, irrespective of the guidance given in Table 6, it is possible that the enforcing body might be of the view that a level 3 management system will not meet the legislative requirements placed on the occupiers, owners or other responsible persons.

In determining the level of fire safety management proposed, or provided, it is necessary to take into account a number of different factors. Advice on each of these factors is given in **8.3**. In order to achieve a level 1 fire safety management overall, it will be necessary for a level 1 to be achieved for all factors; for a level 2 fire safety management, it will be necessary to achieve at level 2 or level 1 for all factors.

Table 6 **Management levels for different risk profiles**

Occupancy characteristic (Table 2)	Fire growth rate (Table 3)		Risk profile (Table 4)	Management level
A (Occupants who are awake and familiar with the building)	1	Slow	A1	3 [A)]
	2	Medium	A2	2
	3	Fast	A3	1
	4	Ultra-fast	A4 [B)]	Not applicable [B)]
B (Occupants who are awake and unfamiliar with the building)	1	Slow	B1	2
	2	Medium	B2	2
	3	Fast	B3	1
	4	Ultra-fast	B4 [B)]	Not applicable [B)]
C (Occupants who are likely to be asleep)	1	Slow	C1	2
	2	Medium	C2	1
	3	Fast	C3 [B)]	1
	4	Ultra-fast	C4 [B)]	Not applicable [B)]

A) A level 3 system might not be acceptable in some circumstances (see **8.2**).
B) See Table 4.

8.3 Assessing the management levels

8.3.1 General

Table 7 gives a guide to the principal factors that should be taken into account when determining the level of fire safety management to be proposed or provided. It also refers to the subclauses in which each individual factor is discussed in greater detail. The list of factors given in the table and the following subclauses is not exhaustive, but highlight some of the issues that need to be taken into account when assessing the management level.

Table 7 **Factors used in assessing management levels**

Management factor	Subclause
Planning for changes in risk profile	**8.3.2**
Resources and authority	**8.3.3**
Staffing level (staff–occupant ratio)	**8.3.4**
Fire training	**8.3.5**
Work control (e.g. repairs to structure)	**8.3.6**
Communications procedures	**8.3.7**
Maintenance and testing of fire safety systems	**8.3.8**
Liaison with fire and rescue service	**8.3.9**
Contingency planning	**8.3.10**

8.3.2 Planning for changes in risk profile

Management systems should include procedures for anticipating and taking into account, either on a permanent or a temporary basis, changes to the occupancy and/or fire growth characteristics of the building and its contents over the life cycle of the building. These procedures should form part of the overall audit and review process for the fire safety strategy and should be able to determine whether any such changes will necessitate alterations to the fire precautions provided, including the management systems, and to put any such alterations into effect.

- A level 1 system anticipates and proactively identifies the impact of any proposed changes, including changes to the occupancy, periods of abnormal occupancy, and fire growth characteristics. The system identifies any alternative protection and management measures that will be required as a result, and ensures that they are implemented.
- A level 2 system identifies and reacts to any changes as they occur, including changes to the occupancy, periods of abnormal occupancy, and fire growth characteristics. The system identifies any alternative protection and management measures that will be required as a result, and ensures that they are implemented.
- A level 3 system reviews any changes on a periodic basis. The system then identifies any alternative protection and management measures that will be required as a result, and ensures that they are implemented.

In all instances the procedures should include any necessary consultations with building control bodies and the fire and rescue authority.

8.3.3 Resources and authority

For the management of fire safety to be effective, the fire safety manager(s) needs to be empowered and able to command sufficient resources to maintain the systems.

- In a level 1 system, the manager(s) with responsibility for fire safety are empowered to ensure that legislative requirements are met; initiate testing, initiate maintenance or repair, and, where necessary, have direct control of staff responsible for these tasks. Such powers are supported by the necessary, sufficient and appropriate resources, including funds.
- In a level 2 system, the responsibility for fire safety, and the necessary supporting staff and resources, is likely to be divided over a number of different individuals, departments or even companies. It is likely that the implementation of any necessary changes will require approval of those not directly responsible for the routine management of fire safety within the premises.
- In a level 3 system, the managers determined as being responsible for fire safety are likely to have limited or no power or resources, and are thus unlikely to be able to ensure that the fire safety systems are kept fully functional without reference to a third party.

8.3.4 Staffing level (staff–occupant ratio)

The role of staff is an important element of the fire safety package provided. The appropriate staffing level (for fire safety purposes) for a particular building is influenced by the use of the building and fire growth characteristics; the types of occupant; the fire safety systems in place; and the roles and levels of the staff concerned in ensuring the fire safety of the occupants.

- In a level 1 system, the staffing level provided is specifically appropriate to the building concerned, including the use of the building, the nature of the occupants, the management systems in place, and the active and passive systems provided. It also includes sufficient trained personnel to ensure that all occupants are assisted, or supported, to make their way out of the building effectively in an emergency – where necessary, e.g. in the case of elderly or disabled persons, or children, this might include making appropriate additional arrangements to ensure their safe evacuation. A level 1 system may include arrangements for security such as regular patrols, perimeter controls, entry control systems, and staff able to respond to an intrusion. A level 1 system will also provide for contingencies such as training, sickness, and other unexpected absences etc.
- In a level 2 system, there will not be any arrangements for contingencies such as training, sickness, and other unexpected absences, etc., nor will there be provision for security such as regular patrols, perimeter controls, entry control systems, or staff able to respond to an intrusion.
- In a level 3 system, the staffing levels and systems provided do not routinely and specifically address the issues identified above.

Particular attention is needed in certain occupancies, such as a hotel, which although provided with what is considered to be otherwise an appropriate standard of passive and active fire precautions might, if it is predominantly occupied by elderly or disabled persons or children, require a higher staffing level than would otherwise be the case where the occupants were predominantly "mixed adult".

Management systems should include procedures for situations where the occupancy density could seriously affect evacuation plans, e.g. Christmas sales or food shortage scares for retail premises, and special one-off events involving celebrities or jubilee-type occasions for public buildings.

If it is proposed to have a situation where members of the public will be admitted to a building where no staff are available, a full risk assessment should be carried out to evaluate whether people will be able to evacuate the building safely. Unstaffed buildings are generally not acceptable where there is a fast or ultra fast rate of fire growth. The assessment should take into account issues such as:

- means of escape – provision should be good, and other protection facilities, such as fire alarms, exit signage, compartmentation and emergency lighting designed, installed and appropriately maintained;
- management of the building – staff should be able to respond to an emergency in a reasonable time although not on site;
- occupancy levels – should be low for the use of the building;
- evacuation – occupants should be able to self-evacuate.

8.3.5 Fire training

Training of staff and others for action in the event of a fire is an essential element of fire safety management.

- In a level 1 system, the training ensures that there are sufficient numbers of staff trained in all aspects of fire prevention, fire protection and evacuation procedures, and able to use the appropriate extinguishing equipment (and media), so as to provide full coverage of the building, with provision for contingencies, sickness or holiday absences.
- In a level 2 system, the training ensures that there are sufficient numbers of staff trained in all aspects of fire prevention, fire protection and evacuation procedures, and able to use the appropriate extinguishing equipment (and media), so as to provide full coverage of the building, but has no contingency provision.
- In a level 3 system, general training is provided on a periodic basis.

8.3.6 Work control

Management systems should control work on site, e.g. repairs to structure, and in particular hot work.

- A level 1 work control system is developed proactively with clear lines of responsibility; a permit system; logging and audit processes and routine checking and supervision.
- A level 2 work control system is developed reactively to work required on site to include clear lines of responsibility; a permit system; and logging and audit processes.
- A level 3 work control system is reactive to work required on site.

8.3.7 Communications procedures

Communications procedures include means of being alerted to a fire; communications between management, and between management and staff; messages to occupants; and communications with the fire and rescue service in the event of a fire.

- A level 1 communications system is able to ensure that all of those involved, or potentially involved, in an incident are informed rapidly and effectively, of relevant information. In addition the systems make use of alternative formats as necessary, with contingency plans for when systems fail.
- A level 2 communications system will provide information to all those involved, with alternative formats as necessary, but will not have contingency arrangements.
- A level 3 communications system is one that provides the necessary information, but does not allow for alternative formats or contingency arrangements.

8.3.8 Maintenance and testing of fire safety systems

Maintenance and testing is essential to ensure that fire safety systems will operate correctly in the event of a fire.

- A level 1 maintenance system is one where there is dynamic monitoring of the fire safety systems, and the equipment is kept fully functional at all the times the building is in use. There will also be alternative procedures, etc., identified for those times when systems, equipment and other arrangements are not available or not functioning correctly.
- A level 2 maintenance system is one where there is monitoring of the fire safety systems, and the equipment is kept fully functional at all the times the building is in use. When systems, equipment and other arrangements are not available or not functioning correctly, alternative procedures, etc., are determined reactively.
- A level 3 maintenance system will not have a predetermined regime of maintenance and testing in place.

8.3.9 Liaison with the fire and rescue service

A good relationship with the fire and rescue service will have benefits for both the occupier and the fire and rescue service. In particular it will ensure that the fire and rescue service are able to have an appropriate pre-determined response strategy for the premises concerned and will enable the occupier to seek advice where appropriate on:

a) how to prevent fires and restrict their spread in their buildings and other property;

b) the means of escape from buildings and other property in case of fire.

- In a level 1 system, the liaison is proactive in nature and includes effective arrangements for notifying the fire and rescue service of changes to the occupancy, periods of abnormal occupancy, fire growth characteristics, and other relevant factors. The arrangements will also allow for routine meetings with the fire and rescue service, and additional meetings where a change in the building or its occupancy is proposed.
- In a level 2 system, the liaison includes arrangements for notifying the fire and rescue service of changes to the occupancy, periods of abnormal occupancy, fire growth characteristics, and other relevant factors. However, the arrangements are unlikely to provide for routine meetings with the fire and rescue service or where a change in the building or its occupancy is proposed.
- In a level 3 system, the liaison is likely to be either non-existent or spasmodic.

8.3.10 Contingency planning

Contingency plans need to include preparation and response to a wide range of foreseeable events.

- A level 1 planning system is proactive, and takes into account a wide range of possible emergencies and incidents. These are likely to include planning for logistical issues such as the provision of shelter, communications, transport, the weather, time of day, time of week, time of year (holidays, etc.) and traffic-related issues, as well as scenarios such as power failures or floods.
- A level 2 system takes into account a narrow range of possible emergencies and incidents. These are likely to include planning for logistical issues such as the provision of shelter, communications, transport, the weather, time of day, time of week, time of year (holidays, etc.) and traffic-related issues, as well as scenarios such as power failures.
- A level 3 system does not have effective pre-planning, and is unlikely to secure ongoing business continuity in the event of an emergency or incident.

9 Fire safety manual

The design of buildings needs to be documented for the benefit of the management of the premises. All relevant information should be included in a fire safety manual. The manual needs to set out the basis on which the fire safety design was planned, the type of management organization envisaged for running the building, and the consequential staff responsibilities. It needs to explain the operation of all the mechanical and electrical systems and to give information on routine testing and maintenance requirements.

The assumptions made at the design stage regarding these aspects should be recorded in the fire safety manual.

The fire safety manual should form part of the information package that contributes to any fire risk assessment that might need to be carried out.

The fire safety manual, its contents, use and upkeep should conform to the recommendations given in Annex H.

10 Designing so that a building can be managed

10.1 General

The key management issues relating to a new project should be identified at the earliest possible stage (preferably at the concept stage) and should be taken into account when designing the building. Liaison with other agencies, e.g. building control bodies, fire prevention officers, health and safety inspectors and insurance bodies, should be initiated as early as possible.

Although the formal responsibilities of the designer and the fire safety engineer largely end once the building is completed and occupation and/or use has commenced, many, if not all, of the systems included will entail management assumptions. Some of these will be implicit, e.g. the assumption that structural fire protection remains in place, or the assumption that the fire load within the building does not exceed certain assumed limits, but many others will be explicit, in particular with regard to maintenance and testing of active systems.

By careful and considered design or location, the designer or fire engineer can provide the building with facilities and equipment which can assist fire safety managers in carrying out their duties in preventing the occurrence of fire.

The day-to-day activity of the fire safety manager is made more difficult if the fire safety design conflicts with the normal, everyday, use of the building, e.g. by placing fire doors across through-routes, or if it fails to take account of real behaviour during an incident, such as counter-flows in escape routes as parents search for children.

In practice, the designer or fire safety engineer can assist the work of the fire safety manager by ensuring that:

a) active fire safety systems are able to be properly maintained and tested;

b) passive fire safety systems are not likely to be made ineffective, e.g. during repair work to or penetrations of fire-resisting walls, or by blocking of escape routes;

c) the building design accurately reflects the anticipated use, fire loading and management of the building, e.g. by making appropriate provisions for disabled people;

d) suitable facilities and equipment are provided to prevent fires from occurring, including suitable housekeeping measures and security measures (see **10.3.2** and **10.3.4**);

e) suitable facilities and equipment are provided for use in the event of a fire, to contain the fire as far as possible and to enable effective evacuation;

f) contingency planning is taken into account at the design stage.

*NOTE The recommendations given in Clause **10** are based on the assumption that the building is being designed to meet a specific occupancy with a defined management system. However, if greater flexibility is required in the future use of the building, the designer might need to provide for greater levels of safety, and to reduce management issues as far as possible. If the systems provided for fire safety, e.g. sprinkler systems and storage systems, are specified for a defined level of risk, this can determine the management requirements of the building.*

Designers should familiarize themselves with the responsibilities and tasks of the fire safety manager so that these can be taken into account in the design.

10.2 Management input

In designing management systems, designers should take account of human behaviour (see **10.4.3**) and should ensure that the fire safety systems will be appropriate for what people actually do, not what the designer would like them to do.

Fire safety systems should be considered as an inherent part of the basic design, and not as supplementary to other matters such as services or finishes. Where there are conflicts of interest, compromises can be necessary. In any case, a flexible approach is essential if novel problems are to be solved. There can be conflicts between the fire safety requirements and the normal use of the building or with building services or with other safety systems, e.g. a door to restrict the movement of fire or smoke will also restrict the movement of people. There can also be confusion between a fire door, which needs to be kept shut, and a fire exit door, which may be kept open. These conflicts can, however, normally be overcome as there is no purpose in putting in place fire safety measures which do not allow the normal use of the building or will be negated by such normal use.

NOTE A design that does not fulfil the management brief can adversely affect the safety of the complex. It can also adversely affect running costs, staffing levels and general efficiency, and can sometimes lead to extensive modifications to cater for conditions that were not anticipated by the designers.

A clear statement of the design requirements for the management of the complex has to be obtained from the client and conveyed to the design team: architect, designer (and fire safety engineer).

Good management at the design stage is necessary to ensure that full benefit is taken of the experience of specialists in relevant areas. All parties involved in the design of a building should cooperate to ensure that fire safety systems are compatible and that if any changes are made, the consequential effects can be accommodated. In particular:

a) the owner/developer should give the design team a comprehensive brief on the requirements for management of the building. If it is to be a multi-occupancy complex then this brief should include the management requirements for the components;

b) those responsible for the future management of the building should, as far as possible, form part of the design team. They should monitor the development of the design concept and the detail of the systems they will eventually have to use and maintain. When construction is under way, they should have access to the site so that they can inspect and understand the various fire safety systems, some of which will not be visible when installation is complete;

c) the principles and details of all life safety systems should be fully discussed and agreed with the regulatory authorities and all affected specialists in the design team.

Where a project is speculative, without a particular occupier in mind, or even a particular use, then level 3 management should be assumed in the design (see **8.2**).

Other aspects to consider are the management of environmental issues, e.g. water run-off, and the long-term implications of the proposed design for management over the life of the building.

10.3 Designing for the management of fire prevention

10.3.1 General

By careful and considered design or location, the designer can provide the building with facilities and equipment which can assist the fire safety manager in carrying out their duties in preventing fire occurring.

Recommendations for provisions to assist with good housekeeping, building maintenance and security are given in **10.3.2** to **10.3.4**. The general recommendations given in **10.3.5** are also applicable.

10.3.2 Housekeeping

Good housekeeping is essential to reduce the chances of fire starting or developing, and escape routes being blocked. The designer should provide means for as many of the following items as necessary:

- keeping combustible materials separate from possible ignition sources;
- safe storage of flammable liquids, paints and polishes in appropriate containers;
- safe storage of other hazardous items, e.g. LPG cylinders, aerosol cans;
- ensuring that escape routes can readily be kept clear;
- ensuring that fire doors can readily be kept closed;
- waste control and waste disposal;
- carrying out catering and cooking in appropriately designed and protected facilities;
- protection for essential hot work or heat-dissipating processes.

In addition:

a) buildings should be designed and laid out in such a way that all escape routes can be maintained free from obstruction;

b) adequate provision should be made for enclosed and/or secure storage areas within the building;

c) storage should be provided so that goods, materials, unwanted furniture, etc., need not be stored within escape routes;

d) seating areas should not be provided within escape corridors;

e) surface finishes and coverings (including carpets) on walls, ceilings and floors within escape routes should be such that maintenance would not require the use of materials that might propagate surface spread of flame and/or fire, or adversely affect the means of preventing such propagation;

f) floor surfaces within escape routes should be maintainable, even and slip-resistant;

g) provision should be made for refuse, waste paper, etc., to be stored separately pending its removal from the premises, so that it does not accumulate on the premises. Wherever possible, it should be possible for all combustible waste to be baled and removed from the premises daily;

h) means should be provided of restricting goods in store rooms so that they are not stacked close to windows, and if there is a sprinkler and/or detection system, that they are stacked not higher than the height recommended in BS EN 12845, BS 5306-2 and BS 5839-1;

i) where it is expected that large fixtures will be introduced into the building (e.g. shop fittings, linings, special displays), the provision for their siting should be such that exits can be kept clear and unobstructed, and exit signs will be visible from the relevant parts of the premises.

10.3.3 Equipment and fittings maintenance

A significant way of preventing fire incidents is to maintain equipment and fittings that might start a fire and to control materials that might allow a fire to develop and spread. The designer should provide means for the fire safety manager to inspect and maintain as many of the following items as necessary:

- potential sources of ignition such as gas, oil and electrical heating installations;
- other electrical and gas installations;
- other heat-dissipating equipment (e.g. factory machines, factory processes or office machines);
- floor coverings, furniture, furnishings, décor, scenery, props, curtains and drapes;
- any other equipment that presents a particular fire risk, such as oxygen-handling equipment (e.g. oxygen tents).

10.3.4 Security

Good security arrangements can reduce the risk of serious fires by arson. In order to reduce the likelihood of arson, and to mitigate its effects if it does occur, the designer should provide means for as many of the following as are deemed appropriate:

- security against intruders;
- intruder detection;
- means of controlling of ignition sources and easily ignitable materials;
- fire detection;
- fire suppression;
- compartmentation;
- segregation of materials and/or processes that could present a risk;
- limiting the proximity of ancillary buildings and of external storage, particularly of combustibles and waste.

The designer should ensure that security arrangements do not prevent occupants from reaching a place of relative or ultimate safety (see **42.5**). Security of the building can be in both directions: ingress and egress. In certain premises, such as homes for people with mental ill health, the need to restrict the occupants from leaving the premises should be integrated with adequate and manageable emergency egress.

NOTE Some door hardware, e.g. letter-plates, can compromise the fire performance of the door.

The selection of hardware should take account of the types of people using the building.

When planning the security arrangements, the designer should take account of the needs of members of the fire and rescue service who might need to enter the building to effect rescue or fire-fighting, and those of insurers.

10.3.5 Other design issues

A clear space should be provided and maintained around heaters of all types, including convector, tubular and thermal storage heaters. Guards should be provided to prevent the stacking of any combustible materials close to heaters. Similarly, a clear space should be provided around vents of refrigerator compressor motors.

Means of shutting down equipment, stopping machines and processes and isolating power supplies, where appropriate, should be provided.

NOTE If a brief is agreed with the relevant enforcing authority at an early stage as to the intended use of the premises and the materials to be stored or used, this can overcome the need for costly additional fire safety measures to be put in place after the premises are occupied.

Special requirements can be imposed by the relevant enforcing authority for areas of high fire risk. Where highly flammable or explosive substances are to be stored or used in excess of prescribed amounts, the area is considered to be of high fire risk and the relevant enforcing authority should be consulted at the earliest possible stage. Similar considerations might be needed for certain storage modes, e.g. high rack, etc.

10.4 Designing for the management of fire protection

10.4.1 General

Fire protection is needed to assist and protect occupants in the process of moving safely away from danger after a fire has started, via notification of systems such as fire alarm systems, passive and/or active fire safety systems.

A careful and considered approach to the design of fire protection systems can assist the fire safety manager in enabling people to evacuate the building, and enabling the fire and rescue service to gain access, in the event of a fire occurring. Specific recommendations are given in **10.4.2** to **10.4.6**.

10.4.2 Safety systems

10.4.2.1 Control systems and control rooms

The sophistication of the fire alarm system and public address arrangements should be taken into account when establishing which evacuation procedures might be possible in large or complex buildings.

Control systems should be designed such that:

- all sound systems which do not perform safety functions, including temporary ones, are silenced in the event of fire;
- passenger lifts are brought immediately to the designated exit level, and kept there during the fire emergency (see Annex G for evacuation lifts and **21.3.4** for fire-fighting lifts);
- urgent information is clearly identified and requires minimal response procedures.

Efforts should be made to create systems that avoid information overload, taking into account the fact that in a fire incident, events can be occurring faster than the controller can respond.

Wherever possible, manual control apparatus should be provided outside the building for use by the fire and rescue service, or in protected rooms inside the building, close to the entrances to the building.

*NOTE Clause **25** gives recommendations for the equipping of fire control centres.*

Recommendations for the management of fire control centres are given in Annex I (see also **44.4**).

10.4.2.2 Availability

Systems are sometimes unavailable because of maintenance, testing, repair, breakdown or impairment. There should be clearly defined limits for the periods when a system is out of commission, and special procedures, including those relating to evacuation, should also be implemented. In some cases it can be necessary to have a duplicate system.

The equipment provided should be such that there is likely to be spare parts, replacement components, or replacement equipment in total, available for the working life of the building.

10.4.2.3 Reliability, durability and resilience

NOTE Systems that are prone to false alarms or failures on a regular basis are more likely to be taken out of service by occupants than systems that function correctly. Systems that are prone to false alarms on a regular basis, even if they are retained in service, can make building occupants complacent and therefore unlikely to react to an alarm signal speedily, thus putting occupants at risk in the event of an actual fire occurring.

The equipment provided should be sufficiently reliable that it is possible to depend on it in an emergency, and should not be prone to false alarms or failures.

Similarly, equipment should be provided that is expected to be durable over a reasonable working life, within the relevant environmental and operational conditions, and able to continue working even with some parts temporarily inoperable.

10.4.2.4 Testability, maintainability and reparability

The design of the equipment provided should be such that it can be readily and easily tested and maintained, both as an item and as part of a larger system, in such a way as to minimize business interruption. There should be an available source of spare parts for the equipment.

If successful operation of a system depends upon devices in other systems (e.g. smoke control systems and fire detection systems), it should be possible to test the systems as a complete entity as well as individually.

10.4.2.5 Other factors

Account should be taken of the functionality and ergonomics of fire safety equipment to ensure that it is compatible with the normal use of the building. Equipment provided solely for fire safety can present injury risks (e.g. self-closing fire doors can present problems to people who are unable to move rapidly, have limited strength or are in a wheelchair).

NOTE Annex J gives examples of fire safety equipment, facilities and systems requiring inspection, maintenance, testing and repair.

The designer should provide for the following where appropriate:

- protection against common mode failures, e.g. with any building management system;
- vandal-proofing and tamper-proofing;
- weather resilience, especially of escape routes (e.g. final exit doors opening into areas prone to snowdrifts) and air-intakes (e.g. for smoke control);
- reliability of water supplies;
- interactions between normal heating, ventilation and air conditioning systems (HVACs) and smoke control systems;
- software-controlled safety systems, means of testing, resilience, failure modes and manual overrides;
- protection of safety-critical software;
- protection of safety-critical electrical and electronic equipment from the risk of damage by discharge of water.

All equipment and systems should be in accordance with the appropriate British Standards.

10.4.3 Fire doors and escape routes

*NOTE Recommendations for fire doors are given in **33.1**; recommendations for designing escape routes are given in Section **5**.*

Buildings should be designed and equipped such that in an emergency the occupants of the building can make their way easily to a place of relative or ultimate safety. Designers need to take account of human behaviour, in particular in emergency situations, and seek to use this behaviour to lead people to safety, rather than design a complex system that requires a rapid learning process by the occupants at a time of stress.

For example, people generally prefer to leave a building the same way that they came in, and tend to use routes with which they are familiar, rather than special dedicated escape routes. Escape routes should follow the normal circulation within the building as far as is practicable.

Escape routes that consist of stairs, corridors, balconies, etc., are generally expected to be safe for the occupants to move to a recognized safe place outdoors. The designer should take into account how the building is to be used and managed, and should design door equipment and provisions along escape routes such that:

a) all doors on escape routes can be made readily available for use;

b) all emergency fastenings can be checked to ensure that they release, or can be released, in an emergency;

c) any doors, gates or shutters that are required to be locked in the open position can be so locked;

d) all escape routes and escape doors (both internally and externally) can be kept free from obstruction;

e) where practicable, fire doors are in positions where they are not likely to be wedged or propped open. Where this is not practicable, fire doors should be provided with hold-open devices on an automatic release mechanism which can be returned to the closed position when required;

f) where hold-open devices are not provided for a fire door, the door has a warning notice on it reminding people to keep it closed;

g) any fire door that subdivides a corridor is provided with vision panels;

h) any doors or shutters provided for compartmentation do not impede means of escape;

i) escape routes and escape route signs are adequately illuminated (see **10.4.4**) and, where necessary, two power supplies are provided, e.g. mains and battery;

j) final exit doors open into a place of ultimate safety (e.g. not into a roadway or, if so, adequate non-limiting safety barriers are provided). Such exits should be designed to avoid or minimize any risk of obstruction to rapid dispersal of persons from the vicinity of the building;

k) door securing systems using swipe cards, combination locks or any other electrical or mechanical device are released in an emergency and failsafe unlocked;

l) any evacuation lifts can be kept operative.

10.4.4 Signs and signage

NOTE 1 Attention is drawn to EC Directive 92/58/EEC [22] in respect of the provision of safety signs at work. Attention is also drawn to the Health and Safety (Safety Signs and Signals) Regulations 1996 [23] and to the Health and Safety (Safety Signs and Signals) Regulations (Northern Ireland) 1996 [24], which require employers to provide safety signs where other methods, properly considered, cannot deal satisfactorily with the risks.

*NOTE 2 Recommendations for exit signs are given in **16.4**. Information on categories of signs and signage is given in Annex K. Guidance on the regulations is given in HSE publication L 64 [25].*

NOTE 3 Consideration might need to be given to the provision of signage in appropriate language(s) for the intended occupants of a building, and/or to the provision of special signage for sensory-impaired people, e.g. tactile signage.

Fire safety signs and signing systems form an integral part of the overall fire safety strategy of a building and are fundamental to the communication of good fire safety management information. Clearly visible and unambiguous signage is essential for speedy escape, particularly in buildings where many of the occupants might be unfamiliar with the building layout.

All fire safety signs should be illuminated under normal conditions (signs that are not internally lit or back-lit should be lit by primary or secondary lighting). Internally lit or back-lit signs should remain illuminated in the event of power failure.

Where a fire risk assessment identifies the need for a sign, the sign should be displayed prominently, conspicuously and appropriately having regard to the environment and occupancy characteristic of the building. Fire safety signs should not be sited such that they are overridden with other types of public information or property management signs, and should be consistent in style and design throughout the building.

Signs should be provided in stairways to identify the current floor, and the final exit from the stair.

The location of fire safety signs should be recorded in the fire safety manual (see Clause **9** and Annex H).

10.4.5 Access to the building and its surroundings

The building should be designed in such a way that access for the fire and rescue service to the building itself and to any fire main, foam or other inlet, and fire appliance access to required positions within the building, can be kept free of obstruction (see Section **6**).

The means by which occupants might expect to leave (see Section **5**) should also be taken into account, since people using these routes can impede fire and rescue service access.

Fire and rescue service access roads and gates leading to the building can become seriously obstructed by the indiscriminate parking of cars and other vehicles using the site. Control and enforcement of parking restrictions can prove difficult, but the provision and maintenance of notices giving clear instructions regarding parking arrangements can go some way to alleviating this problem.

It is important that fire and rescue service access facilities are provided which can be kept clear and unobstructed to allow access by the fire and rescue service and other emergency vehicles at all times. Parking and signage should be provided to reduce the likelihood of cars being left on these roads. In particular:

a) means should be provided to ensure as far as possible that roads and service roadways used for fire and rescue service access are not obstructed in an emergency and that emergency vehicles are able to proceed to within the required distance of any fire main, foam or other inlets. In the interest of security, it might also be necessary to agree with the fire authority to restrict entry along such roadways;

b) when making provision for car parking, the designer should take account of the fact that cars parked within the building or nearby will often need to be left there until after an emergency, and of the associated risk of impeding access for the fire and rescue service (see also **E.1.5**);

c) assembly points should be located sufficiently far from the premises to minimize interference with the fire and rescue service or danger from falling debris, but should be accessible and not so far away as to discourage people from assembling.

10.4.6 First-aid fire-fighting

Nearly all large fires start out as small fires and if they can be dealt with quickly and safely then major incidents might be avoided.

First-aid fire-fighting equipment should be provided in accordance with BS 5306-0, BS 5306-1 or BS EN 671, and BS 5306-3. It should be of a type appropriate for the risks and for the users of the building, and placed in locations where it can be readily deployed.

Portable fire extinguishers should be selected and installed in accordance with BS 5306-8.

Fixed means of fire-fighting should be installed where the fire risk assessment shows it to be appropriate or necessary.

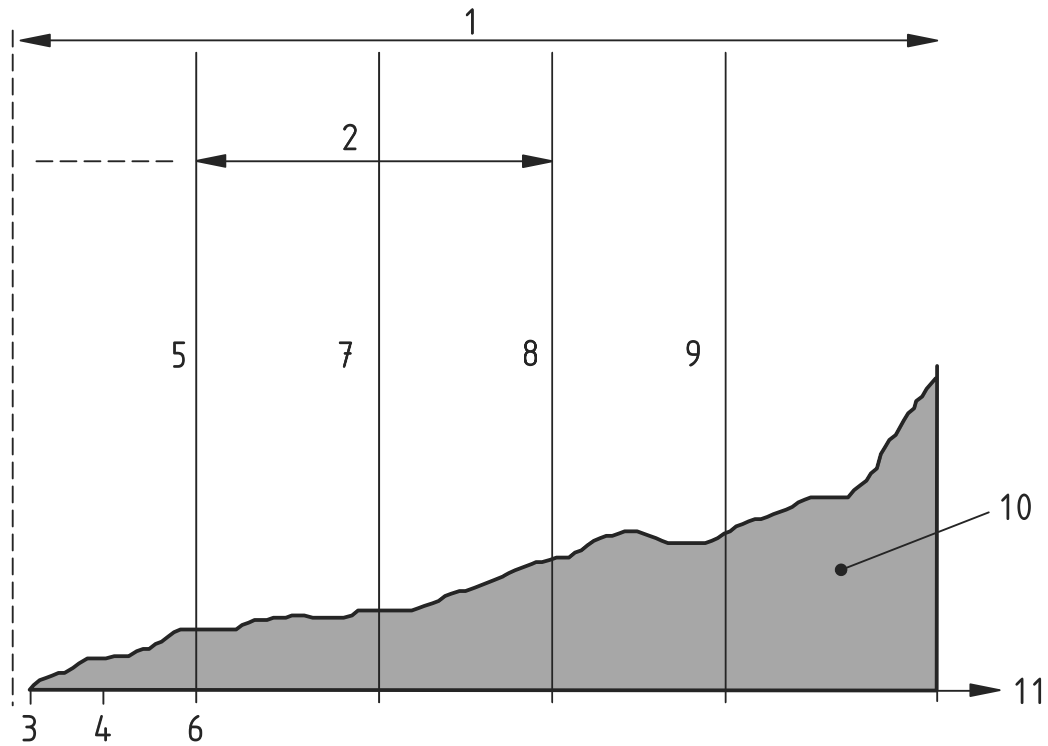
Section 5: Designing means of escape

11 Principles of means of escape

*NOTE The importance of management in relation to all aspects of escape is covered in Section **9**.*

The expected reaction and subsequent actions of those responsible for the management of the building should be assessed against the development of the fire threat and time, and the provision of adequate means of escape should be determined accordingly. Figure 1 shows an example of the relationship between the development of the fire threat and time.

Figure 1 **Comparison of fire and time line development**



Key

1 Time line 1 (fire): fire, heat and effluent development
2 Time line 2 (occupants): means of escape
3 Ignition
4 Detection
5 Occupants become aware of fire
6 Alarm
7 Occupants begin life safety strategy
8 Life safety strategy complete
9 Tenability limits reached (i.e. danger to life and possibility of secondary ignition)
10 Fire growth
11 Time

Each building type should be allocated a risk profile (see Clauses **6** and **15**) depending on the occupancy characteristic and the fire growth rate associated with its use. The time to escape to a place of relative safety should be less than the allowable travel time (see Figure 2), which is based on the risk profile.

The major stages of occupant response that should be taken into account in determining the provision of means of escape are:

a) time to detect a fire and sound an alarm;

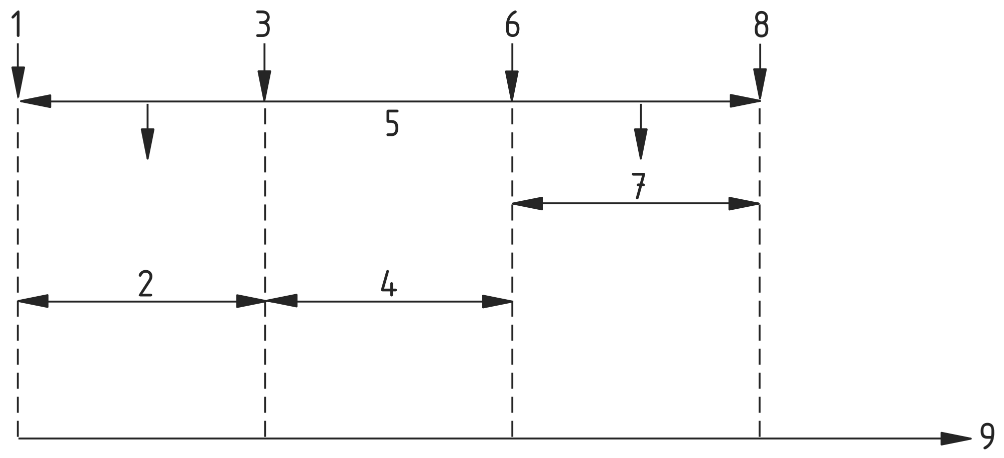
b) pre-movement time which consists of the recognition time and the response time;

c) travel time, including queuing, to a place of relative safety;

d) movement within a place of relative safety (e.g. protected stair or adjacent compartment).

The relationship between these factors is shown in Figure 2. The objective is to limit the time taken to travel through those areas of a building which could potentially be exposed to fire and smoke.

Figure 2 **Occupant response and travel time**



NOTE This drawing is not to scale in terms of the divisions of available safe escape time (ASET).

Key

1 Ignition
2 Time to alarm
3 Alarm
4 Pre-movement time
5 Available safe escape time (ASET)
6 Travel starts
7 Allowable travel time
8 Tenability limits reached (i.e. danger to life)
9 Time

NOTE The movement to escape in many cases might not be along the optimum travel route as predicted in the design, particularly in situations where occupants are unfamiliar with the building. This is less important in cases where queuing at a door is the primary control of the exiting time. However, since no evacuation is perfect and human behaviour can be uncertain, relatively slow travel speeds have been used to provide a margin of comfort to allow for potential unknowns.

As shown in Figure 2, there are two primary early stages that occur before the occupants start to move to escape:

1) time from ignition to warning using manual or automatic detection (time to alarm);
2) time from warning to the start of the movement to escape (pre-movement time).

Both of these stages are related to the management, the occupancy characteristics, fire growth rate and the package of active and passive fire protection measures.

In an emergency there should be sufficient escape capacity to allow all the occupants to reach an area of relative safety, e.g. protected routes, separate fire compartments or stairways leading to a final exit, without delay. The place of ultimate safety is beyond the final exit but it is not always practicable or desirable to evacuate the whole of the building immediately upon the incidence of fire in any part. In large premises, it is sometimes practical and appropriate to evacuate in stages, which is also beneficial for escape for people with impaired ability to evacuate.

Where compartments are separated in such a way as to prevent the spread of smoke in the early stages of a fire, or if there is a suitable smoke control system controlling the movement of smoke, the occupants can escape to a fire compartment not affected by the fire. They should however still be free to leave the building without being affected by the fire.

Motivation to escape is important. Research into several major fatal fires and evacuations suggests that in large internal spaces people in a crowd have difficulty in recognizing the threat from a fire elsewhere in the building. People are also likely to underestimate how quickly a fire can spread. In a fire disaster, the uncertainty of the situation in its early stages is usually compounded by a serious delay in warning the occupants in time for them to start to evacuate and reach safety.

12 Evacuation strategy

12.1 General

The primary objective of an evacuation strategy is to ensure that in the event of a fire, the occupants of a building can reach a place of ultimate safety outside the building.

The evacuation strategy should not rely on external assistance (e.g. from the fire and rescue service) and should be chosen to take into account the risk profile of the building and the allowable travel time.

12.2 Categories of evacuation procedure

The evacuation procedures are an essential part of the overall fire strategy. There are two basic categories of evacuation procedure:

a) *total evacuation* of the occupants to a place of ultimate safety, by either simultaneous or phased procedures (see **12.3**);
b) *progressive evacuation* of the occupants, initially to a place of relative safety within the building where they can remain or, if necessary, complete the evacuation to ultimate safety as part of a managed system (see **12.4**).

12.3 Total evacuation

12.3.1 Simultaneous evacuation

*NOTE Recommendations for widths of escape stairs for simultaneous evacuation are given in **18.4.2**.*

Simultaneous evacuation is a common approach adopted in premises where it would be unreasonable to expect the occupants to remain in an affected area for a prolonged time when there is a fire. This takes into account not only the physical effects of the fire, but the psychological response of occupants confronted by an outbreak of fire.

There are two categories of simultaneous evacuation.

a) *Single-staged evacuation*
In a single-staged evacuation, the activation of a call point or detector gives an instantaneous warning from all fire alarm sounders for an immediate evacuation.

b) *Two-staged evacuation*
In a two-staged evacuation, there is an investigation period (or grace period) before the fire alarm sounders are activated. A typical sequence of events for two-staged evacuation is as follows.

1) Initially a coded staff alert is given.
2) There is then an investigation period (or grace period).
3) The evacuation signal is broadcast:
   - if a fire is confirmed; or
   - if an agreed investigation period lapses without the alarm being cancelled; or
   - if a second detector is activated, "break glass" operated or sprinkler flow switch operated during the investigation period.

12.3.2 Phased evacuation

*NOTE 1 Recommendations for widths of escape stairs for phased evacuation are given in **18.4.3**.*

Phased evacuation is a common approach adopted in high-rise premises where the floors are separated by fire-resistant construction, or in certain atrium buildings (see Annex B). In a phased evacuation the first people to be evacuated are all those on the storey most immediately affected by the fire, and those on other floors with impaired ability to evacuate, unless their PEEP has determined otherwise (see **46.7**). The remaining floors are then evacuated, usually two floors at a time, at phased intervals.

Such an approach provides for significant economies in the plan area occupied by the protected stairways, but demands the provision and maintenance of a range of additional passive and active fire protection measures, together with supportive management arrangements (see Clause **10** and **44.5**). Potential reverse flow situations can also be a particular problem with phased evacuation; see **14.1**c).

The following conditions should be met in any building or part of a building that is designed on the basis of phased evacuation.

a) The stairways should have a protected lobby or protected corridor (except a top storey consisting exclusively of plant rooms), or a pressure differential system, under the circumstances described in **18.2.4**.

b) Every floor should be a compartment floor.

c) If the building has a storey with a floor over 30 m above ground level, the building should be protected throughout by an automatic sprinkler system conforming to BS EN 12845.

d) The building should be fitted with a fire warning system, conforming to at least the L3 standard given in BS 5839-1:2002+A2:2008.

e) An emergency voice communication system should be provided in accordance with BS 5839-9, with outstations at each floor level which communicate with a master station located in the building control room (where one exists) or some other suitable control point at fire and rescue service access level.

NOTE 2 This may be linked to the communication system required for refuges (see Annex G).

*NOTE 3 Recommendations for communication systems for fire and rescue service use are given in Clause **24**.*

f) Lifts should be approached through a protected lobby.

12.4 Progressive evacuation

12.4.1 Progressive horizontal evacuation

Progressive horizontal evacuation is the process of evacuating people into an adjoining fire compartment on the same level, from which they can later evacuate to a place of ultimate safety.

12.4.2 Zoned evacuation

Zoned evacuation is a common approach adopted in large retail developments, where an operational loss could be created by evacuating a large building for a relatively small fire. The zoned evacuation is achieved by moving the occupants away from the affected zone to an adjacent zone. An example of this would be a shopping centre where the occupants would be moved to the adjacent smoke control zone while the fire-affected zone was brought under control.

Such an approach demands the provision and maintenance of a range of additional passive and active fire protection measures, together with supportive management arrangements (see Clause **10** and **44.5**).

13 Internal subdivision and spatial/visual orientation

13.1 General

The manner in which a building is subdivided internally affects the risk to users and their ability to use the planned means of escape in the event of a fire. The following subclauses give advice on the various aspects of internal subdivision that should be taken into account when designing means of escape.

13.2 Compartments

Buildings can be subdivided to restrict the spread of fire by the use of walls and/or floors of fire resisting construction.

These walls and/or floors may be provided to comply with life safety requirements or to increase the amount or performance of compartmentation for other reasons.

The internal subdivision of a building into fire compartments influences the escape arrangements, evacuation procedures and the number of stairs and exits. Only the occupants and contents within the fire compartment have to be regarded as being initially at risk from a fire.

In an uncompartmented building, all the occupants and contents of the building have to be considered at risk in the event of fire. However, larger, higher spaces are not so quickly affected by smoke from a developing fire.

13.3 Cellular planning

Cellular planning is the subdivision of all or parts of floor areas, e.g. into separate rooms with access corridors.

Cellular planning carries a risk of fire being undiscovered, which could threaten escape routes unless appropriate precautions are taken.

13.4 Open storey (horizontal) planning

In open storey planning, almost the whole floor area of a storey is undivided by partitions, although there may be some screens or high furniture for display purposes in, for example, office storeys and in shop sales areas, or to give privacy to some areas. With open storey planning, many of the occupants are likely to be aware of smoke from a fire at the outset and this gives the advantage of early warning.

13.5 Atria

In atria, several storeys are contained in one volume. Atria are created by, for example:

a) split-level floors;

b) floors arranged as a spiral throughout the height of the building;

c) balconies or gallery floors overlooking a central well or courtyard.

Atria can result in smoke and heat travelling readily throughout all levels of the building.

NOTE Design solutions and exemplars for atria are given in Annex C.

All buildings with a void through structural floors should be designed in accordance with Annex B.

13.6 High fire risk areas

NOTE Attention is drawn to the Dangerous Substances (Explosive Atmospheres) Regulations 2002 [27] and specifically in the case of petroleum spirit, i.e. petrol, to the Petroleum (Consolidation) Act 1928 [28].

Where a significant amount of dangerous substances or preparations, e.g. substances or preparations that have a fast or ultra-fast fire growth rate (see **6.3** and **6.4**) or are classified as explosive, oxidizing, extremely flammable, highly flammable under the Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 [26], are stored and/or used, the area is considered to be of high fire risk (see also **15.2**).

Early consultation with the relevant authorities is therefore recommended when the storage and use of such substances is proposed.

13.7 Process plant and outdoor structures

The means of escape (Section **5**) and structural design (Section **7**) recommendations for buildings and structures that are purpose-designed to house process and storage plant may be modified in accordance with Annex F.

14 Designing means of escape

14.1 General

The package of fire precautions provided for a building should reflect the nature of the use of the building, the occupants, the processes, the materials stored and used, and the fire safety management provided (see also Section **4**). These characteristics are categorized as risk profiles, which provide a basis against which the risk to occupants can be assessed and the appropriate level of fire precautions determined. The risk profile should be determined in accordance with Clause **6**.

There are a number of general principles in respect of what is or is not acceptable as a means of escape; these are listed in **14.2** and **14.3** respectively. However, circumstances can vary and the means of escape chosen for a building should take into account the particular needs of that building.

A flowchart showing the basic process for designing means of escape is given in Figure 3. The following general guidance should also be taken into account.

NOTE 1 Guidance on the use of tactile paving for external areas is given in BS 8300.

a) The floorings of all escape routes (including the treads of steps, and surfaces of ramps and landings) should have appropriate slip resistance.

b) Where a crèche is provided for children separately from their parents or guardians, it should be sited adjacent to escape routes used by parents or guardians on their way out to avoid the clashing of streams of people as parents or guardians collect their children. A crèche should be at or as near ground level (or the level at which the final exits discharge) as practicable. In no circumstances should the accommodation for children be:

   1) on a floor above the level at which their parents or guardians are accommodated, unless the escape route is through the upper level; or

   2) at basement level, unless the final exit is at basement level.

   The crèche should preferably be adjacent to an external wall and should not have fewer than two exits, one of which should be a final exit.

c) Other potential reverse flow situations, e.g. fire-fighters entering the building, should be taken into account for both horizontal and vertical means of escape strategies. In particular, in tall buildings over 30 m in height where phased evacuation is adopted, there is a potential that persons attempting to escape could be impeded by fire-fighters entering and operating within the building. This potential varies with the height of the building and with the number of escape stairs that are available. Generally, this can be addressed by incorporating special management procedures into the evacuation strategy in consultation with the fire and rescue service, taking into account local high-rise fire-fighting procedures. However, in some very tall buildings, typically those over 45 m in height, physical measures might need to be incorporated into the building (e.g. by discounting a stair or by some other suitable means).

d) Many buildings use mezzanines or galleries as a way of creating additional space for various purposes. When large quantities of readily combustible products are stored or displayed under a large plan mezzanine or gallery with a solid floor (as in some DIY outlets) there is always a risk of rapid fire growth resulting in flames spreading beyond the edge of the mezzanine or gallery floor and hence posing a threat to life safety, particularly when the occupants of the building are members of the public. Additional safeguards might therefore be necessary to compensate for the increased level of hazard if a fire occurs below the mezzanine or gallery.

NOTE 2 See also Clause ***46****.*

Additional measures might be necessary to assist management to aid the evacuation of disabled people from the building, e.g. when extended travel distances are being considered (see Clause **19**) or when a high number of disabled people might be expected to be present. No situation is exactly the same, so specific assessments should be made by the management team to ensure that the needs of disabled people can be met, particularly where the travel distance is more than 50 m.

The following are examples of the types of measures that might be necessary.

1) Extend CCTV coverage to refuges so that management can know exactly where people are situated waiting for assisted escape.

2) Install communication facilities in refuges where there is no CCTV coverage so that disabled people can contact the control to give information on where they are within the building. These facilities should comprise two-way communication and a visual indication that the call is answered.

3) Make provisions to enable disabled people to rest [see also 4)].

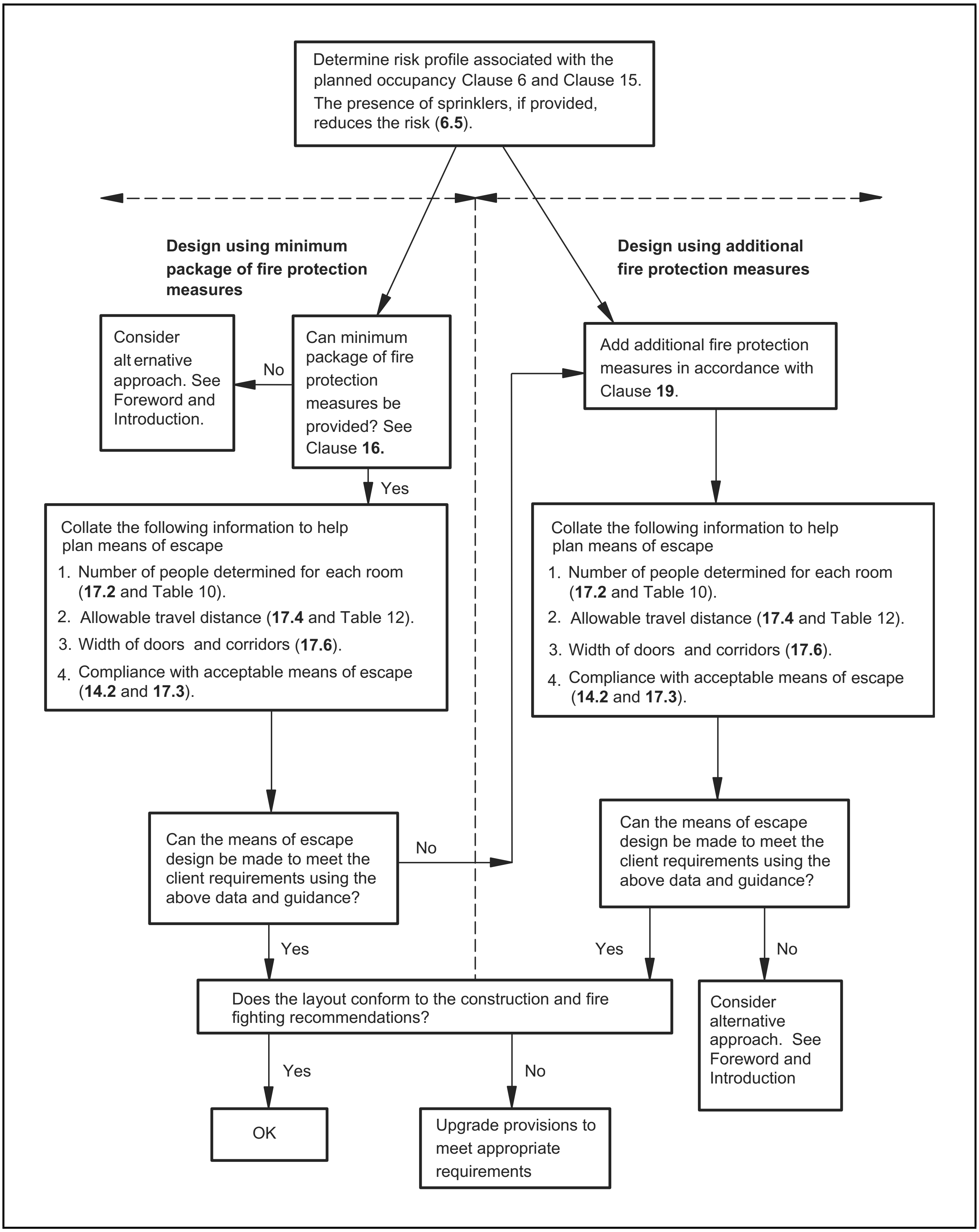
4) Install handrails to assist disabled people where the extended distance is along a corridor. They give an opportunity to rest and can also be used as way-finding devices by people who cannot see the exit signs. Handrails, where provided, should be situated each side of the corridor.

5) Provide additional signing and way-finding devices, e.g. tactile directional markings, to assist blind and partially sighted people who might not be able to see exit signs.

6) Give disabled people working within the building additional warning of an impending escape, e.g. advise them to escape during the first stage of a two-stage evacuation.

It is also necessary to ensure that there are no obstacles on the escape route that might hinder the escape of the occupants. This includes the use of steps, stairs or inappropriate doors on escape routes.

Figure 3 **Designing means of escape**



14.2 Acceptable means of escape

NOTE 1 Some of these elements of means of escape might not be appropriate for use by people with some disabilities and therefore alternative arrangements will need to be made.

The following means of escape are generally deemed to be acceptable for all buildings:

a) door leading directly to outside air (final exit);

b) door leading to a protected staircase (storey exit);

c) doors leading to another fire compartment (progressive horizontal evacuation);

d) open staircase (accommodation stairs) where the distance along the length of the stair is part of the travel distance;

e) escape stairs enclosed in fire-resisting construction;

NOTE 2 Attention is drawn to the Building Regulations 2000, Approved Document K [29] and Approved Document M [30]; to the Building (Scotland) Regulations 2004, as amended [20]; and to the Building Regulations (Northern Ireland) 2000 [31], in respect of the design of ramps and associated landings, and in respect of aisles and gangways, from the aspect of safety in use.

f) ramps conforming to BS 8300, at a gradient of no more than 1:12;

g) moving walkways where the distance is part of the travel distance and the moving walkway is designed to come to a slow stop;

h) suitably designed and installed evacuation lift (see **46.9**);

i) wicket doors and gates (except from high risk areas), provided that:

   1) they are not intended to be used by members of the public;

   2) not more than 10 persons are expected to use them in an emergency;

   3) they provide an opening at least 500 mm wide, with the top of the opening not less than 1.5 m above the floor level and the bottom of the opening not more than 250 mm above the floor level;

j) fail-safe turnstiles, revolving doors and automatic doors conforming to the relevant part of BS 7036, provided that either:

   1) they are arranged to fail safely in the open position or be easily openable in an emergency; or

   2) outward opening hinged doors, of an appropriate width and fastened in accordance with **16.5.2** are provided immediately adjacent to such doors or turnstiles.

NOTE 3 These restrictions are imposed because revolving doors, automatic doors and turnstiles can obstruct the passage of persons escaping.

All stairs should conform to BS 5395-1.

14.3 Generally unacceptable means of escape

The following systems are not normally deemed to be acceptable as means of escape, but they may be used in some situations provided that the reliability of the method can be demonstrated to the appropriate authorities:

a) lifts, except for a suitably designed and installed evacuation lift that may be used for the evacuation of people who find other evacuation routes difficult in a fire;

b) fixed ladders, except those in plant rooms which are rarely used and accommodate less than ten people. Where such ladders are used they should conform to BS EN ISO 14122-4;

c) portable ladders and throw-out ladders;

d) manipulative apparatus and appliances, e.g. fold-down ladders;

e) power-operated or manually operated sliding doors, except those designed to fail open on loss of power or that can break open from any position throughout their operating parameters;

f) security grilles and shutters (roller, folding or sliding), loading doors, goods doors, sliding doors and up-and-over doors, unless they are capable of being easily and quickly opened. If power operated they should:

   1) be provided with a fail-safe system for opening if either the mains supply and/or any alternative power supply fails;

   2) be capable of being easily and quickly opened manually;

g) wicket doors and gates at exits from high risk areas;

h) escalators.

NOTE In certain situations, such as transport interchanges, escalators may be used as part of the means of escape solution. In these cases a fully fire engineered assessment will be needed, which would include an ASET/ARSET analysis as explained in BS 7974.

Escalators are not normally considered as part of the means of escape. They should be treated as accommodation stairs in that they are effectively a method of transportation between floors that are in addition to the means of escape. The management solution for the premises should ensure that occupants are discouraged from using escalators during an incident. Escalators should be programmed to stop on the actuation of the fire alarm to avoid the possibility of discharging people into an area of risk.

15 Allocation of risk profile

15.1 General

NOTE Examples of typical risk profiles are given in Table 5.

Risk profile assessments should be made on a case-by-case basis following the recommendations given in Clause **6**.

15.2 Enclosure of fire risks

Areas of high fire risk (see **13.6**) are generally allocated at least fire growth rate category 3 (see Table 3). However, if an enclosure or compartment that contains a localized area of high fire risk (such as a cooking range within a catering area) is provided with an effective localized suppression system (see Clause **39**), then the overall risk profile can be considered as medium risk rather than high risk (e.g. B2 rather than B3).

High fire risk areas within a building should be enclosed so that they do not affect the means of escape (see **32.5.7**).

The following areas are not considered a high fire risk and do not need to be enclosed in fire-resisting construction:

a) kitchens (cold preparation/reheat);

b) water storage tank rooms;

c) plant rooms with air handling units only.

16 Minimum package of fire protection

16.1 General

Every building should incorporate as a minimum the fire protection measures described in **16.2** to **16.9**, to allow the occupants to escape from the building in the event of a fire and to ensure that there are appropriate management systems in place.

NOTE 1 These include both active and passive measures of fire protection, e.g. detection, alarm, restricting the development of a fire and securing the safe escape of the occupants.

NOTE 2 The package of fire protection measures for specific building types might need to be varied to meet the needs of that particular building type. Guidance for specific building types is given in the following annexes:

a) Annexes B and C – atria;

b) Annex D – theatres, cinemas and similar venues;

c) Annex E – shopping complexes;

d) Annex F – process plant and structures.

16.2 Fire detection and alarm systems

NOTE Generally, the minimum requirement for premises is an electrical system in accordance with the recommendations applicable to a Type M as described in BS 5839-1:2002+A2:2008. Premises with a higher fire growth rate usually require a more sophisticated system. In some low-risk premises, an alternative means of giving warning in case of fire might be more appropriate.

The minimum level of fire alarm and detection systems for most premises should be in accordance with Table 8 (see Note).

Automatic fire alarm and detection systems do not provide any degree of fire containment. However such systems, in addition to giving an alarm, can be used to initiate such functions as:

a) closing down ventilation and air conditioning plant;

b) operating fire suppression and/or smoke control systems;

c) releasing passive fire protection equipment (e.g. automatic closing doors and shutters);

d) activating ventilation systems.

As a minimum, an L3 detection and alarm system should be installed where a phased, staged (see **12.3.1**) or zoned evacuation is proposed.

Multiple occupancy premises should be provided with a common detection and alarm system appropriate to the individual risks.

In areas with noisy environments or where people might otherwise have difficulty in hearing the fire alarm, flashing warning beacons can be useful.

16.3 Artificial and emergency escape lighting

Suitable lighting should be provided to all premises to enable the safe movement of persons along escape routes to a place of relative or ultimate safety. Emergency escape lighting, when needed, should be provided in accordance with Table 9, BS 5266-1 and BS 5266-7.

Guidance on types of luminaire and recommendations for the installation of luminaires are given in **38.4**.

Table 8 **Minimum level of fire alarm/detection system for premises**

Risk profile	Minimum acceptable alarm/detection system
A1	M
A2	M
A3	L2
A4 [A)]	Not applicable [A)]
B1 [B)]	M
B2 [B), C)]	M
B3 [B)]	L2
B4 [A)]	Not applicable [A)]
Ci1	Automatic fire detection in individual units
Ci2	Automatic fire detection in individual units
Ci3 [A)]	L3
Cii1	L2
Cii2	L2
Cii3 [A)]	L1
Ciii1	L1
Ciii2	L1
Ciii3 [A)]	L1
C4 [A)]	Not applicable [A)]

NOTE Type M, L3, L2 and L1 systems are defined in BS 5839-1:2002+A2:2008.

A) See Table 4.
B) In some circumstances where people are in an unfamiliar building the provision of a voice and/or visual alarm system can help reduce evacuation time.
C) Not including primary or special needs schools – L3 system advisable.

Table 9 **Provisions for emergency escape lighting**

Occupancy characteristic	Areas needing emergency escape lighting
A	Underground or windowless accommodation Stairways in a central core or serving storey(s) more than 18 m above ground level Internal corridors more than 30 m long Open-plan areas of more than 60 m^2
B [A)]	All escape routes [B)] (except in shops of three or fewer storeys with no sales floor more than 280 m^2 provided that the shop is not a restaurant or bar)
C	All common escape routes [B)], except in two-storey blocks of flats
Any use	All sanitary accommodation with a floor area over 8 m^2 Windowless sanitary accommodation with a floor area not more than 8 m^2 Electricity and generator rooms Switch room/battery room for emergency lighting system Emergency control room

A) In areas of shops where the public are not admitted use occupancy characteristic A.
B) Including external escape routes.

16.4 Exit signs

NOTE In some buildings additional signs might be needed to meet legislative requirements.

Every doorway or other exit providing access to a means of escape, other than exits in ordinary use (e.g. main entrances), should be distinctively and conspicuously marked by an exit sign in accordance with BS 5499-1 and BS 5499-4.

Final exit levels from stairs should be clearly marked as such, particularly where the exit opens off a stair that continues down or up beyond the level of the final exit.

16.5 Doors

16.5.1 General

*NOTE 1 See **33.1** for additional guidance on fire doors.*

NOTE 2 Guidance on the visual identification of doors is given in BS 8300.

The time taken to negotiate a closed door can be critical in escaping. Doors on escape routes (both within and from the building) should therefore be easily identified and readily openable by all people.

16.5.2 Door fastenings

NOTE This is not intended to prevent doors being fitted with hardware to allow them to be locked when the rooms are empty. There are also some situations, such as hotel bedrooms, where locks may be fitted that are operated from the outside by a key and from the inside by a handle as specified in BS EN 179.

In general, doors on escape routes (whether or not the doors are fire doors) should either not be fitted with lock, latch or bolt fastenings, or be fitted only with simple fastenings that can be readily operated from the side approached by people making an escape. The operation of these fastenings should be readily apparent and without the use of a key and without having to manipulate more than one mechanism.

Where a door on an escape route has to be secured against entry when the building or part of the building is occupied, it should only be fitted with a lock or fastening which is readily operated, without a key, from the side approached by people making their escape.

Similarly, where a secure door is operated by a code, combination, swipe or proximity card, biometric data or similar means, it should also be capable of being overridden from the side approached by people making their escape.

Electrically powered locks should return to the unlocked position either:

a) on operation of the fire alarm; or

b) on loss of power or system error; or

c) on activation of a manual door release unit (Type A) conforming to BS EN 54-11:2001+A1:2006 positioned at the door on the side approached by people making their escape. Where the door provides escape in either direction a unit should be installed on both sides of the door.

Except for premises in occupancy characteristic A, doors on escape routes from rooms with an occupant capacity of more than 60 either should not be fitted with lock, latch or bolt fastenings, or should be fitted with panic exit devices in accordance with BS EN 1125.

In non-residential buildings it might also be appropriate to accept on some final exit doors locks for security that are used only when the building is empty. In these cases the emphasis for the safe use of these locks should be placed on management procedures.

16.5.3 Direction of opening

NOTE With respect to industrial activities where there is a high fire risk with potential for rapid fire growth, it might be necessary (e.g. as a result of risk assessment) for doors to open in the direction of escape regardless of the number of occupants.

The door leaf of any doorway or exit should, where reasonably practicable, be hung to open in the direction of escape, and should always do so if the number of persons that might be expected to use the door at the time of a fire is more than 60.

16.5.4 Amount of opening and effect on associated escape routes

All doors on escape routes should be hung to open not less than 90°, and with a swing that is clear of any change of floor level.

A door that opens towards a corridor or a stairway should be sufficiently recessed to prevent its swing from encroaching on the effective width of the stairway or corridor.

16.5.5 Vision panels in doors

NOTE Attention is drawn to the Building Regulations 2000, Approved Document M [30] in respect of vision panels in doors across accessible corridors and passageways, and Approved Document N [32] in respect of provisions for the safety of glazing.

Vision panels should be provided where doors on escape routes subdivide corridors, or where any doors are hung to swing both ways.

16.5.6 Final exits

Final exits need to be dimensioned and sited to facilitate the evacuation of persons out of and away from the building. Accordingly, they should be not less in width than the escape route(s) they serve and should also meet all of the following conditions.

a) Final exits should be sited to ensure rapid dispersal of persons from the vicinity of the building so that they are no longer in danger from fire and smoke. Direct access to a street, passageway, walkway or open space should be available. The route clear of the building should be well defined, and if necessary (e.g. potential traffic hazard) suitably guarded.

b) Final exits should be apparent to persons who might need to use them. This is particularly important where the exit opens off a stair that continues down, or up, beyond the level of the final exit.

c) Final exits should be sited so that they are clear of any risk from fire or smoke in a basement (such as the outlets to basement smoke vents, or from openings to transformer chambers, refuse chambers, boiler rooms and similar risks).

d) Where a final exit leads to steps outside the building, care should be taken to ensure that there is space for a wheelchair user to move so they do not obstruct the flow of other people leaving the building. Wherever possible final exits should provide a level or ramped route away from the building.

e) Where a ground floor storey exit shares a final exit with a stair via a ground floor lobby, the width of the final exit should be sufficient to enable a maximum evacuation flow rate equal to or greater than that from the storey exit and stair combined (see Figure 4). This can be calculated from the following formula:

$$W = [(N/2.5) + (60S)]/80$$

where:

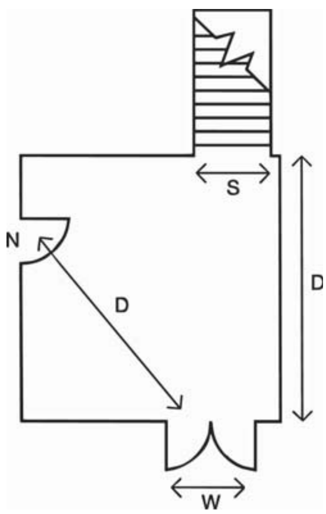
N = number of people served by ground floor storey exit;

S = stair width, in metres (m);

W = width of final exit, in metres (m).

Where the number of persons (N) entering the lobby from the ground floor is more than 60 then the distance from the foot of the stair, or the storey exit, to the final exit should be a minimum of 2 m (see Figure 4). Where this cannot be achieved then the width of the final exit (W) should be no less than the width of the stair (S) plus the width of the storey exit. In all cases, W should be no less than S.

Figure 4 **Merging flows at final exit**



D = minimum 2 m, where N is greater than 60.

16.6 Protected power circuits

The cables for fire alarm circuits should conform to BS 5839-1:2002+A2:2008, **26.2**.

The cables for all other circuits that require a resistance to fire, either for life safety, fire-fighting or property protection should conform to BS 7346-6.

16.7 Lifts

16.7.1 General

NOTE Further guidance on the systems and procedures necessary to support the use of lifts for evacuation is given in ***46.9*** *and Annex G. See also* ***18.8.2****.*

Generally lifts are not considered in the evacuation procedures in buildings for the following reasons:

a) it is possible for the occupants using the lift to become trapped due to loss of power;

b) it is possible that lifts could discharge occupants onto the floor containing the fire;

c) people sometimes have to wait for long periods for the lift car to arrive, extending the escape time.

However, lifts that are specifically designated for the purpose can be used to evacuate people safely and effectively, with priority being given to people who might have difficulty with other escape routes.

16.7.2 Fire protection of lift installations

Lift wells should either be contained within the enclosures of a protected stairway, or be enclosed throughout their height with fire-resisting construction. A lift well connecting different compartments should form a protected shaft.

In basements and enclosed car parks the lift should be approached only by a protected lobby (or protected corridor) unless it is within the enclosure of a protected stairway. This is also the case in any storey that contains high fire risk areas, if the lift also delivers directly into corridors serving sleeping accommodation. Examples of fire risk areas in this context are kitchens, lounges and stores.

A lift should not be continued down to serve any basement storey if it is in a building (or part of a building) served by only one escape stair, or if it is within the enclosures to an escape stair that is terminated at ground level.

Lift machinery spaces should be sited over the lift well whenever possible. If the lift well is within a protected stairway which is the only stairway serving the building (or part of the building), then if the machinery space cannot be sited above the lift well it should be located outside the stairway (to avoid smoke spread into the stairway from a fire in the machinery space). Any machine, pulley or other associated equipment located outside of the lift well should still be within the same fire compartment as the well.

A corridor can be protected from a lift shaft by means of sealing the lift doors with additional automatic fire/smoke doors or fire/smoke barriers, thus eliminating the need for a lobby.

In buildings designed for phased or progressive horizontal evacuation, where the lift well is not contained within the enclosures of a protected stairway, the lift entrance should be separated from the floor area on every storey by a protected lobby.

Lifts, such as wall-climber or feature lifts, which rise within a large volume such as a mall or atrium, and do not have a conventional well, might be at risk if they run through a smoke reservoir and should not be used for evacuation. Such lifts should return to the designated exit landing, as defined in BS EN 81-73.

16.8 Mechanical ventilation and air conditioning systems

Any system of mechanical ventilation should be designed to ensure that in a fire the air movement in the building is directed away from protected escape routes and exits, or that the system (or an appropriate section of it) is closed down. (See also **33.4** for guidance on fire protection for these systems.) In the case of a system which recirculates air, it should meet the relevant recommendation for recirculating distribution systems in **33.4.8**, in terms of its operation under fire conditions.

Where a smoke control system is installed, ventilation and air conditioning systems in the building should be compatible with it when operating under fire conditions.

16.9 Refuse chutes and storage

Refuse storage chambers, refuse chutes and refuse hoppers should be sited and constructed in accordance with BS 5906.

Refuse chutes and rooms provided for the storage of refuse should:

a) be separated from other parts of the building by fire-resisting construction; and

b) not be located within protected stairways or protected lobbies.

Rooms containing refuse chutes, or provided for the storage of refuse, should be approached either directly from the open air or by way of a protected lobby provided with not less than 0.2 m^2 of permanent ventilation.

Access to refuse storage chambers should not be sited adjacent to escape routes or final exits, or near to windows.

17 Horizontal means of escape

17.1 General

*NOTE Specific guidance on horizontal means of escape for disabled people is given in **17.7**.*

This clause deals with the provision of means of escape from any point in a storey to the nearest storey exit of the floor in question, for all types of building other than atria and shopping complexes. Means of escape for atria should be provided in accordance with Annex B, and for shopping complexes in accordance with Annex E.

Escape routes from each storey (or level) should be so sited that a person confronted by fire can turn away and make a safe escape through an alternative exit. Routes of travel should be free from any serious obstacle that could cause undue delay, especially to disabled people, e.g. raised thresholds or steps, or doors that are difficult to open.

The time between the fire ignition and the start of the evacuation, and the time taken to travel to a place of relative safety, have a significant affect on the safety of the occupants. In spaces where there are relatively few people it is the distance to a place of relative safety that has the main influence on the travel time. Where there are relatively large numbers of people on a floor it is the queuing at the exits that has the main influence on the travel time.

17.2 Number of occupants

A realistic estimate should be made of the maximum occupancy associated with the intended use of the building, taking into account that a proportion of people have some form of disability. The occupant capacity of a room, storey, building or part of a building is either:

a) the maximum number of persons it is designed to hold; or

b) the number calculated by dividing the area of room or storey(s) (m^2) by the appropriate floor space factor (m^2 per person) such as those given in Table 10.

NOTE 1 "Area" excludes stair enclosures, lifts, sanitary accommodation and any other fixed part of the building structure, but includes such features as counters, bars, seating and display units.

NOTE 2 The factors given in Table 10 are only typical and higher or lower factors might be more appropriate depending on the circumstances of the intended use and nature of the occupants.

The capacity of the stairs should not be used as a basis for determining the occupancy capacity of a room, as this might result in an estimated occupancy that could not be controlled in the event of an emergency.

17.3 Layout and number of escape routes and exits

17.3.1 Minimum number of escape routes

An escape route can be rendered impassable by fire, smoke or fumes. Generally, therefore, at least two alternative escape routes should be provided from every storey or floor level. However in certain circumstances a single direction of escape (from a dead end) can provide reasonable safety (see **17.3.3**). The number of escape routes and exits from any room, tier or storey should be not less than the minimum recommended in Table 11 for the intended number of occupants.

*NOTE 1 The numbers given in Table 11 are the absolute minimum; the actual number of escape routes and exits that will be needed depends on the risk profile (see Clause **6**), the number of occupants in the room, tier or storey in question, and the limits on travel distance to the nearest storey exit (see **17.4**), and is likely to be higher than the numbers in the table.*

NOTE 2 It is only the distance to the nearest exit that is so limited. Any other exits may be further away than the defined distances.

One of these escape routes may be to an adjoining compartment provided that:

a) the building is one occupancy;

b) the adjoining compartment is separated from the fire-affected area by walls of fire-resisting construction with openings therein fitted with self-closing fire doors;

c) the adjoining compartment is of sufficient size to accommodate both its own occupants and those exiting to it from the fire-affected area; and

d) the adjoining compartment has storey exits of sufficient capacity to cater for 50% of the total occupancy of the compartment, taking into account both the number of the occupants in the adjoining compartment and the number of persons escaping to it.

Where unavoidable, an escape route for the public may be via an area of ancillary accommodation, other than an area of special fire hazard, provided that it is not the only available escape route from the area concerned. The route through the area of ancillary accommodation to a storey exit should be clearly defined by means of guardrails.

Table 10 **Examples of typical floor space factors**

Occupancy	**Floor space factor** m² per person	**Occupancy**	**Floor space factor** m² per person
Administration office	5.0	Individual seating	0.4
Amusement arcade	0.5	Indoor games/training rooms in schools	10.0
Archive/library reading area	5.0	Kitchen	7.0
Art gallery	5.0	Licensed betting office (public area)	1.0
Assembly hall	0.5	Lobbies	2.0
Banking hall	3.0	Lounge	1.0
Bar	0.3	Machine/printing room	10.0
Bazaar	2.0	Mechanical plant room	30.0
Bench seating	0.4	Meeting room	1.0
Billiards or snooker room	10.0	Museum	5.0
Bingo hall	0.5	Office (closed-plan or less than 60 m^2)	8.0
Bowling alley	10.0	Office (open-plan or exceeding 60 m^2)	5.0
Business centre	7.0	Queuing area	0.5
Car park (per parking space)	2.0	Reading or writing room (seated)	2.0
Classroom	2.0	Reading room (standing)	1.0
Club	0.5	Reception area	2.0
Committee room	1.0	Restaurant	1.0
Common room	1.0	Shop	2.0
Computer room	7.0	Showrooms	7.0
Conference room	1.0	Skating rink	2.0
Crush hall	0.5	Space with loose seating	0.75
Dance area	0.5	Space with loose tables	1.0
Deposit/strong room	30.0	Stadia and grandstands	0.6
Design studio/drafting office	7.0	Staff room	1.0
Dining room and canteens	1.0	Storage and warehousing	30.0
Dining rooms with loose tables	1.0	Studio (radio, television, film, recording)	1.5
Dormitory	5.0	Teaching laboratories	3.0
Exhibition areas	1.5	Venue for pop concerts	0.5
Factory production area	5.0	Waiting area/visitors' lounge	2.0
Filing room/store	10.0	Waiting room	2.0
Foyers in theatres and cinemas	0.3	Workshop	5.0
Gymnasium – open plan (where fixed machines are used, the occupancy is based on the number of machines provided)	0.6		

Table 11 **Minimum number of escape routes and exits from a room, tier or storey**

Maximum number of persons	**Minimum number of escape routes/exits**
60	1
600	2
More than 600	3

Where in multi-storey buildings more than one stair might be needed for escape, every part of each storey should have alternative access to more than one stair. For those areas involving initial dead-end conditions, this access should be provided when the alternative routes become available.

In mixed use buildings, separate means of escape should generally be provided from any storeys (or parts of storeys) used for residential or assembly and recreation purposes (see also Annex D).

17.3.2 Alternative escape routes

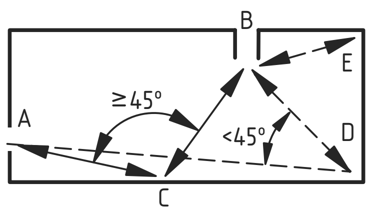
If alternative escape routes are provided, they need to be sited so as to minimize the possibility of all being rendered unavailable at the same time. Alternative escape routes should therefore be either:

a) 45° or more apart (see Figure 5); or

b) if less than 45° apart, separated from each other by fire-resisting construction.

NOTE Fire-resisting construction may incorporate self-closing fire doors.

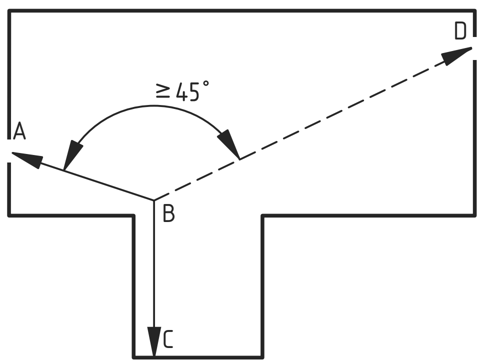
Figure 5 **Escape routes 45° or more apart**



Alternative routes are available from C because angle ACB is 45° or more, and therefore CA or CB (whichever is the less) should be no more than the maximum distance for travel given for alternative routes.

Alternative routes are not available from D because angle ADB is less than 45°. There is also no alternative route from E.

a) Option 1



Angle ABD should be at least 45°. CBA or CBD (whichever is less) should be no more than the maximum distance of travel given for alternative routes, and CB should be no more than the maximum distance for travel where there are no alternative routes.

b) Option 2 (travel distance in dead-end condition)

NOTE The use of dotted lines is to aid use of the diagrams and does not have any other significance.

17.3.3 Single escape routes and exits

A single escape route is acceptable in the following situations:

a) parts of a floor from which a storey exit can be reached within the travel distance limit for travel in one direction, provided that, in the case of places of assembly and bars, no one room in this situation has an occupant capacity of more than 60 people, or 30 people if the occupants require assistance to escape;

b) storeys with an occupant capacity of not more than 60 people, provided that the travel distance limit for travel in one direction only is not exceeded (see **17.4**).

In many cases there is no alternative at the beginning of the route. For example, there might be only one exit from a room to a corridor, from which point escape is possible in two directions. This is acceptable provided that the overall distance to the nearest storey exit is within the limits for routes where there is an alternative, and the "one direction only" section of the route does not exceed the limit for travel where there is no alternative.

17.3.4 Inner rooms and access rooms

An inner room can be at risk if a fire starts in the access room (see Figure 6). An inner room arrangement is acceptable only if all of the following conditions are met:

a) the occupant capacity of the inner room does not exceed 60 (30 where the occupants require assistance escaping);

b) the inner room is not a bedroom;

c) the inner room is entered directly from the access room;

d) the escape route from the inner room does not pass through more than one access room;

e) the travel distance from any point in the inner room to the exit(s) from the access room does not exceed the allowable one-way travel distance;

f) the access room is not a place of special fire hazard and is in the control of the same occupier as the inner room;

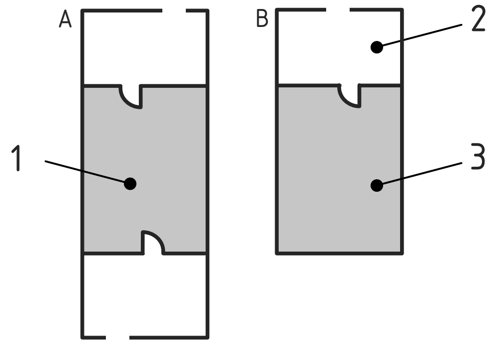
g) one of the following arrangements is made:

1) the enclosures (walls or partitions) of the inner room are stopped at least 500 mm below the ceiling; or

2) a suitably sited vision panel not less than 0.1 m^2 is located in the door or walls of the inner room, to enable occupants of the inner room to see if a fire has started in the outer room; or

3) the access room is protected by an automatic smoke detector that either operates an alarm that is audible in the inner room, to a sound pressure level in accordance with the minimum recommended in BS 5839-1, or gives a visual indication in the inner room if the ambient noise levels are so great as to make an alarm inaudible.

Figure 6 **Inner room and access room**



Key
1 Room with alternative exits
2 Access room
3 Inner room

A needs no special provision.
B should conform to ***17.3.4****.*

17.3.5 Planning of exits in a central core

Buildings with more than one exit in a central core should be planned so that storey exits are remote from one another, and so that no two exits are approached from the same lift hall, common lobby or undivided corridor, or linked by any of these (see Figure 7).

17.3.6 Access to storey exits

Any storey that has more than one escape stair should be planned so that it is not necessary to pass through one stairway to reach another. However, it would be acceptable to pass through one stairway's protected lobby to reach another stair.

17.3.7 Separation of circulation routes from stairways

Unless the doors to a protected stairway and any associated exit passageway are fitted with an automatic release mechanism (actuated by an automatic fire detection and alarm system), the stairway and any associated exit passageway should not form part of the primary circulation route between different parts of the building at the same level.

NOTE This is because self-closing fire doors are more likely to be rendered ineffective as a result of their constant use, or because some occupants might regard them as an impediment; for example, doors might be wedged open or have their closers removed.

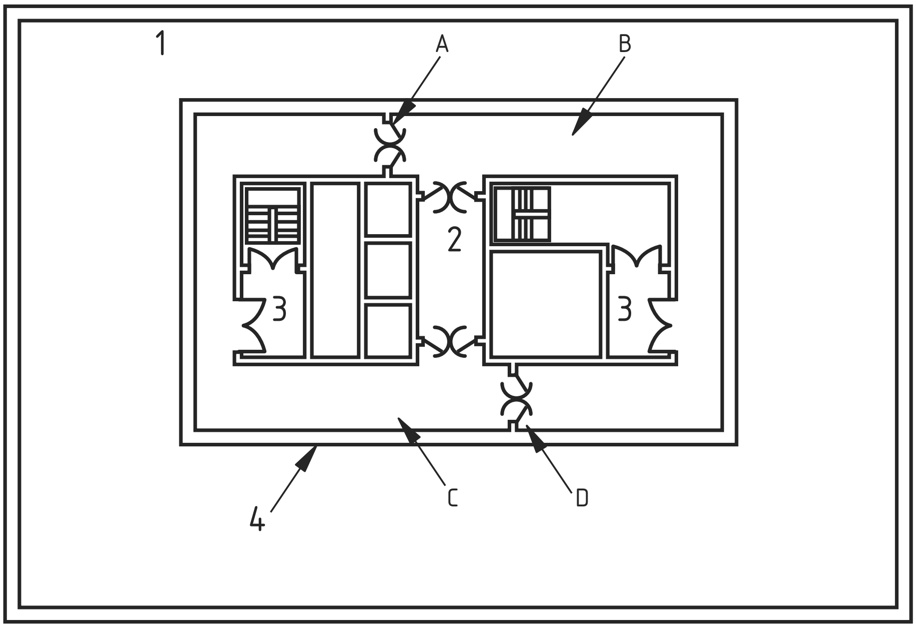
17.3.8 Storeys divided into different uses

Where a storey contains an area (which is ancillary to the main use of the building) for the consumption of food and/or drink (other than staff refreshment rooms which meet the provisions in **17.3.4**), then:

a) not less than two escape routes should be provided from each such area; and

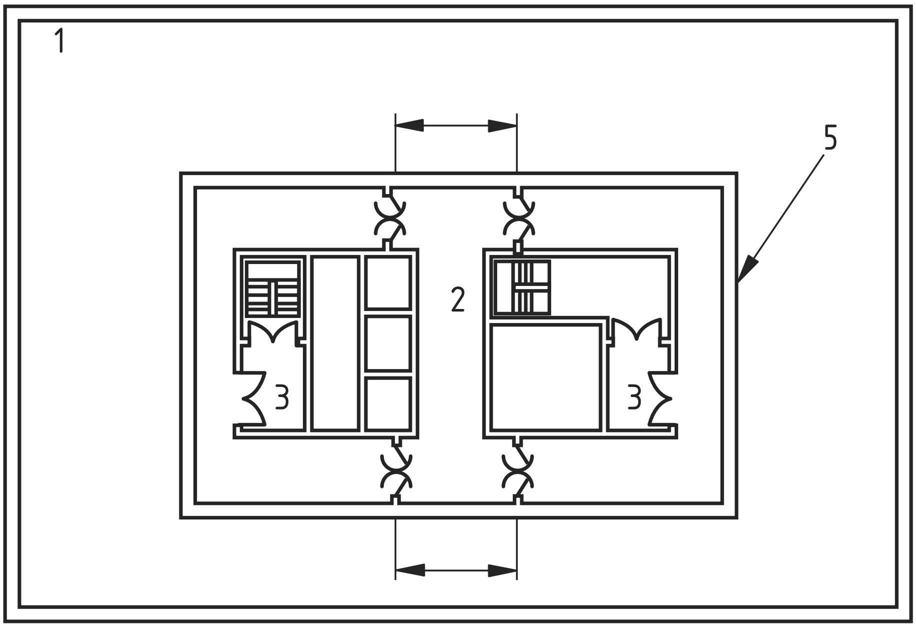
b) one of the escape routes should lead directly to a storey exit without entering the remainder of the storey, a kitchen or an area of special fire hazard.

Figure 7 **Exits in a central core**



Two doors may be at A and D or at B and C, but not at A and C or at B and D.

a) Example 1



b) Example 2

A corridor connecting both stairs should be divided both sides of the central core by doors arranged as indicated in a) or b).

Key

1 External wall
2 Lift lobby
3 Stairs need lobby approach in buildings over 18 m in height
4 Doors to accommodation (not shown) may be placed anywhere in this wall
5 Doors to accommodation (not shown) may be placed anywhere in this wall except between the arrows

17.3.9 Storeys divided into different occupancies

Where a storey is divided into separate occupancies (i.e. where there are separate ownerships or tenancies of different organizations):

a) the means of escape from each occupancy should not pass through any other occupancy; and

b) if the means of escape include a common corridor or circulation space, then either it should be a protected corridor, or a suitable automatic fire detection and alarm system should be installed throughout the storey.

17.3.10 Height of escape routes

NOTE 1 The headroom is taken to be the clear height from the floor to the underside of the structure above, e.g. a ceiling, a beam, etc.

NOTE 2 For width of escape routes, see ***17.6****.*

All escape routes should have a clear headroom of not less than 2 m except in doorways.

17.3.11 Corridors

NOTE For width of corridors, see ***17.6****.*

17.3.11.1 Protected corridors

Where used as part of the means of escape, the following types of corridor should be constructed as protected corridors:

a) every corridor serving a bedroom;

b) every dead-end corridor exceeding 2 m in length;

c) any corridor common to two or more different occupancies (but see also **17.3.9**).

17.3.11.2 Enclosure of corridors that are not protected corridors

Where a corridor that is used as a means of escape, but is not a protected corridor, is enclosed by partitions, the partitions should be:

a) smoke-retarding, even if they have no required fire resistance rating;

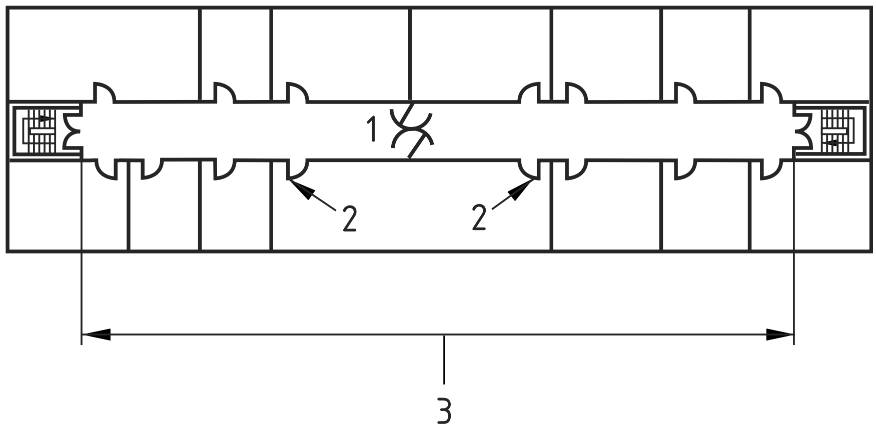
b) carried up to the soffit of the structural floor above, or to a suspended ceiling.

Openings into rooms from the corridor should be fitted with doors, which need not be fire-resisting but should be close-fitting.

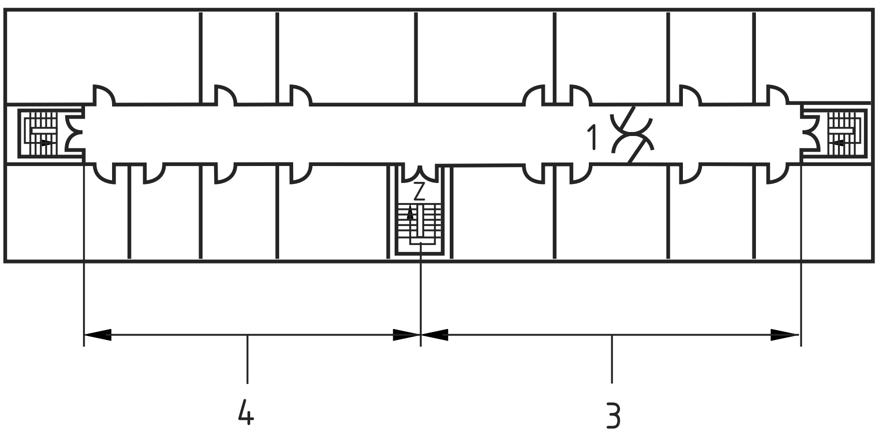
17.3.11.3 Subdivision of corridors

If a corridor provides access to alternative escape routes, there is a risk that smoke will spread along it and make both routes impassable before all occupants have escaped. To avoid this, every corridor more than 12 m long which connects two or more storey exits should be subdivided by self-closing fire doors (and any necessary associated screens), so that the fire door(s) and any associated screen(s) are positioned approximately mid-way between the two storey exits. Any doors to the accommodation that would allow smoke to bypass the separating door should be self-closing. Corridors connecting alternative exits are illustrated in Figure 8.

Figure 8 **Corridors connecting alternative exits**

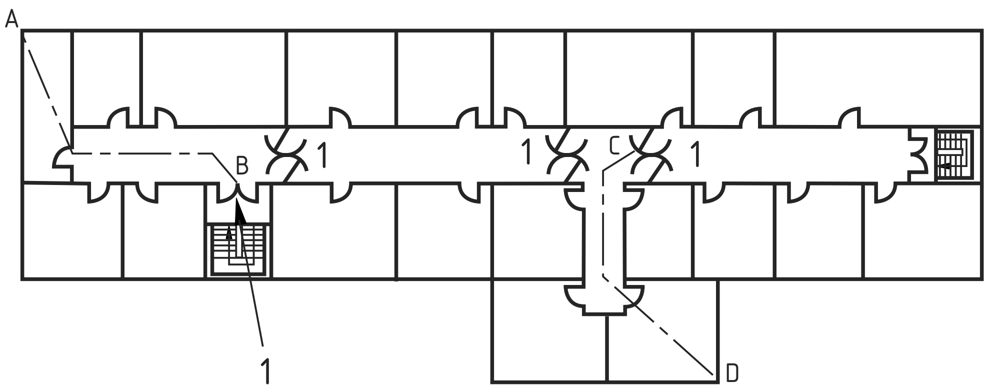


a) Corridors connecting two exits



NOTE Doors to central stair should be at position Z.

b) Corridors connecting three exits



AB and DC are dead ends.

c) Dead-end corridors

Key

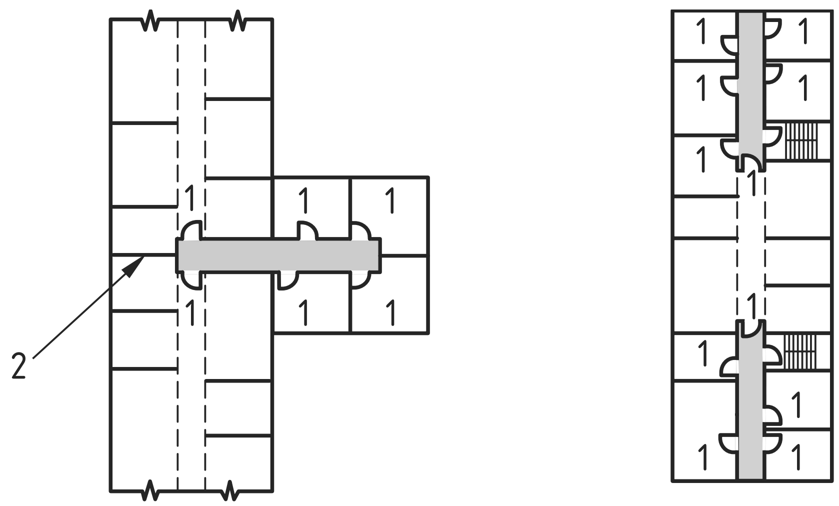
1 Fire door with 20 min fire resistance with smoke seal
2 Self-closing doors
3 Distance between exits >12 m
4 Distance between exits ⩽12 m

Dead-end portions of corridors need not be separated from the remainder of the corridor by a fire door as shown in Figure 8c) if the protected stairways and corridors are protected with a smoke control system using pressure differentials that is in accordance with BS EN 12101-6.

If alternative escape routes are immediately available from a dead-end corridor, there is a risk that smoke from a fire could make both routes impassable before the occupants in the dead end have escaped. To avoid this:

a) either the escape stairway(s) and corridors should be protected by a pressurization system conforming to BS EN 12101-6; or
b) every dead-end corridor exceeding 4.5 m in length should be separated by self-closing fire doors (together with any necessary associated screens) from any part of the corridor which:
   1) provides two directions of escape [see Figure 9a)]; or
   2) continues past one storey exit to another [see Figure 9b)].

Figure 9 **Dead-end corridors**



a) "T" junction with main corridor

b) Continuation past stairway

Key

1 Self-closing fire door
2 Fire-resisting construction (same fire resistance as protected corridor)
Protected corridor

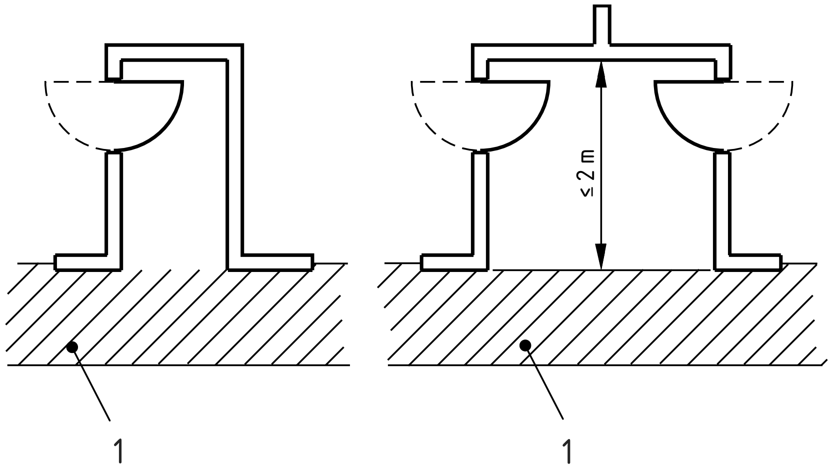
NOTE Recommendations for fire resistance of fire doors (FD) and protected corridors are given in ***32.1****.*

17.3.11.4 Recesses off corridors

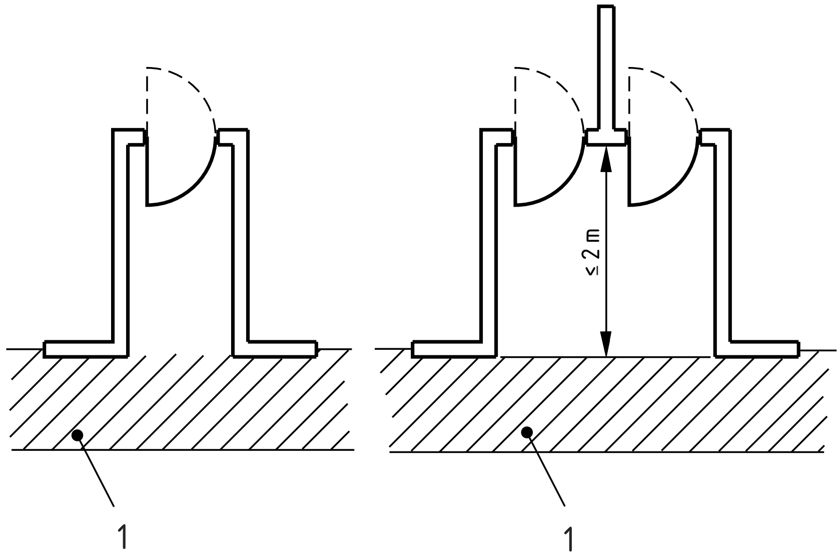
Recesses off corridors as shown in Figure 10 and extensions of corridors beyond protected stairways as shown in Figure 11 need not meet the recommendations of **17.3.11.1** and **17.3.11.3** in respect of dead-end situations unless:

a) the corridor otherwise should be a protected corridor; or
b) the accommodation served otherwise should be separated from other parts of the building by fire-resisting construction.

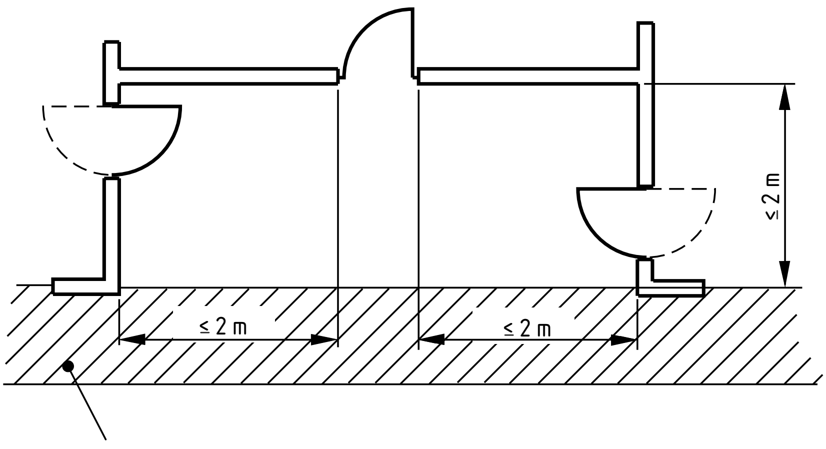
Figure 10 **Recesses off corridors**



a) Room(s) off sides of recess



b) Room(s) off end of recess

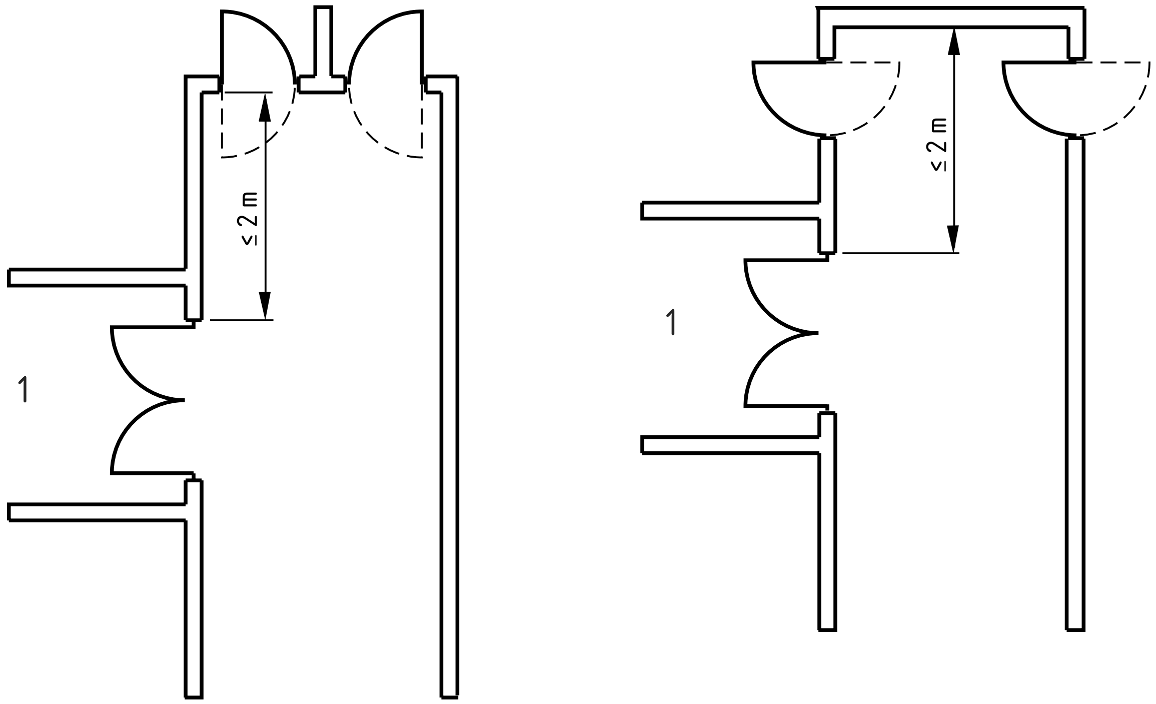


c) Rooms off sides and end of recess

Key

1 Corridor

Figure 11 **Extension of corridor beyond a protected stairway**



a) Example 1

b) Example 2

Key

1 Protected stairway

17.3.12 External escape routes

If more than one escape route is available from a storey, or part of a building, one of those routes may be by way of a flat roof, provided that all of the following conditions are met:

a) the route does not serve a building where the occupants require assistance in escaping, or part of a building intended for use by members of the public;

b) the flat roof is part of the same building from which escape is being made;

c) there are no ventilation openings of any kind within 3 m of the escape route;

d) any wall, including a door or a window in the wall, within 3 m of the escape route has at least 30 min fire resistance for integrity from the inside and there is no unprotected area below a height of 1.1 m measured from the level of the escape route;

e) any roof hatch or roof light forming part of the roof within 3 m of the escape route has at least 30 min fire resistance for integrity from the underside;

f) the route is adequately defined and guarded by walls and/or protective barriers conforming to BS 6180;

g) the route across the roof leads to a storey exit or an external escape route.

Where any such route leads to an external staircase, the staircase should conform to **18.7**.

17.3.13 Progressive horizontal evacuation

*NOTE Progressive horizontal evacuation is a suitable means of evacuating disabled people in all occupancies (see **17.7**).*

Progressive horizontal evacuation, i.e. escape to an exit in a compartment wall, is acceptable provided that:

a) each compartment has at least one other escape route that is independent of the route into the adjoining compartment (see Figure 12); and

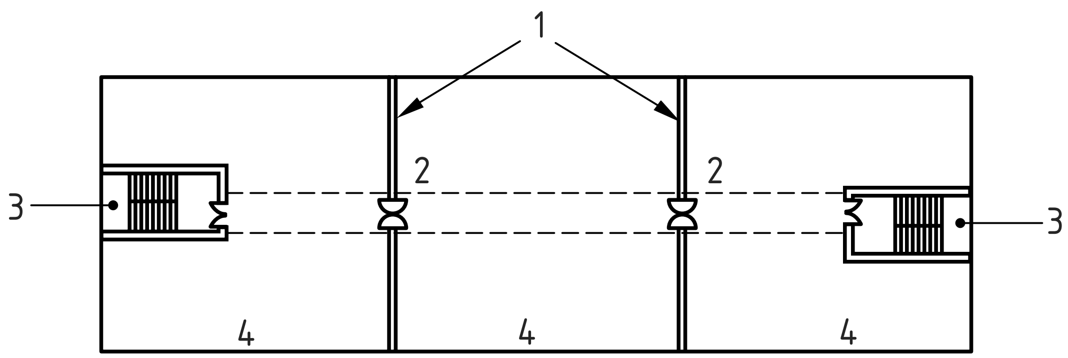
b) one or other of the following conditions is met:

   1) either there is standing room for all the occupants of both compartments, in the adjoining compartment, assuming a density of 0.3 m^2 person; or

   2) the escape route width available from the adjoining compartment is adequate for the sum of the occupancy capacities of both compartments.

Ventilating systems serving both compartments should be provided with smoke dampers actuated on smoke detection. Doors should have cold smoke seals, and should close on smoke detection.

Figure 12 **Progressive horizontal evacuation**



Key

1 Compartment wall
2 Fire door (equivalent to storey exit)
3 Storey exit
4 Compartment

NOTE Travel distance limits apply to storey exits in compartment walls.

17.4 Travel distance

The travel distance should generally not exceed the value given in Table 12 for the appropriate risk profile; however, if additional fire protection measures are provided the travel distance may be increased subject to certain limitations (see Clause **19**).

*NOTE 1 The travel distances recommended in this subclause are based on the time available to travel safely to an exit (see Clause **11**).*

*NOTE 2 These distances have been determined according to the risk profile (see Clause **6**), taking into account the following issues.*

a) Distances need to be shorter for higher fire growth rates or where the occupants are unfamiliar with the building.

*b) Distances may be longer when additional fire protection measures are provided (see Clause **19**).*

c) A person escaping might not go direct to their storey exit in the first instance.

d) Speed of movement can vary widely according to the occupancy characteristics.

e) Pre-movement time can vary with the size of room, the occupancy characteristics and the management provision.

Table 12 **Maximum travel distance when minimum fire protection measures are provided** [A)]

Risk profile	**Travel distance**, in metres (m)	
	Two-way travel	**One-way travel**
A1	65	26
A2	55	22
A3	45	18
A4 [B)]	Not applicable [B)]	Not applicable [B)]
B1	60	24
B2	50	20
B3	40	16
B4 [B)]	Not applicable [B)]	Not applicable [B)]
C1	27	13
C2	18	9
C3 [B)]	14	7
C4 [B)]	Not applicable [B)]	Not applicable [B)]

Where exact travel distances are not known, direct distances should be taken as two thirds of the travel distance.

NOTE Where premises contain provisions for the consumption of alcoholic beverages then a reduction in the travel distances of 25% might be advisable for those particular parts of the premises.

A) This is the maximum travel distance that is allowable when the minimum level of fire protection measures is provided (see Clause **16**). For example, the maximum length of one-way travel is 22 m for a category A2 risk according to Table 12. By fitting sprinklers, this risk is changed to A1, so the maximum length of one-way travel is increased to 26 m. If additional fire protection measures are provided then the travel distance may be increased (see Clause **19**).

B) See Table 4.

17.5 Cellular plan floors

In certain designs, such as office accommodation, the floor plan is divided into small cellular compartments. This can increase the risk to occupants who are not in the room where a fire has started and who might therefore be unaware of the fire, and can also result in occupants having to move past the room of origin during an evacuation. It is therefore necessary to limit the distance that occupants have to travel in these situations and also provide protection from the noxious gases from the fire.

When calculating door widths and travel distance for cellular plan floors the following issues need to be taken into account.

a) Travel distances should be measured to the nearest storey exit, i.e. not to the cellular room exit.

b) Partitions should be smoke-resisting even if they do not have a required fire resistance rating, because the occupants might not be immediately aware that there is a fire in nearby accommodation.

c) The width of the final exit from the floor should be determined according to the total number of occupants who are expected to use that particular exit (see **17.6**).

17.6 Width of doors, corridors and escape routes

17.6.1 Doors

*NOTE 1 For doors in corridors, see **17.6.2**.*

NOTE 2 An increased door width might be necessary on some access routes.

The door width per person expected to use the door should generally not be less than the value given in Table 13 for the appropriate risk profile and the total door width should be:

a) not less than the aggregate of the exit widths given in Table 13; and

b) not less than 800 mm regardless of risk profile (see Figure 13).

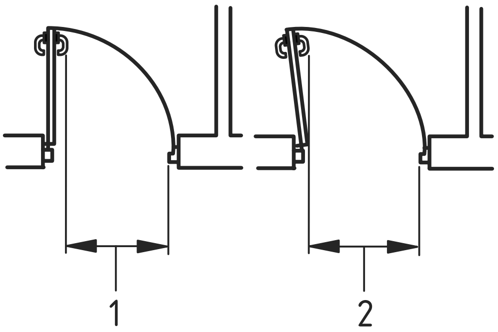
However, if additional fire protection measures are provided the width may be reduced subject to certain limitations (see Clause **19**).

Table 13 **Door widths when minimum fire protection measures are provided**

Risk profile	**Minimum door width per person** mm
A1	3.3
A2	3.6
A3	4.6
A4 [A)]	Not applicable [A)]
B1	3.6
B2	4.1
B3	6.0
B4 [A)]	Not applicable [A)]
C1	3.6
C2	4.1
C3 [A)]	6.0
C4 [A)]	Not applicable [A)]

[A)] See Table 4.

Figure 13 **Measurement of door width**



Key

1 Effective clear width (door stop to projecting building hardware)

2 Effective clear width (door stop to door leaf)

If a storey has two or more storey exits it has to be assumed that a fire might prevent the occupants from using one of them. The remaining exit(s) need to be wide enough to allow all the occupants to leave quickly. Therefore, when calculating the aggregate of the exit widths given in Table 13, the largest exit width should be discounted.

NOTE 3 This could have implications for the width of stairs, which need to be at least as wide as any storey exit leading onto them (see ***18.4.1****).*

NOTE 4 The total number of persons that two or more available exits can accommodate is found by adding the maximum number of persons for each exit width. For example, three exits each 850 mm wide, in a building with a B2 risk profile, will accommodate 386 persons. This is calculated by:

- *850 divided by 4.4 (from Table 13) = 193;*
- *discount one exit;*
- *2 × 193 = 386 persons [not the 579 persons who could be accommodated through a single exit 2 550 mm (i.e. 3 × 850 mm) wide].*

Where a room is crowded, the time to evacuate becomes less dependent upon the travel distances and more dependent upon the queuing behaviour at the exits and so the door capacity becomes the critical feature of the design.

17.6.2 Corridors and escape routes

The width of a door in a corridor should be not less than either the calculated corridor width minus 150 mm, or 1 050 mm, whichever is the greater (see Note 1).

Where double doors are provided the width of one of the leaves should be not less than 800 mm.

NOTE 1 In those limited circumstances where the corridor is not required to be accessible to wheelchair users, e.g. in maintenance areas, the width of the door may be reduced to 800 mm.

The width of a corridor or escape route should be not less than the calculated width of any door leading on to it (see **17.6.1**), or 1 200 mm, whichever is the greater (see Note 2).

NOTE 2 Where the corridor is not required to be accessible to wheelchair users, e.g. in maintenance areas, the width may be reduced to 1 000 mm.

In any building with no public access, the width of any gangways and stairways within a storage area containing fixed obstructions (including fixed racking or shelving and high-bay storage) should be not less than 530 mm, except in buildings for the bulk storage of spiritous liquor, where gangways may be reduced to 400 mm.

17.7 Methods of horizontal escape for disabled people

Where a building has phased/zoned evacuation systems, this can be of great benefit for the management of evacuation of disabled people. If disabled people can move horizontally through a building, this can reduce the need for staff to assist wheelchair users and other people with restricted mobility to move downstairs.

*NOTE See **46.9** for evacuation using lifts.*

In phased evacuation, disabled people can move out of the building or compartment in the first stage by evacuation lift.

In zoned evacuation, they can move horizontally into another fire compartment either to be evacuated by lift, provided that the lift has a back-up power supply, or to await assistance from building management with the next part of their movement to a place of ultimate safety.

18 Vertical means of escape

18.1 General

*NOTE Specific guidance on vertical means of escape for disabled people is given in **18.8**.*

Vertical escape involves the transition from horizontal escape from a building to a place of ultimate safety, which is usually open air, and clear of the building. Therefore the design for vertical means of escape should meet the performance recommendations for horizontal escape (see Clause **17**), for each storey exit in a building. The most common form of vertical means of escape is a protected staircase.

Stair design can have an effect on the speed of evacuation in a building. Occupants who fear an accident occurring during an evacuation down a stair are likely to travel more slowly. The effective use of lighting, handrails, and the correct ratio of riser to tread can all increase the travel speed.

The majority of accidents on stairs are caused by falls, which are usually the result of an incorrect size or ratio of riser to tread. As little as a 5 mm difference in riser height can result in a fall, which could be catastrophic in an evacuation.

Marked step edges also add to the safety of the escape stair.

In designing stair widths for vertical escape, an important factor is the flow rate that can be achieved. Throughout a simultaneous evacuation, occupants enter the staircase from all levels and leave via the final exit. People on the fire floor are likely to enter the stair first as their pre-movement times are likely to be substantially lower than on non-fire floors. The stair might become congested due to occupants from levels above, which could in turn result in people being unable to leave compartments. This is taken into account in the recommended widths for escape stairs (see **18.4**).

18.2 Design of escape stairs

18.2.1 General

The flights and landings of every escape stair should be constructed of materials of limited combustibility (see **35.1.6**) in the following situations:

a) if it is the only stair serving the building, or part of the building, unless the building is of two or three storeys and is risk profile A2 or better;

b) if it is within a basement storey;

c) if it serves any storey having a floor level more than 18 m above ground or access level;

d) if it is external, except in the case of a stair that connects the ground floor or paving level with a floor or flat roof not more than 6 m above or below ground level; or

e) if it is a fire-fighting stair.

18.2.2 Enclosure of escape stairs

Every internal escape stair should be a protected stair (i.e. it should be within a fire-resisting enclosure). However, an unprotected stair (e.g. an accommodation stair) in a low-risk premises may form part of an internal route to a storey exit or final exit, subject to the outcome of an appropriate risk assessment.

Additional enclosure measures might be necessary if the protected stairway is also a protected shaft or a fire-fighting shaft.

18.2.3 External walls of protected stairways

Where a protected stairway projects beyond, or is recessed from, or is in an internal angle of, the adjoining external wall of the building, then the distance between any unprotected area in the external enclosures to the building and any unprotected area in the enclosure to the stairway should be at least 1 800 mm (see Figure 14).

18.2.4 Added protection to stairs

An escape stair should have a protected lobby or protected corridor or a pressure differential system under the following circumstances:

a) where the stair is the only one serving a building (or part of a building) that has more than one storey above or below the ground storey; or

b) where the stair serves any storey at a height greater than 18 m; or

c) where the building is designed for phased evacuation; or

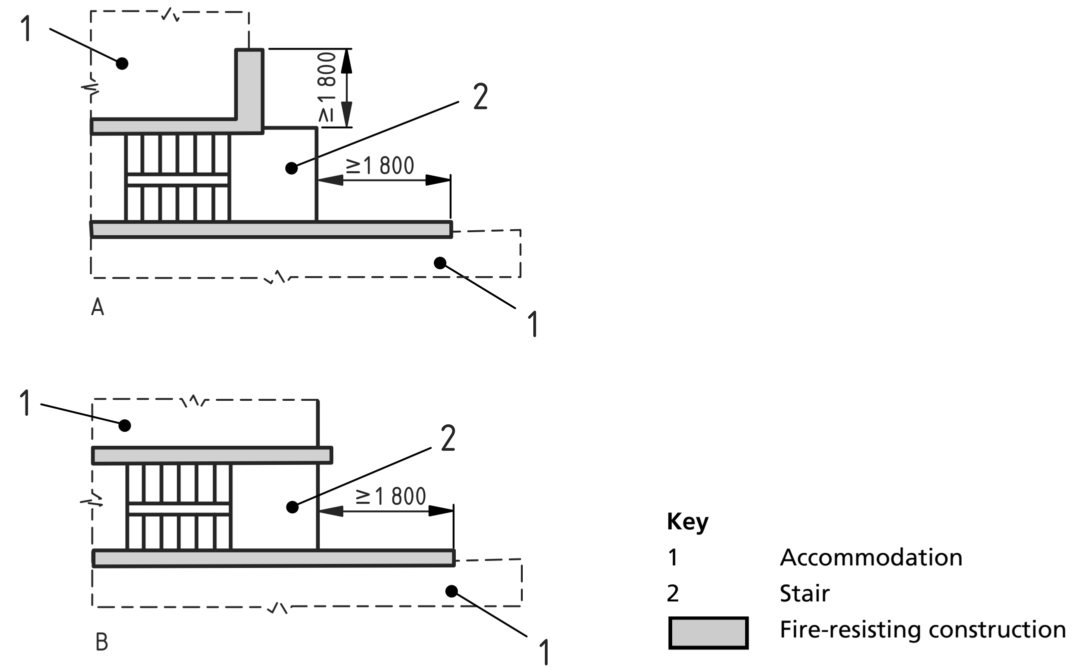
d) in a building in which the stair width has not been based on discounting one stairway (see **18.3.2**).

In these cases, protected lobbies or protected corridors, where used, should be provided at all levels, except the top storey; including all basement levels.

A protected lobby should also be provided between an escape stairway and a place of high fire risk.

Figure 14 **External protection to protected stairways – Configurations of stairs and external wall**

Dimensions in millimetres



18.2.5 Exits from protected stairways

Every protected stairway should discharge directly to a final exit, or by way of a protected exit passageway to a final exit.

18.2.6 Separation of adjoining stairways

Where two protected stairways are adjacent, either they, and any protected exit passageways linking them to final exits, should be fire separated, or both stairways should be discounted in any calculations (see **18.3.2**).

18.2.7 Final exits from stairs

The exit route from a stairway should be at least as wide as the stair leading to it.

Where an exit route from a stairway also forms the escape route from the ground and/or basement storeys, the width of the exit route might need to be increased accordingly.

18.2.8 Single steps

NOTE Ramps can often be used to avoid single steps.

Single steps can cause falls and should be avoided on escape routes. Where such steps are unavoidable, they should be prominently marked.

18.2.9 Helical stairs and spiral stairs

If helical stairs or spiral stairs form part of an escape route, they should be designed in accordance with BS 5395-2. Helical and spiral stairs should not be used as the only means of escape without additional compensating features.

18.3 Number of escape stairs

18.3.1 General

The number of escape stairs needed in a building (or part of a building) is determined by:

a) the constraints imposed in Clause **17** on the design of horizontal escape routes;

b) whether a single stair is acceptable (see **18.3.3**);

c) whether independent stairs are required in mixed occupancy buildings (see **18.3.4**); and

d) the provision of adequate width for escape (see **18.4.1**) while allowing for the possibility that a stair might have to be discounted because of fire or smoke (see **18.3.2**).

In larger buildings, it might be necessary to provide access for the fire and rescue service, in which case some escape stairs might also need to serve as fire-fighting stairs (see **21.3**).

18.3.2 Discounting of stairs

Where two or more stairways are provided it should be assumed that one of them might not be available due to fire or smoke. When determining the aggregate capacity of all the stairways, it is therefore necessary to discount each stair in turn in order to ensure that the capacity of the remaining stairway(s) is adequate for the number of persons needing to escape, unless:

a) the escape stairs are approached on each storey through a protected lobby. In such a case the likelihood of a stair not being available is significantly reduced and it is not necessary to discount a stair. A protected lobby need not be provided on the topmost storey for the exception still to apply;

b) the stairways are protected by a smoke control system designed in accordance with BS EN 12101-6.

The stair discounting process does not apply to a building fitted with a sprinkler system.

18.3.3 Single escape stairs

Provided that independent escape routes are not necessary from areas put to different uses (see **18.3.4),** the situations where a building (or part of a building) may be served by a single escape stair are:

a) a basement which is allowed to have a single escape route in accordance with **17.3.3**;

b) a building that has no storey with a floor level more than 11 m above ground level, and in which every storey is allowed to have a single escape route in accordance with **17.3.3**.

18.3.4 Mixed use buildings

Where a building contains storeys (or parts of storeys) put to different uses, it is important to consider the effect of one risk on another. A fire in a shop, or unattended office, could have serious consequences on, for example, a residential or hotel use in the same building. A risk assessment should be carried out to determine whether completely separate routes of escape should be provided from each different use within the building or whether other effective means to protect common escape routes can be provided.

18.4 Width of escape stairs

18.4.1 Absolute minimum width

NOTE 1 Handrails and strings which do not intrude more than 100 mm into this width may be ignored.

*NOTE 2 For door widths for simultaneous evacuation, see **18.4.2**.*

The width of an escape stair should be measured as the clear width between the walls or balustrades, at the narrowest point up to 1 500 mm above pitch line.

The width of escape stairs:

a) should be not less than the width(s) of any exit(s) affording access to them;

b) should not be reduced at any point on the way to a final exit; and

c) should be not less than the dimensions given in Table 14 for the appropriate occupancy characteristic.

Table 14 **Absolute minimum width of stairs**
Dimensions in millimetres

Occupancy characteristic	Width of stair for downward travel	Width of stair for upward travel
A	1 000	1 200
B (except assembly)	1 000	1 200
B (assembly only)	1 100	1 200
C	1 000	1 200

An escape stair should not exceed 1 400 mm if its vertical extent is more than 30 m, unless, for reasons of safety in use, the stair is provided with a central handrail, in which case there should be not less than 1 000 mm space each side of the central handrail. In such a case the stair width on each side of the central handrail should be assessed separately for the purpose of determining the stair capacity.

18.4.2 Simultaneous evacuation

*NOTE See also **12.3.1**.*

Every escape stair should be wide enough to accommodate the number of persons needing to use it in an emergency; this width depends on the number of people using the stair on each storey. In a building designed for simultaneous evacuation, the escape stairs should have the capacity to allow all floors to be evacuated simultaneously and to enable people on the fire floor to leave the floor quickly.

Simultaneous evacuation may be used in any building or part of a building, but should always be used for:

a) all stairs serving basements;

b) all stairs serving buildings or parts of buildings with open spatial planning.

The width of escape stairs for simultaneous evacuation should be not less than the greater of the following, unless additional fire protection measures are provided (see Clause **19**):

1) the dimensions given in Table 14 for the appropriate occupancy characteristic;

2) the dimensions given in Table 15 for the appropriate risk profile and number of floors.

Table 15 **Minimum width of escape stairs for simultaneous evacuation**
Dimensions in millimetres

Risk profile	Minimum width of stair per person served over total number of floors served									
	1 floor	**2 floors**	**3 floors**	**4 floors**	**5 floors**	**6 floors**	**7 floors**	**8 floors**	**9 floors**	**10+ floors**
A1	3.90	3.40	2.95	2.45	2.15	2.00	1.80	1.70	1.50	1.40
A2	4.50	3.80	3.25	2.75	2.45	2.20	2.00	1.90	1.70	1.60
A3	5.40	4.60	4.00	3.50	3.10	2.80	2.60	2.30	2.10	2.00
A4 [A]	—	—	—	—	—	—	—	—	—	—
B1	4.20	3.60	3.10	2.60	2.30	2.10	1.90	1.80	1.60	1.50
B2	4.80	4.00	3.40	2.90	2.60	2.30	2.10	2.00	1.80	1.70
B3	7.00	6.00	5.30	4.60	4.20	3.70	3.40	3.10	2.80	2.60
B4 [A]	—	—	—	—	—	—	—	—	—	—
C1	4.20	3.60	3.10	2.60	2.30	2.10	1.90	1.80	1.60	1.50
C2	4.80	4.00	3.40	2.90	2.60	2.30	2.10	2.00	1.80	1.70
C3 [A]	7.00	6.00	5.30	4.60	4.20	3.70	3.40	3.10	2.80	2.60
C4 [A]	—	—	—	—	—	—	—	—	—	—

NOTE The widths of stairs have been calculated on the assumption that all floors are evacuating simultaneously. This is conservative, as the occupants on the fire floor are likely to move more quickly than on the other floors. The flow times on the stairs are based on research data.

[A] See Table 4.

18.4.3 Phased evacuation

*NOTE See also **12.3.2**.*

Where it is appropriate to do so, it can be advantageous to design stairs in high buildings on the basis of phased evacuation.

It enables narrower stairs to be incorporated than would be the case if simultaneous evacuation were used, and has the practical advantage of reducing disruption in large buildings, but is not appropriate in every building.

The aggregate width of escape stairs for phased evacuation should be not less than the greater of the following, unless additional fire protection measures are provided (see Clause **19**):

a) the dimensions given in Table 14 for the appropriate occupancy characteristic;

b) the dimensions given in Table 15 for the appropriate risk profile and the maximum capacity on any two floors.

18.5 Basement stairs

NOTE It is more onerous to carry wheelchair users up a stairway than to carry them down, and this can have an effect on the time taken to evacuate a basement. Some ambulant people might also find it more difficult to climb stairs than to go down them, e.g. people with heart conditions.

Because of their situation, basement stairways are more likely to be filled with smoke and heat than stairs in ground and upper storeys. The following measures are therefore needed in order to prevent a basement fire endangering upper storeys.

If an escape stair forms part of the only escape route from an upper storey of a building (or part of a building) it should not be continued down to serve any basement storey. The basement should be served by a separate protected stair. If the stairway is protected by a smoke control system designed in accordance with BS EN 12101-6, it can be continued into a basement provided that steps are taken to ensure that users are aware when they have reached the final exit level, and to guide them to the final exit.

If there is more than one escape stair from an upper storey of a building (or part of a building), only one of the stairs serving the upper storeys of the building (or part) need be terminated at ground level. Other stairs may connect with the basement storey(s) if there is a ventilated protected lobby, or a ventilated protected corridor between the stair(s) and accommodation at each basement level.

18.6 Protected stairs

Stairs used as means of escape need to be free of potential sources of fire. However, in limited circumstances certain facilities may be incorporated into protected stairs. Examples of such facilities are:

a) sanitary accommodation or washrooms, provided that the accommodation is not used as a cloakroom. A gas water heater or sanitary towel incinerator may be installed in the accommodation but not any other gas appliance;

b) a lift well, provided that the stair is not a fire-fighting stair;

c) a reception desk or inquiry office area at ground or access level, provided that it is not in the only stair serving the building or part of the building. The reception or inquiry office area should be not more than 10 m^2 in area;

d) cupboards enclosed with fire-resisting construction, provided that they are not in the only stair serving the building or part of the building;

e) gas service pipes and associated meters.

*NOTE See also **38.1**.*

18.7 External escape stairs

Where more than one escape route is available from a storey or part of a building, one or more of the escape routes from the storey or part of the building may be by way of an external escape stair, provided that there is at least one internal escape stair from every part of each storey (excluding plant areas) and that the external stair(s) meet the following recommendations.

NOTE A full enclosure is not necessary. The extent of enclosure needed will depend on the location of the stair and the degree of protection given to the stair by the building itself. Trace heating is acceptable but needs to be maintained throughout the life of the building and be treated to the same standard as emergency lighting and provided with thermostatic control to operate in cold weather.

If the building (or part of the building) is served by a single access stair, that stair may be external provided that the following measures are incorporated.

a) All doors giving access to the external stair should be fire-resisting and self-closing, except that a fire-resisting door is not needed at the head of any stair leading downwards where there is only one exit from the building onto the top landing.

b) Any part of the external walls within 1 800 mm of (and 9 m vertically below), the flights and landings of an external escape stair should be of fire-resisting construction, except that the 1 800 mm dimension may be reduced to 1 100 mm above the top level of the stair if it is not a stair up from a basement to ground level (see Figure 15).

c) Any part of the building (including any doors) within 3 m of the escape route from the stair to a place of relative or ultimate safety should be provided with protection by fire-resisting construction.

d) Glazing in areas of fire-resisting construction [see c)] should also be fire-resisting to meet the criteria for both integrity and insulation, and should be fixed shut.

e) Where a stair is more than 6 m in vertical extent it should be protected from the effects of adverse weather conditions.

18.8 Methods of vertical escape for disabled people

18.8.1 General

The preferred method of evacuation for disabled people is by horizontal evacuation to the outside of the building or another fire compartment or by evacuation lift. If these are not available or not in operation, then it might be necessary to carry a person with limited mobility up or down the escape stair. Means of escape for disabled people may comprise a combination of structural provisions (e.g. lifts, refuge areas, ramps) and management procedures (e.g. assisted escape). A strategy should be designed to enable a flexible response to different situations.

Even with extended distances (where additional means of support are included), most disabled people are expected to be able to reach a place of relative safety without assistance. However certain people, such as some wheelchair users, cannot negotiate stairs unaided. The following subclauses give advice on additional measures that can be taken to aid the evacuation of disabled people.

18.8.2 Escape using a lift

18.8.2.1 Evacuation lifts

*NOTE See also **16.7.1**.*

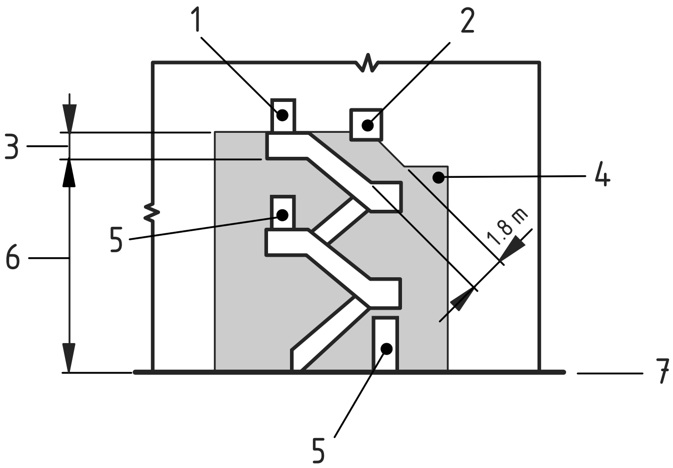
If an evacuation lift is provided, it should conform to Annex G.

18.8.2.2 Other lifts

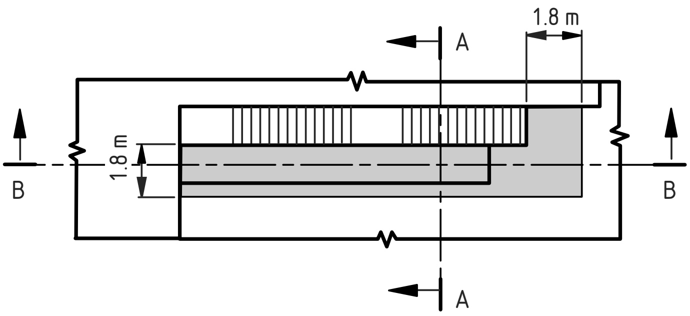
NOTE See also Annex G.

Lifts should not be used for general evacuation, but they may be used for the evacuation of disabled people. There are instances where lifts not designed as evacuation lifts may be used for the evacuation of disabled people; further guidance is given in **46.9**.

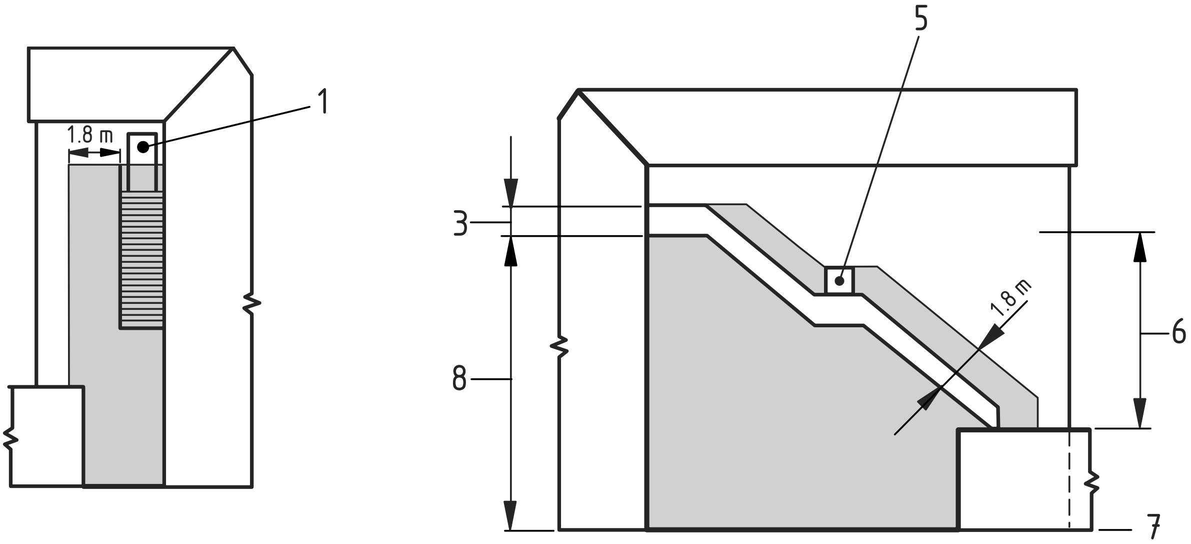
Figure 15 **Fire resistance of areas adjacent to external stairs**



a) Example 1



Plan



Section A–A

Section B–B

b) Example 2

Key

1 No fire resistance needed for door
2 Window with 30 min fire-resisting construction
3 1 100 mm zone above top landing
4 1 800 mm zone of fire-resisting construction at side of stair
5 Self-closing fire door with 30 min fire-resisting construction
6 6 m maximum height of stair without weather protection
7 Ground level or a roof or podium served by an independent stairway
8 9 m zone of fire-resisting construction below stair

18.8.3 Evacuation by stairs

If a stair is to be used for conveying disabled people up or down, the staircase design should reflect the evacuation strategy to be adopted.

*NOTE See also **46.10**.*

The management plan of a building should specify the procedure to be used for carrying disabled people up or down stairs where this is necessary. Staff should be identified and trained to convey disabled people up and/or down the evacuation stair.

18.8.4 Refuges

The use of refuges within a building can be of great advantage in the evacuation of disabled people as it enables their escape to be managed in a way that does not hinder that of other users of the building.

*NOTE See also **46.8**.*

If a refuge is provided, it should conform to Annex G.

19 Additional fire protection measures

19.1 General

The provision of automatic sprinklers is covered in **6.5** and affects the risk profile, which needs to be determined at an early stage (see Clause **6**). This should not be confused with additional fire protection measures.

NOTE The authority having jurisdiction is also likely to review and assess any changes.

Every building should incorporate the minimum level of fire protection measures recommended in Clauses **16** to **18**. However, if additional fire protection measures are provided as described in **19.2** and **19.3**, it is permissible to increase the travel distance (Table 12) and reduce the door widths (Table 13) and stair widths (Table 15) in accordance with those subclauses, subject to the maximum variations given in **19.4**. Any such increase/reduction should, however, be carefully reviewed and assessed by the designers. Two worked examples are given below, for the same building risk profile, one with and one without sprinklers.

EXAMPLE (without sprinklers) For travel distances the baseline is Table 12. If a shop sales area with risk profile B3 is fitted with a smoke detection system and a voice alarm giving evacuation instructions, the maximum two-way travel distance may be increased by 15% from 40 m to 46 m. Similarly the maximum one-way travel distance may be increased from 16 m to 18.4 m. Using Table 16, if the ceiling height is between 4 m and 5 m, an additional 10% may be added, to bring the limits to 50.6 m and 20.24 m. In Table 17, the limits are 60 m and 20 m for two-way and one-way travel distances, so in this example the limits would be 50.6 m and 20 m.

For the same shop, the minimum door width per person is 6.0 mm in accordance with Table 13 for risk profile B3. Fitting a smoke detection system and a voice alarm giving evacuation instructions permits the width to be reduced by 15% to 5.1 mm per person. Using Table 16, if the ceiling height is between 4 m and 5 m, the width may be reduced an additional 10% to 4.59 mm. This is less than the minimum value for risk profile B3 of 5.3 mm given in Table 18, so in this example the minimum limit of 5.3 mm should be used.

If the shop has two storeys (i.e. one above ground and thus one level of stairs), the minimum width per person for the escape stairs is 7.0 mm for risk profile B3 in accordance with Table 15. Fitting a smoke detection system and a voice alarm giving evacuation instructions permits the width to be reduced by 15% to 5.95 mm per person. Using Table 16, if the ceiling height is between 4 m and 5 m, the width may be reduced an additional 10% to 5.35 mm. This is greater than the minimum value for risk profile B3 of 5.3 mm given in Table 18 and should thus be used.

EXAMPLE (with sprinklers) For travel distances the baseline is Table 12. If a shop sales area with risk profile B3 is fitted with sprinklers its risk profile becomes B2 and the maximum two-way travel distance is increased from 40 m to 50 m. Similarly the maximum one-way travel distance may be increased from 16 m to 20 m. If a smoke detection system and a voice alarm giving evacuation instructions are also fitted, the maximum two-way travel distance may be increased by 15% from 50 m to 57.5 m. Similarly the maximum one-way travel distance may be increased from 20 m to 23 m. Using Table 16, if the ceiling height is between 4 m and 5 m, an additional 10% may be added, to bring the limits to 63.25 m and 25.3 m. In Table 17 the limits are 75 m and 24 m for two-way and one-way travel distances, so in this example the limits would be 63.25 m and 24 m.

For the same shop with sprinklers, the minimum door width per person is 4.1 mm in accordance with Table 13 for risk profile B2. Fitting a smoke detection system and a voice alarm giving evacuation instructions permits the width to be reduced by 15% to 3.48 mm per person. Using Table 16, if the ceiling height is between 4 m and 5 m, the width may be reduced an additional 10% to 3.13 mm. This is less than the minimum value for risk profile B2 of 3.3 mm given in Table 18, so in this example the minimum limit of 3.3 mm should be used.

If the shop has two storeys (i.e. one above ground and thus one level of stairs) and is sprinklered, the minimum width per person for the escape stairs is 4.8 mm for risk profile B2 in accordance with Table 15. Fitting a smoke detection system and a voice alarm giving evacuation instructions permits the width to be reduced by 15% to 4.08 mm per person. Using Table 16, if the ceiling height is between 4 m and 5 m, the width may be reduced an additional 10% to 3.67 mm. This is greater than the minimum value for risk profile B2 of 3.3 mm given in Table 18 and should thus be used.

19.2 Automatic detection and informative warning systems

The provision of automatic smoke detection systems can be of significant benefit in terms of providing early warning for the occupants. If such systems are installed they should be designed and installed in accordance with BS 5839-1.

NOTE 1 The speed of response is likely to vary with different types of occupancy: for example, in an office building where the occupants are familiar with the building layout and receive regular training, they are likely to respond relatively quickly to a fire alarm; whereas in a shop where the occupants are unfamiliar with the layout and focused on their personal business, they will respond much more slowly and might not begin evacuation until requested to do so by the staff.

The response of occupants of a building is generally enhanced by the installation of a fire warning system that provides information about a fire incident. In circumstances where the occupants might be unaware of a fire they will rely upon the level of information given by the warning system in making the decision to evacuate or not.

Depending on the type of occupancy and level of management within the building, the provision of an automatic detection and alarm system, primarily utilizing smoke detectors and incorporating an informative warning system such as a voice alarm, might allow longer travel distances and narrower doors.

*NOTE 2 Where detection and warning systems are required as part of the minimum package of fire protection measures recommended in Clause **16**, no variation is permitted to the travel distances, door widths, corridor widths and stair widths recommended therein.*

Where a clear benefit resulting from the addition of detection and warning systems is demonstrated and is appropriate to the circumstances, a 15% increase in allowable travel distance and a 15% reduction in door width, corridor width and stair width can be applied.

19.3 Effect of ceiling heights

Rooms with high ceilings are safer than rooms with lower ceilings as they have a greater capacity to hold smoke and delay the time taken to fill with smoke to a level that affects escape.

For rooms with high ceilings, it is permissible to increase the travel distance and decrease the door width, corridor width and stair width, provided that the increase/reduction is no more than the percentages given in Table 16 and that the entire escape route, with the exception of corridors and lobbies, has a high ceiling. This flexibility is only appropriate when a full account is taken of the risk presented. i.e. position, height and nature of fire load.

The height of the room should be measured clear of obstructions such as roof eaves and downstand beams.

Table 16 **Permissible variations in travel distance, door width, corridor width and stair width with ceiling height**

Room height	**Maximum permissible increase in travel distance and reduction in door width, corridor width and stair width**	
	All risk profiles except A4, B4 and C4 [A]	**Risk profiles A4, B4 and C4** [A]
m	%	%
⩽3	Not allowable	Not allowable
>3, ⩽4	5	Not allowable
>4, ⩽5	10	Not allowable
>5, ⩽6	15	Not allowable
>6, ⩽7	18	Not allowable
>7, ⩽8	21	Not allowable
>8, ⩽9	24	Not allowable
>9, ⩽10	27	Not allowable
>10	30	Not allowable

[A] See Table 4.

19.4 Maximum acceptable variations

19.4.1 General

The percentage variations given in **19.2** and **19.3** may be aggregated, provided that the result is within the limits given in **19.4.2** to **19.4.4**.

19.4.2 Travel distances

Travel distances should not exceed the maximum distance given in Table 17 for the appropriate risk profile.

Table 17 **Maximum travel distances when additional fire protection measures are provided**

Risk profile	Maximum permissible travel distance	
	Two-way travel m	One-way travel m
A1	90	30
A2	75	24
A3	60	22
A4 [A]	Not applicable [A]	Not applicable [A]
B1	90	28
B2	75	24
B3	60	20
B4 [A]	Not applicable [A]	Not applicable [A]
C1	37	18
C2	27	13
C3 [A]	18	9
C4 [A]	Not applicable [A]	Not applicable [A]

[A] See Table 4.

19.4.3 Door and corridor widths

Door and corridor widths should be not less than the value given in Table 18 for the appropriate risk profile, subject to the minimum width recommendations in **17.6.1**.

Table 18 **Door widths when additional fire protection measures are provided**

Risk profile	Minimum door width per person mm
A1	2.4
A2	3.0
A3	4.1
A4 [A]	Not applicable [A]
B1	2.4
B2	3.3
B3	5.3
B4 [A]	Not applicable [A]
C1	2.4
C2	3.3
C3 [A]	5.3
C4 [A]	Not applicable [A]

[A] See Table 4.

19.4.4 Stair width

The stair width should be not less than the absolute minimum defined in Table 15 and the available width per person should be not less than 75% of the value given in Table 16.

Section 6: Access and facilities for fire-fighting

NOTE 1 This section is not applicable to buildings under construction.

*NOTE 2 This standard does not currently map the provisions in this section against risk profile. Where it is proposed to vary the provisions in Section **6** it is essential that early liaison and agreement is obtained from the fire and rescue service.*

20 General recommendations for fire-fighting facilities

Fire-fighters need to be able to reach a fire quickly, with their equipment. Physical safety and lives, both those of the fire-fighters and those of the occupants of the building, and the preservation of the building and its contents, can be jeopardized by delays in reaching the area of the fire.

In designing new buildings and the provisions for the evacuation of occupants, consideration should be given to the requirements for fire and rescue service access into and around buildings for fire-fighting purposes.

NOTE 1 The exact choice of facilities depends on the use, size or layout of the building, the nature of its contents, and the site upon which it is situated.

Fire-fighting facilities should be selected and designed to assist the fire and rescue service in protecting life, protecting fire-fighters, reducing building losses, salvaging property and goods and minimizing environmental damage. Early consultation with appropriate approving authorities (including the fire and rescue service and building control bodies) is recommended when deciding which facilities should be provided.

Fire-fighting facilities should include, where appropriate:

a) the provision of vehicular access for fire appliances to the perimeter of the building or site;

b) provision of easy and speedy entry to the site and/or the interior of the building for fire-fighters and their equipment;

NOTE 2 The usual fire-fighting medium is water, but other media might be required.

c) provision of and access to sufficient supplies of a fire-fighting medium;

d) means of enabling fire-fighters, once they have entered a building, to reach any point within that building in the shortest possible time, including the provision of fire-fighting lifts if appropriate;

e) means of ensuring that once fire-fighters have arrived at a location within a building, they can remain there in relative safety whilst they carry out their fire-fighting operations;

f) provision for fire and rescue service communications;

g) provision of facilities to release, or extract, smoke and heat from the building or site;

h) provision for removing spent fire-fighting extinguishing medium.

21 Facilities for fire-fighting

21.1 General

Since the ladders on most modern fire and rescue service vehicles only reach a maximum height of 11 m, a fire within buildings with a storey height of over 11 m necessitates the provision of additional facilities to avoid delay and to provide a sufficiently secure operating base to allow effective action to be taken.

21.2 Fire-fighting shafts

21.2.1 Provision of fire-fighting shafts

Fire-fighting shafts should be provided in tall buildings, buildings with deep basements, and buildings with large floor areas.

In large complexes, fire-fighting shafts may serve separate parts of the complex. It is important that any arrangement of the fire-fighting shafts is logical and simple, so that fire and rescue service personnel have no difficulty in finding the fire-fighting shafts serving the areas they need to reach.

At least one fire-fighting shaft should be provided in each of the types of building shown in Table 19 (for numbers of fire-fighting shafts, see **21.2.2**), and each fire-fighting shaft should contain all of the appropriate facilities for the type of building.

Table 19 **Provision of fire-fighting shafts**

Type of building (qualifying storeys)	**Content of fire-fighting shaft**
Buildings with a height of 11 m or more, but less than 18 m	Escape stair Unvented fire-fighting lobby provided with a fire main
Buildings intended to be used as shops, factories or for assembly and recreation where the height of the topmost storey exceeds 7.5 m, with the floor area of any storey above the ground storey not less than 900 m^2	Fire-fighting stair Fire-fighting lobbies provided with a fire main
Buildings or parts of buildings [A)] where the height of the surface of the floor of the topmost storey (excluding any storey consisting entirely of plant rooms) exceeds 18 m	Fire-fighting stair Fire-fighting lobbies provided with a fire main Fire-fighting lift installation
Buildings where the depth of the surface of the floor of the lowermost storey exceeds 10 m	Fire-fighting stair Fire-fighting lobbies provided with a fire main Fire-fighting lift installation
Buildings where there are two or more basement levels, each with a floor area exceeding 900 m^2	Fire-fighting stair Fire-fighting lobbies provided with a fire main

A) The reference to parts of buildings covers situations such as tower blocks rising above a podium.

21.2.2 Number of fire-fighting shafts

A sufficient number of fire-fighting shafts should be provided to meet the maximum hose distances set out in **21.2.3**, and at least two fire-fighting shafts should be provided in buildings with a storey of 900 m^2 or more in area.

21.2.3 Siting of fire-fighting shafts

Fire-fighting shafts should serve every storey through which they pass, although the fire-fighting lift need not serve any storey on which there is no entrance to any accommodation, or the topmost storey of the building if it consists exclusively of plant rooms (see **21.3.4.1**).

Wherever possible, fire-fighting shafts should be sited against an exterior wall. If this is not possible, the route from the fire and rescue service entrance to the fire-fighting shaft should be as short as possible, and should be protected by fire-resisting construction to ensure that fire does not affect the route or cut off the means of escape for fire and rescue service or other personnel within the building.

Fire-fighting shafts should be located to meet the maximum hose distances set out in a) and b) below.

a) If the building is fitted throughout with an automatic sprinkler system in accordance with BS EN 12845, then sufficient fire-fighting shafts should be provided such that every part of every qualifying storey is no more than 60 m from a fire main outlet in a fire-fighting shaft, measured on a route suitable for laying hose.

b) If the building is not fitted with sprinklers, then every part of every qualifying storey should be no more than 45 m from a fire main outlet contained in a protected stairway and 60 m from a fire main in a fire-fighting shaft, measured on a route suitable for laying hose.

NOTE 1 Qualifying storey means a storey that meets the criteria in Table 19, e.g. floors with a height of more than 11 m, or basements more than 10 m in depth.

NOTE 2 In order to meet the 45 m hose criterion in b), it might be necessary to provide additional fire mains in escape stairs. This does not imply that these stairs need to be designed as fire-fighting shafts.

NOTE 3 It is not necessary for lobbies to be provided to escape stairs solely to accommodate dry riser outlets. The riser outlets may be sited on landings or half-landings to the stair, provided that sufficient space is available for their use by fire-fighters without obstructing the opening of doors.

21.2.4 Fire resistance of fire-fighting shafts

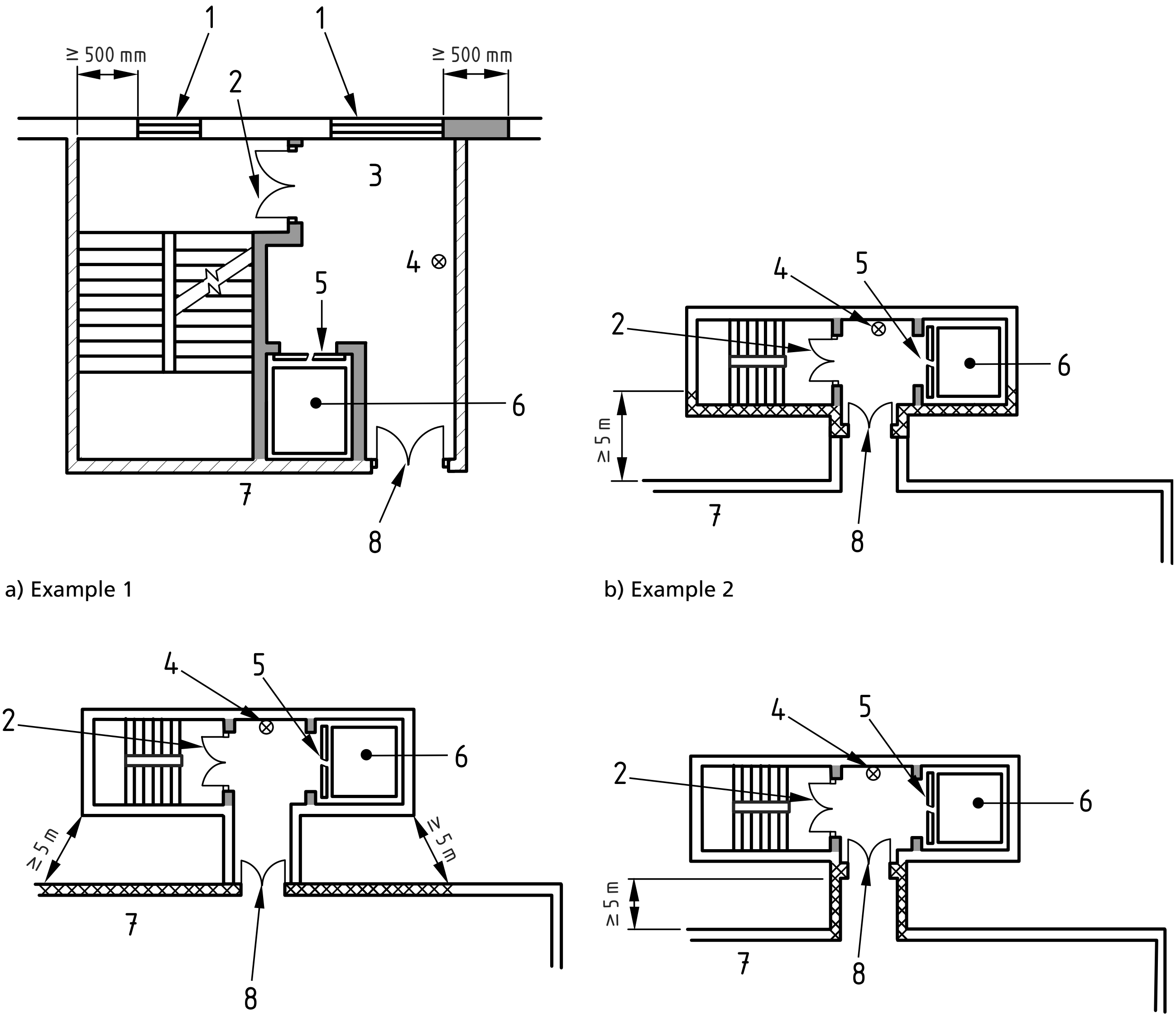
Where a fire-fighting shaft is sited against an exterior wall, if any glazed area or opening in the exterior wall of the fire-fighting shaft is less than 500 mm from the junction of the fire-fighting shaft with the exterior wall, then the fire resistance of the external wall immediately adjacent to the glazed area or opening should be not less than 1 h from both sides for a horizontal distance of 500 mm [see Figure 16a)].

If one or more walls enclosing a fire-fighting shaft are exterior walls, one of the following recommendations apply unless the distance between the fire-fighting shaft and the accommodation is not less than 5 m [see Figure 16b), 16c) and 16d)]:

a) either the side nearest the accommodation of any exterior wall facing or adjacent to the fire-fighting shaft should have a fire resistance of 2 h; or

b) the side internal to the fire-fighting shaft of any exterior wall facing or adjacent to the accommodation should have a fire resistance of 2 h.

Figure 16 **Examples of protection of the fire-fighting shaft from external fire**



a) Example 1

b) Example 2

c) Example 3

d) Example 4

Key

1	Openable areas
2	Fire door with 30 min fire resistance with smoke seal
3	Fire-fighting lobby
4	Fire main
5	Fire door with 30 min fire resistance without smoke seal
6	Fire-fighting lift
7	Accommodation
8	Fire door with 60 min fire resistance with smoke seal
	Minimum fire resistance of 1 h from both sides
	Minimum fire resistance of 2 h from outside the fire-fighting shaft and 1 h from inside the fire-fighting shaft
	Minimum fire resistance of 2 h from accommodation

The stair from a fire-fighting shaft may be extended into a part of the building not requiring a fire-fighting shaft provided that either:

1) the fire-fighting shaft is extended accordingly, including the provision of fire-fighting lobbies and any fire main; or
2) the extension to the stair is separated from the fire-fighting shaft by 2 h fire-resisting construction.

21.2.5 Resistance to damage of enclosing and separating partitions

Unless constructed of materials such as brick or concrete, partitioning should satisfy the criteria for conformity given in Table 20 when tested in accordance with BS 5234-2.

NOTE The tests are carried out on a test specimen between 4.5 m and 6.0 m in length incorporating an 1 100 mm wide doorset (650 ± 50) mm from one end with a 900 mm wide partition fixed at right angles to the other end. The way in which the components are fixed to each other needs to be in accordance with the supplier's recommendations with regard to their nature, type, position and spacing.

The test specimen is to be mounted in a rigid rig (such that the application of a load of 2 kN at any point, in addition to any load imposed by the test specimen, does not result in a deflection exceeding 1 mm or lateral residual movement exceeding 0.1 mm) and subjected to the tests given in Table 20 in the order in which they are listed.

Table 20 **Tests for partitions**

Test	Severity	Criteria for compliance
a) Stiffness [A]	500 N	No significant damage, maximum deflection [B] 10 mm
b) Small hard body impact [C]:		
1) surface damage	10 N·m	No significant damage
2) perforation	30 N·m	No significant damage
c) Large soft body impact [D]	120 N·m	No significant structural damage

[A] Force applied via a 150 mm diameter plate.
[B] Deflection of the partition from the vertical.
[C] Body is a 50 mm steel sphere.
[D] Body is spheroconical bag 600 mm × 400 mm filled with hardened glass beads.

21.2.6 Flooring and floor coverings within the fire-fighting shaft

NOTE As the slip resistance of resilient floor surfaces is reduced by contamination by dust or materials such as oils or grease, it is essential that they are cleaned frequently. The flammability of any textile floor covering needs to be low.

All floorings and floor coverings should be chosen so as to minimize slipperiness when wet, and resilient floor surfaces should be maintained in accordance with BS 6263-2, with only emulsion polish (i.e. not wax polish) being used.

Textile floor coverings should:

a) when tested, together with any underlay, in accordance with BS 4790, using the test procedure reflecting the method used for securing the floor covering to the floor, either

   1) not ignite; or

   2) have effects of ignition on both the use- and under-surfaces not extending beyond a circle of radius 35 mm centred on the central point of application of the nut;

b) be firmly secured to the floor, with any adhesive used being non-water soluble;

c) be interrupted at all doors to and within the fire-fighting shaft along the line of the threshold of the doorway with a metal or other non-combustible strip not less than 50 mm wide.

21.2.7 Layout of fire-fighting shafts

21.2.7.1 Access level

The layout of the fire-fighting shaft at fire and rescue service access level should be such that fire-fighters entering the fire-fighting lift and persons escaping down the fire-fighting stair do not obstruct each other.

Entry to a fire-fighting shaft at fire and rescue service access level should be available either:

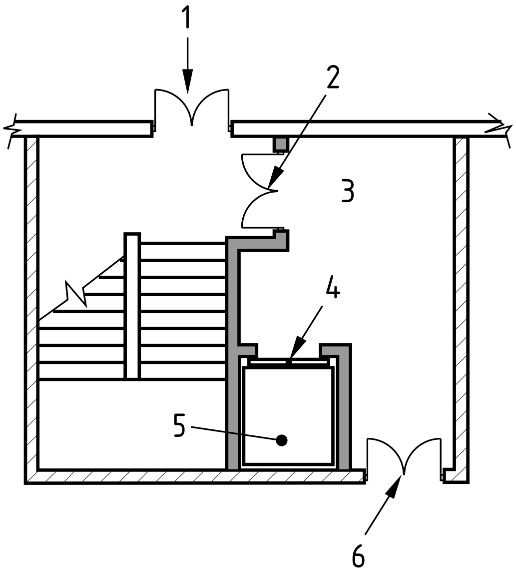
a) directly from the open air (see Figure 17); or

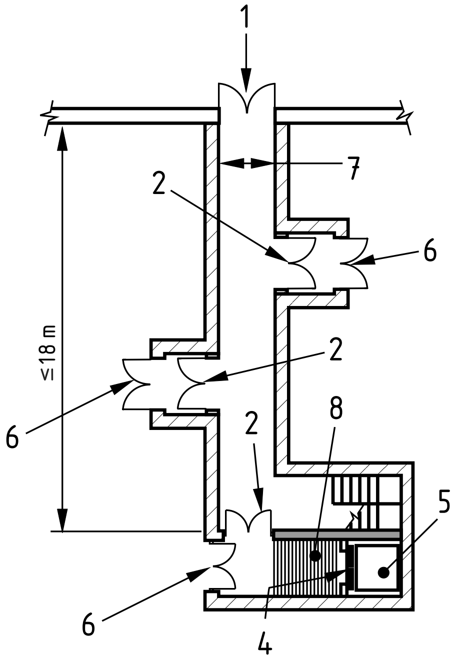
b) by way of a protected corridor not exceeding 18 m in length. The corridor is deemed to be part of the fire-fighting shaft, and any access to it from the accommodation should be by way of protected lobbies.

It should not be necessary for persons escaping down the stair to pass through the fire-fighting lobby at fire and rescue service access level. Where a protected corridor for fire-fighting access also forms part of the means of escape from the accommodation, it should be 500 mm wider than that required for means of escape purposes (to allow room for fire and rescue service personnel to move towards the fire-fighting shaft), and the fire-fighting lobby should have a minimum area of 5 m^2 clear of any escape routes so that it can act as a fire and rescue service mustering point [see Figure 17a)].

The fire-fighting lobby at fire and rescue service access level should be large enough to act as a command post where fire-fighters and fire-fighting equipment can be safely assembled. A building might have a building control centre that could be used by the fire and rescue service, or the fire and rescue service might use a mobile command centre, etc., and such operational details should be discussed by the developer with the fire and rescue service.

Figure 17 **Typical fire-fighting shaft layout at fire and rescue service access level**

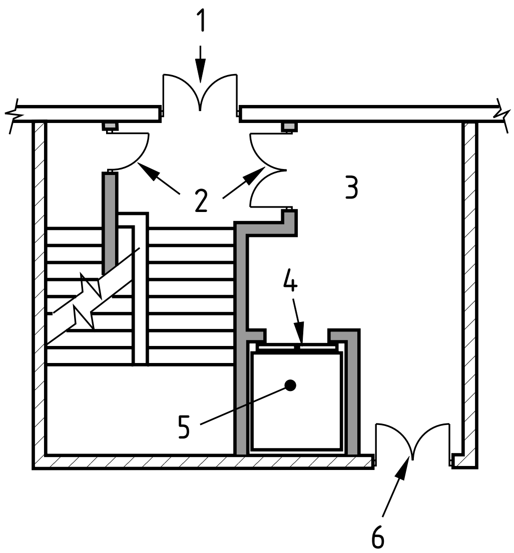


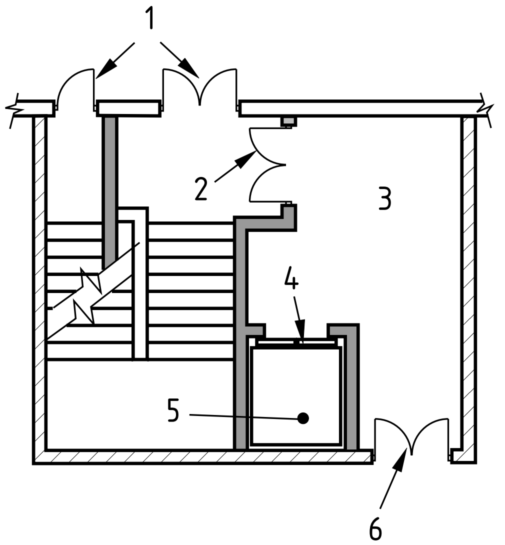


i) Access directly from open air

ii) Access via a corridor

a) Fire and rescue service access at lowest storey





NOTE The corridor should not be used as a circulation space.

i) Access to basement via stair to upper storeys

ii) Access direct to basement

b) Fire and rescue service access directly from open air ground level in a building with basements

Key

1	Fire and rescue service access at fire and rescue service access level
2	Fire door with 30 min fire resistance with smoke seal
3	Fire-fighting lobby
4	Fire door with 30 min fire resistance without smoke seal
5	Fire-fighting lift
6	Fire door with 60 min fire resistance with smoke seal
7	Width of corridor 500 mm wider than needed for means of escape
8	Fire and rescue service mustering point (minimum 5 m^2)
	Minimum fire resistance of 1 h from both sides
	Minimum fire resistance of 2 h from outside the fire-fighting shaft and 1 h from inside the fire-fighting shaft

21.2.7.2 All other levels

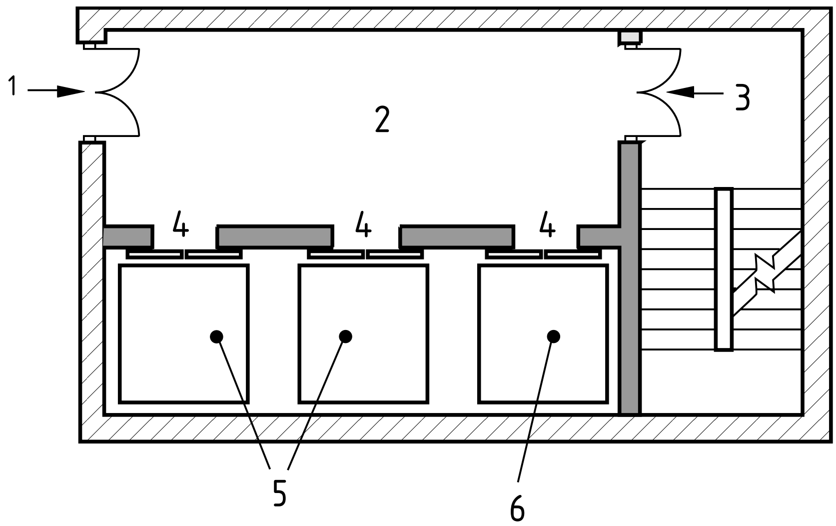
It is essential that the fire-fighting lift, lobbies and stair are within a protected enclosure and that the fire-fighting stair is as close as possible to the fire-fighting lift. Access should be provided at all levels served by the fire-fighting shaft.

Access to the accommodation from a fire-fighting lift or stair should be through a fire-fighting lobby, as a single fire door cannot provide adequate protection to the fire-fighting stair and lift from a fire in the accommodation. The lobby also serves as a bridgehead from which fire-fighting operations can be mounted. The doors between the fire-fighting stair and fire-fighting lobby should be kept free from any fastenings. Doors from the fire-fighting lift or stair into the accommodation should be readily and easily openable by the fire and rescue service.

NOTE The "Do not use for goods or refuse" sign is a building sign and not part of the lift as defined in BS EN 81-72.

Goods lifts and service lifts should not be located within fire-fighting shafts. Passenger lifts should not be located within a fire-fighting shaft unless the lift cars are constructed in accordance with BS EN 81-72, are clearly and conspicuously marked with a notice conforming to BS 5499-1 stating "Fire-fighting lift: Do not use for goods or refuse", and have access only from a fire-fighting lobby (see Figure 18).

Figure 18 **Passenger lifts within a fire-fighting shaft**



Key

1	Fire door with 60 min fire resistance with smoke seal
2	Fire-fighting lobby
3	Fire door with 30 min fire resistance with smoke seal
4	Fire door with 30 min fire resistance without smoke seal
5	Passenger lifts
6	Fire-fighting lift
(solid grey)	Minimum fire resistance of 1 h from both sides
(hatched)	Minimum fire resistance of 2 h from outside the fire-fighting shaft and 1 h from inside the fire-fighting shaft

Only services associated with the fire-fighting shaft should pass through or be contained within the fire-fighting shaft. A fire-fighting shaft should not contain any cupboards or provide access to service shafts serving the remainder of the building.

If a fire-fighting shaft contains sanitary accommodation, such accommodation should not:

a) be used as a cloakroom;

b) contain any portable heating appliances;

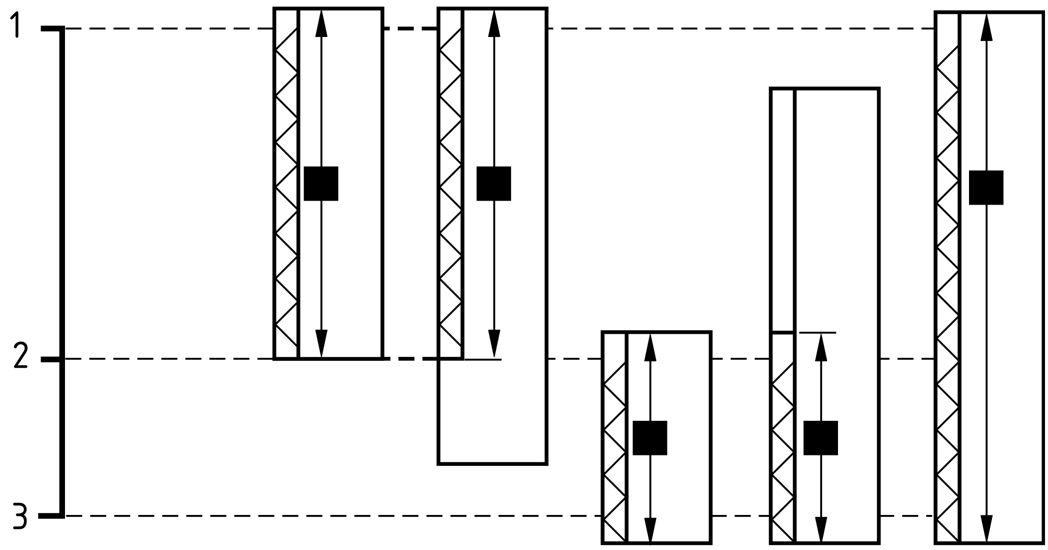
c) contain any gas appliance other than a water heater or an incinerator.

21.3 Fire-fighting stairs and lifts

21.3.1 General

The minimum extent of fire-fighting lifts and stairs in tall buildings and buildings with deep basements is shown in Figure 19.

Figure 19 **Minimum extent of fire-fighting stairs and lifts in tall buildings and buildings with deep basements**



Key

1 Tall building (>18 m)

2 Fire and rescue service access level

3 Building with deep basement (⩾10 m)

Extent of fire-fighting stair

Extent of fire-fighting lift

NOTE 1 A stair serving floors both above and below ground level should be separated at or about ground level (which might not necessarily be fire and rescue service access level) except where the staircase is pressurized.

NOTE 2 It is not necessary for floors above and below fire and rescue service access level to be served by the same stair.

NOTE 3 The lift need not serve the topmost storey if it consists exclusively of plant rooms.

NOTE 4 It is not necessary for floors above and below fire and rescue service access level to be served by the same lift.

The installation of a fire-fighting lift within a stair enclosure is not generally recommended, as it has the potential for increasing the fire load within a means of escape staircase. In the case of refurbished buildings where design constraints make the provision of a fire-fighting lift in a fire-fighting lobby impracticable then, subject to additional measures (see **21.3.4.2**), a lift may be sited within its own fire-resisting shaft in the fire-fighting stair enclosure.

Because it is the line of retreat if the fire-fighting lift fails, the fire-fighting stair needs to serve every storey served by the fire-fighting lift. The lift and stair are also used together during fire-fighting operations.

21.3.2 Fire-fighting stairs

Fire-fighting stairs should be sufficiently wide to be easily used by fire-fighting personnel carrying fire-fighting equipment. Fire-fighting stair enclosures should be provided with facilities for smoke control (see **28.2**) to ensure that they remain relatively smoke-free.

To prevent smoke from basement storeys penetrating the stair enclosure above ground level, fire-fighting stairs serving floors both above and below ground level should be separated at ground floor level by a fire door (see Figure 17).

Fire-fighting stairs should be designed in accordance with BS 5395-1, with a width between the walls or balustrades of not less than 1.1 m. This width should be maintained clear for a vertical distance of 2.0 m, measured from the pitch line or landing floor level, with the following exceptions:

a) stringers, each intruding into the stair not more than 30 mm; and

b) handrails, each intruding into the stair not more than 100 mm.

The design of scissor stairs includes features that are not compatible with the recommendations for a fire-fighting staircase. Scissor stairs should not be used to form a fire-fighting staircase.

Emergency lighting in fire-fighting stair enclosures should conform to BS 5266-1 (see also Clause **29**).

21.3.3 Fire-fighting lobbies

A fire-fighting lobby serves the fire-fighting lift and an approach stair. A lobby has to be of sufficient size and design to enable the fire and rescue service to carry out the following tasks without undue congestion, but not so large as to encourage any form of storage or unauthorized use:

- use it as a command post;
- assemble fire-fighters and fire-fighting equipment;
- connect fire-fighting hoses to the fire main;
- access the fire floor;
- use it for floor-to-floor movement during fire-fighting operations; and
- use it as an assured and safe route of egress if the lift should fail or its reliability become uncertain.

Fire-fighting lobbies should have a clear floor area of not less than 5 m^2. The clear floor area should not exceed 20 m^2 for lobbies serving up to four lifts, or 5 m^2 per lift for lobbies serving more than four lifts. All principal dimensions should be not less than 1.5 m and should not exceed 8 m in lobbies serving up to four lifts, or 2 m per lift in lobbies serving more than four lifts.

The doors between the fire-fighting stair and fire-fighting lobby should be kept free from any fastenings, and doors from the fire-fighting lobby into the accommodation should be readily and easily openable by the fire and rescue service.

NOTE These signs are building signs and not part of the lift as defined in BS EN 81-72.

Fire-fighting lobbies containing lifts should be clearly and conspicuously marked with a notice conforming to BS 5499-1, stating "Fire-fighting lift lobby: do not obstruct lift doors. Do not use for storage". In buildings where the fire-fighting lift is the only lift, an additional notice should be provided stating "Do not leave goods in lift".

The layout of a fire-fighting lobby and the positions of all doors, should reduce, as far as is practicable, risks arising from:

a) the creation of dead ends (in which fire-fighters can become cut off from access to the safety of the stair or become disorientated in poor visibility);

b) the direct exposure of lift landing doors to the effects of fire through the doorway leading into the accommodation.

In buildings containing flats, protected ventilated common corridors or lobbies are expected to protect the fire-fighting stairs without the need to provide additional dedicated ventilated lobbies. However, where a fire-fighting shaft is pressurized (see **28.2.2**), a lobby should be provided in accordance with BS EN 12101-6.

Fire-fighting lobbies should not form part of a general circulation route within any storey except for circulation between storeys and to sanitary accommodation. Such sanitary accommodation should not:

- be used as a cloakroom;
- contain any portable heating appliances;
- contain any gas appliance other than a water heater or an incinerator.

Fire-fighting lobbies should be provided with facilities for smoke control (see **28.2**).

Emergency lighting in fire-fighting lobbies should conform to BS 5266-1 (see also **16.3**).

In shopping complexes, protected lobbies or protected corridors, connecting fire-fighting stairs to malls or other accommodation should be deemed to be fire-fighting lobbies if there is adequate space for fire-fighters to lay out their hose and connect it to the fire main outlet valve.

21.3.4 Fire-fighting lifts

21.3.4.1 General

A fire-fighting lift installation includes the lift car itself, the lift well and the lift machinery space, together with the lift control system and the fire and rescue service communications system.

Fire-fighting lift installations should conform to BS EN 81-72, and to BS EN 81-1 or BS EN 81-2 as appropriate for the particular type of lift.

NOTE 1 BS EN 81-72 refers to lifts serving all floors. However, fire and rescue services in the UK advise that fire-fighting lifts serve the storeys that fire and rescue service personnel need to reach (see Table 19).

NOTE 2 The fire-fighting lift landing doors are fire doors.

NOTE 3 If a fire-fighting lift does not serve the topmost storey of a building, the fire-fighting lobby on the topmost storey serves the fire-fighting stair only. If the topmost storey consists only of the fire-fighting lift machinery space, no lobby is necessary.

A fire-fighting lift, unlike a normal passenger lift, is designed to operate so long as is practicable when there is a fire in parts of the building beyond the confines of the fire-fighting shaft, as it is used to transport fire-fighters and their equipment to a floor of their choice.

NOTE 4 The lift may be used in normal times as a passenger lift by the occupants of the building but, in order to prevent the risk of the entrance being obstructed when the lift is required to go into the fire-fighting mode, it is essential that it is not used for moving refuse, nor for moving goods. In buildings provided with a single lift, its use for the transport of goods needs to be avoided unless essential, lift lobbies need to be kept clear, and when used for moving goods it is essential that the doors are not propped open.

It is essential that the lift doors are power-operated.

Fire-fighting shafts should be provided with fire-fighting lifts (see Figure 19) in:

a) buildings with deep basements (⩾10 m), in which case the fire-fighting shaft should serve fire and rescue service access level and all storeys below it;

b) tall buildings (⩾18 m), in which case the fire-fighting shaft should serve fire and rescue service access level and all storeys above it, although the fire-fighting lift need not serve any storey on which there is no entrance to any accommodation, or the topmost storey of the building if it consists exclusively of plant rooms;

c) buildings that are both deep and tall, in which case the fire-fighting shaft should serve all storeys, although the fire-fighting lift need not serve any storey on which there is no entrance to any accommodation, or the topmost storey of the building if it consists exclusively of plant rooms. Storeys below fire and rescue service access level may be served by a different fire-fighting lift from that serving the upper storeys, and any fire-fighting stair that serves levels both above and below ground level should be separated at ground level.

If a building contains separate units of accommodation with their entrances from common circulation spaces, e.g. as is the case with some flats, there should be access to each unit from a fire-fighting lift, either directly or via a common circulation space.

If a fire-fighting shaft contains a fire-fighting lift, the fire-fighting stair in that shaft should serve every storey served by the fire-fighting lift.

21.3.4.2 Fire-fighting lifts in stair enclosures in refurbished buildings

The fire-fighting lift should generally not be installed in the fire-fighting stair enclosure, but it is acceptable to do so, provided that it is not to be used as a goods or service lift, in the following circumstances (see Figure 20):

a) the building is being refurbished (see **21.3.1**); and

b) the building is put to non-residential use; and

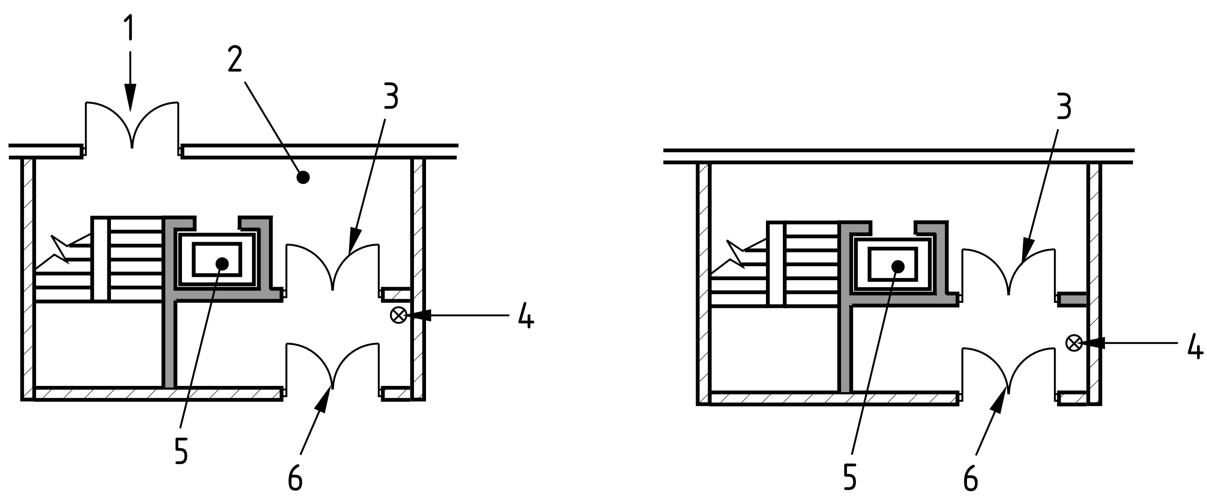
c) the fire-fighting lift is sited so that the movement of fire and rescue service personnel between the lift and the lobby does not impede the use of the stair by the building occupants during an evacuation; and

d) the building evacuation scheme is single-stage; and

e) if the lift is to be used as an evacuation lift, it conforms to the recommendations in **46.9**.

If the fire-fighting lift is installed in the fire-fighting stair enclosure, the fire-fighting shaft should not extend below ground level, and the lift well should be inspected monthly and any combustible materials removed.

Figure 20 **Fire-fighting lift within escape stair**



a) Access level

b) Accommodation level

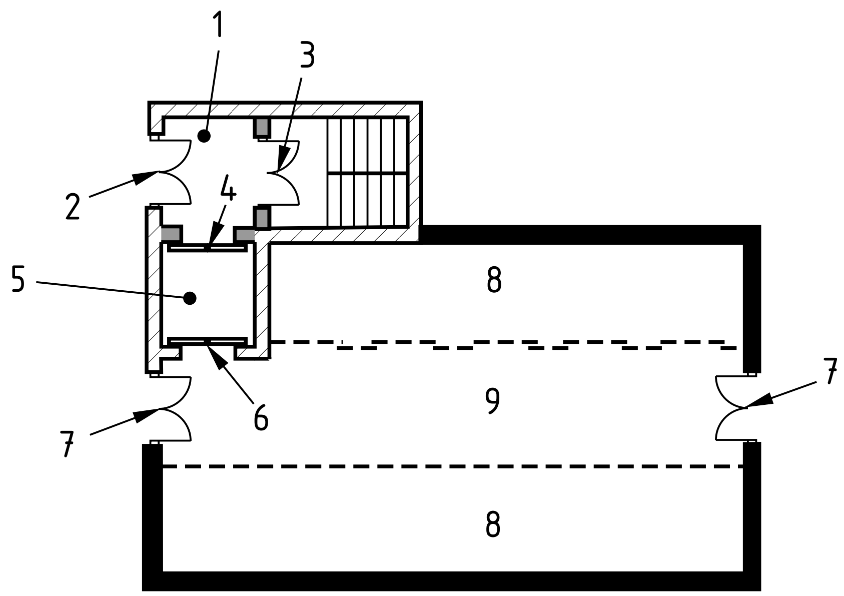
Key

1	Fire and rescue service access level
2	Fire and rescue service access lobby
3	Fire door with 30 min fire resistance with smoke seal
4	Fire main
5	Fire-fighting lift
6	Fire door with 60 min fire resistance with smoke seal
	Minimum fire resistance of 1 h from both sides
	Minimum fire resistance of 2 h from outside the fire-fighting shaft and 1 h from inside the fire-fighting shaft

21.3.4.3 Dual-entry fire-fighting lifts

Where it is impractical to locate all adjacent lifts within the fire-fighting shaft, a dual-entry fire-fighting lift may be provided with a separate fire-fighting lobby accessible through a second set of lift doors (see Figure 21).

Figure 21 **Example of fire-fighting shaft layout for a dual-entry fire-fighting lift**



Key

1	Fire-fighting lift lobby
2	Fire door with 60 min fire resistance with smoke seal
3	Fire door with 30 min fire resistance with smoke seal
4	Fire door with 30 min fire resistance without smoke seal
5	Fire-fighting lift
6	Fire door with 60 min fire resistance without smoke seal
7	Fire door with 30 min fire resistance with smoke seal – may be held open subject to the door being automatically released
8	Passenger lifts (or sanitary accommodation)
9	Main lift lobby
(grey)	Minimum fire resistance of 1 h from both sides
(hatched)	Minimum fire resistance of 2 h from outside the fire-fighting shaft and 1 h from inside the fire-fighting shaft
(black)	Minimum fire resistance of 30 min from both sides

However, because of the additional risks that this arrangement places on the safety of the fire-fighting shaft, a number of additional precautions need to be taken.

a) Certain additional facilities need to be provided by the lift control system (see BS EN 81-72:2003, **5.8.9**).

b) The number of dual-entry fire-fighting lifts serving any storey should not exceed half the total number of lifts for that storey.

c) The fire resistance of the lift landing door to the main lift lobby should be increased to 60 min.

d) Any storey served by a single fire-fighting lift should not be served by a dual-entry fire-fighting lift. Where a fire-fighting lift is dual-entry, the lift landing doors to the main lift lobbies should be separated from the accommodation by an enclosure with a fire resistance of not less than 30 min (see Figure 21). The doors to this enclosure should be self-closing, but not by means of rising butts. Means of overriding the self-closing device may be provided by a hold-open system incorporating an automatic release mechanism conforming to BS 5839-3 or BS EN 1155. The automatic release mechanism should release the door to close automatically in the event of:

   1) the detection of smoke by suitable automatic apparatus mounted at high level in the accommodation adjacent to a door to the main lift lobby enclosure;
   2) failure of a power supply;
   3) operation of a fire-fighting lift switch;
   4) operation of a fire alarm system;
   5) manual operation at a central control point;
   6) actuation of an automatic fire extinguishing system (e.g. a sprinkler system);
   7) the removal, for whatever reason, of a smoke detector in a fire detection zone protecting accommodation directly accessible from the fire-fighting shaft.

Such doors should be suitably marked on both sides, at approximately eye level, with the appropriate sign conforming to BS 5499-1.

21.3.4.4 Fire-fighting lift cars

NOTE As fire-fighting lifts are provided with two independent sources of power, except for some residential buildings, it is not necessary to provide facilities for emergency operation additional to those specified in BS EN 81.

The construction and design of fire-fighting lift cars, together with the installation of fire-fighting lifts, should conform to BS EN 81-72.

In buildings provided with more than one lift, fire-fighting lift cars should be clearly and conspicuously marked with a notice conforming to BS 5499-1 stating “Fire-fighting lift: Do not use for goods or refuse”.

In fire-fighting shafts with a pressure differential system in accordance with **28.2.2**, the lift doors should be capable of opening/closing against the maximum pressure difference attained when the system is fully operational.

21.3.4.5 Water protection of lift wells

NOTE The minimum flow rate from a fire main recommended in BS 9990 is 1 500 l/min, and this is considered to be representative of likely flow rates from other sources.

There have been several recorded occasions when water from a landing valve, hose lines, etc., has entered the lift well and caused malfunction of the installation when it reached electrical door interlocks, car controls, etc. It is therefore necessary to minimize both the effects of water on lift operations, and the probability of water entering the lift well in the first place.

To minimize the effect of water penetration, electrical equipment within the fire-fighting lift well and on the car should be protected against water in accordance with BS EN 81-72.

There are a number of ways in which water penetration can be avoided or minimized, and the method chosen should be appropriate to the building. Suitable methods include the provision of drainage channels and drainpipes, and/or laying the lift landing floor to a fall so that any water entering the lobby will not enter the lift well but will drain away down the stairs and/or into a smoke shaft and/or to gargoyles or scuppers on the outside of the building (see Annex L).

The provision of sprinkler heads within the fire-fighting lift well is not desirable. In lifts conforming to the recommendations given in this British Standard, it is unlikely that fire would arise in the lift well other than from combustibles within the car, which could not be reached by sprinkler discharge. Furthermore, any cooling effect from sprinkler discharge could not reliably control excessive temperatures in the lift well in the event of a fire developing there, which would make the lift unsafe to use. However, absence of sprinkler heads does not obviate the need for protection from water. Any sprinklers installed in the fire-fighting lobby should be sited so that they do not drench the lift landing doors or controls.

21.3.4.6 Fire-fighting lift machinery spaces

Machinery spaces for fire-fighting lifts should conform to all the relevant requirements of BS EN 81.

NOTE A similar degree of protection is necessary for power supplies, generators and all other apparatus essential for the operation of the fire-fighting lift.

It is essential that a fire in the fire-fighting lift machinery space does not lead to the fire-fighting shaft becoming smoke-logged, and that the risk of the operation of the fire-fighting lift machine being affected by water during fire-fighting operations is minimized. To achieve this, the machinery space and associated equipment for a fire-fighting lift should not be sited below the lift well, and should be protected from malfunction caused by water and be protected against fire in accordance with BS EN 81-72. The fire-fighting lift machinery space is most effectively protected by incorporation within the fire-fighting shaft. If the lift machine is sited directly within the lift well, thus obviating the need for a separate machinery space, then similar safeguards should be provided for the lift machine and associated equipment as for a conventional lift machinery space.

21.3.4.7 Fire-fighting lift control systems

21.3.4.7.1 General

Fire-fighting lift control systems should conform to BS EN 81-72. A fire-fighting lift switch should be provided to enable the fire and rescue service to obtain immediate control of the fire-fighting lift(s) in a fire-fighting shaft. Provision should be made to control access to the fire-fighting switch. If there are two or more lifts installed together, there should be clear indication as to which lift is the fire-fighting lift.

Lifts that are located in areas subject to vandalism should conform to BS EN 81-71.

21.3.4.7.2 Operation of the fire-fighting lift control system

Lifts in the fire-fighting shaft should operate normally until the fire-fighting lift switch is activated.

NOTE 1 When the fire-fighting lift is activated it immediately renders inoperative all call buttons both on the lift landings and in the lift cars, and brings the fire-fighting lift and other lifts in the fire-fighting shaft to the fire and rescue service access level. It is not necessary to interconnect separate or multiple groups of lifts with other fire-fighting lifts as it can be undesirable to disable the whole building.

NOTE 2 The locking shut of the landing doors is carried out as part of the normal lift operations. Operation of the fire-fighting lift is dependent on the successful locking shut of these doors.

If, as part of the fire strategy in a particular building, the fire-fighting lift (and any other lifts within the fire-fighting shaft) is brought to the fire and rescue service access level on operation of the fire alarm system, the lift car and landing controls should be disabled until the fire-fighting lift switch has been operated.

If a lift is travelling away from the fire and rescue service access level it should stop (without opening its doors) at the next available floor according to the lift speed and the minimum slow-down distance of the drive system. The lift should then reverse direction to travel without stopping to the fire and rescue service access level.

On arriving at the fire and rescue service access level, all lift doors in the fire-fighting shaft should open to allow any passengers to exit, and then remain open.

NOTE 3 It can be desirable to install a "Lift under fire and rescue service control" sign illuminated within each lift car, which remains illuminated until the fire-fighting lift switch is returned to the "0" position.

The fire-fighting lift should return as soon as practicable to the fire and rescue service access level. It should be possible for the fire-fighting lift (and any other lifts within the fire-fighting shaft) to be returned to fire and rescue service access level at any time by switching the fire-fighting lift switch from "1" to "0" (for a minimum of 5 s) and back to "1".

The car controls of the fire-fighting lift should become active only after it has arrived at the fire and rescue service access level and the fire-fighting lift switch has been operated. Once the fire-fighting lift has arrived at the fire and rescue service access level, its doors should open and it should then operate as follows.

a) Fire personnel entering the lift car should be able to register a call to any selected landing in the building by sustained pressure on a car control until the car doors have fully closed.

b) If a car control is released before the doors have fully closed, the doors should immediately reopen and the call should be cancelled.

c) Once the lift is moving, it should be possible to register additional calls on the car controls. The lift should travel in the direction of the first call registered, and should stop at the first floor encountered for which a call is registered.

d) The doors should remain closed unless they are operated by continuous pressure on the "door open" control. It should not be possible to open the doors without sustained pressure on the control.

NOTE 4 This allows fire and rescue service personnel to observe the situation immediately outside the lift landing doors in the fire-fighting lobby.

e) Release of the "door open" control before the doors are fully open should cause the doors to automatically re-close.

f) Once the doors are fully open they should remain open until a new call is registered at the car control station.

The operating of the lift should be independent of the switch position of:

- any collective control;
- any attendant's changeover switch or control;
- any emergency switch in the lift car;
- any caretaker's immobility switch;
- any security, commissionaire's, caretaker's or similar cut-out switch.

NOTE 5 When the fire-fighting lift is out of service, it is important that a "Lift out of service" sign be placed on the lift at fire and rescue service access level.

21.3.4.7.3 Changeover from primary to secondary supply after operation of the fire-fighting lift switch

*NOTE See also Clause **29**.*

On loss of the primary supply the lift, if travelling, comes to an emergency stop and the lights go out. The emergency lighting comes on immediately. There is then a delay of up to 30 s while the secondary supply is established, which is indicated by the restoration of the main lighting in the lift car. The system design should be in accordance with BS EN 81-72.

Changeover of electrical supplies should be in accordance with BS EN 81-72.

21.3.4.8 Fire-fighting lift communications systems

A lift communication system conforming to BS EN 81-72 should be provided as part of the fire-fighting lift installation and should be separate from the fire and rescue service communications system (see Clause **24**).

22 Vehicle access

22.1 General

Every building should be provided with suitable access for fire-fighting purposes; roadways should be constructed to allow access for fire appliances, and entry points to buildings should be readily identifiable to the fire and rescue service.

22.2 Buildings not fitted with fire mains

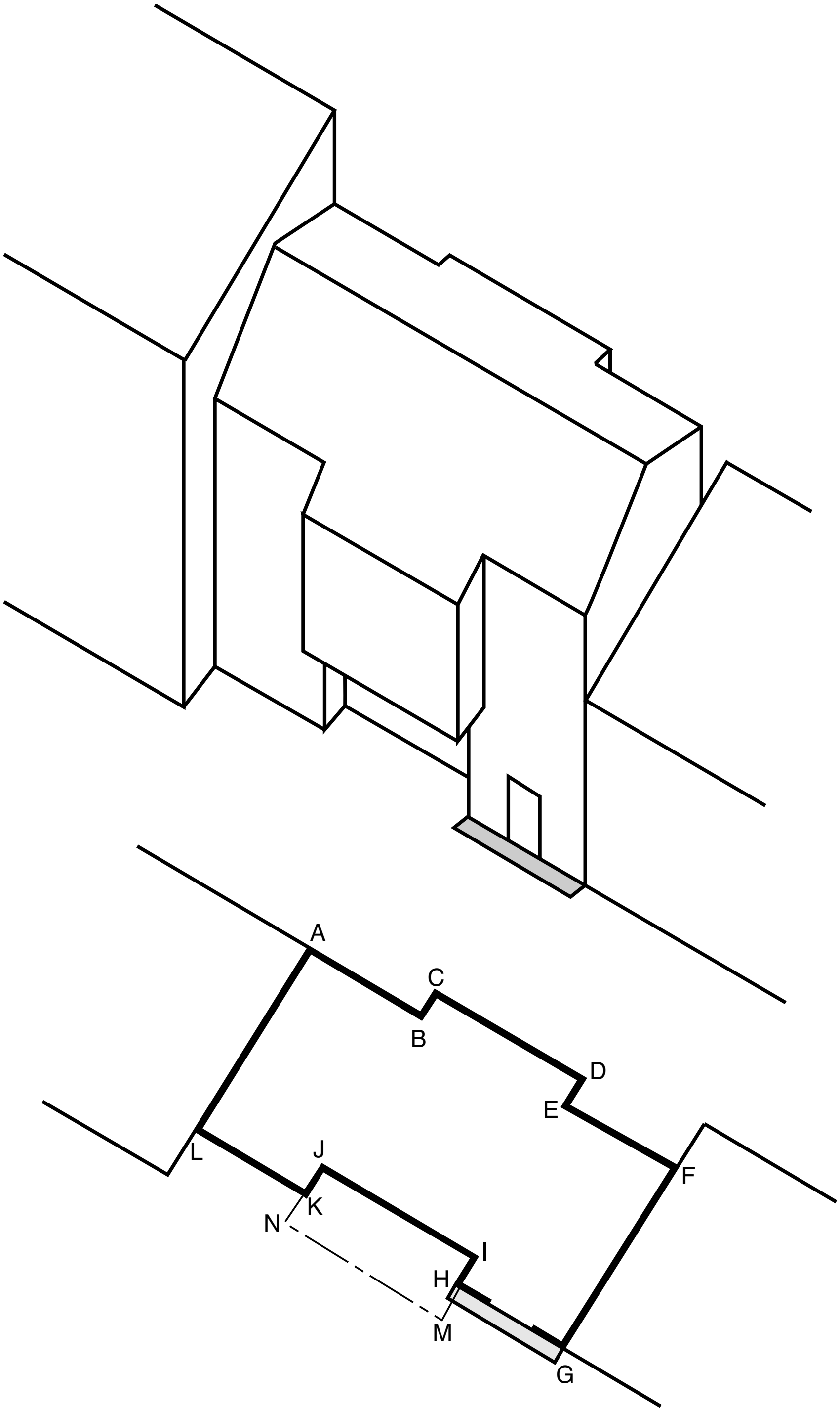
*NOTE For buildings with fire mains, see **22.4**.*

Vehicle access should be provided to small buildings (i.e. buildings up to 2 000 m^2 with a top storey less than 11 m above ground level) to within 45 m of every point on the projected plan area or "footprint" of the building (see Figure 22) or to 15% of the perimeter, whichever is the less onerous. Vehicle access to all other buildings that do not have fire mains should be provided in accordance with Table 21.

Every elevation to which vehicle access is provided should have a suitable door(s) not less than 750 mm wide giving access to the interior of the building. Doors should be provided such that there is no more than 60 m between each door and/or the end of that elevation (e.g. a 150 m elevation would need at least two doors).

For blocks of flats, vehicle access for a pumping appliance should be not more than 45 m from all points within each dwelling.

Figure 22 **Example of building footprint and perimeter**



Plan of building AFGL where AL and FG are walls in common with other buildings.

The footprint of the building is the maximum aggregate plan perimeter found by the vertical projection of any overhanging storey onto a ground storey (i.e. ABCDEFGHMNKL).

The perimeter of the building for the purposes of Table 21 is the sum of lengths of the two external walls, taking account of the footprint, i.e. (A to B to C to D to E to F) + (G to H to M to N to K to L).

If the dimensions of the building were such that Table 21 requires vehicle access, the shaded area illustrates one possible example of 15% of the perimeter.

*NOTE There should be a door into the building in this length (see **22.2**).*

If the building does not have walls in common with other buildings, the lengths AL and FG would be included in the perimeter.

Table 21 **Fire and rescue service vehicle access to buildings (excluding blocks of flats) not fitted with fire mains**

Total floor area of building [A)] m²	**Height to floor of top storey of building** m	**Type of appliance** [B)]	**Position of access** % of perimeter [C)]
<2 000	<11	Pump	— [D)]
	>11	Pump and high-reach	15 [E)]
2 000 to 8 000	<11	Pump	15 [E)]
	>11	Pump and high-reach	50 [E)]
8 000 to 16 000	<11	Pump	50 [E)]
	>11	Pump and high-reach	50 [E)]
16 000 to 24 000	<11	Pump	75 [E)]
	>11	Pump and high-reach	75 [E)]
>24 000	<11	Pump	100 [E)]
	>11	Pump and high-reach	100 [E)]

NOTE 1 Consultation with the relevant approving authority is advised on all matters concerning fire access. For Scotland, access is dictated by hydrant position.

NOTE 2 In the case of storage buildings, height should be measured to mean roof level.

A) The total floor area is the aggregate of the floor areas of all the storeys in the building.
B) "Pump" = pumping appliance; "high-reach" = aerial appliance, e.g. turntable ladder or hydraulic platform.
C) "Perimeter" refers to the face of the total length of all exposed perimeter walls.
D) See **22.2**.
E) Any perimeter wall (elevation) to which vehicle access is provided should have a door, not less than 750 mm wide, giving access to the interior of the building.

22.3 Access for high-reach appliances

Vehicle access to the exterior of a building is needed to enable high-reach appliances, e.g. turntable ladders and hydraulic platforms, and pumping appliances to supply water and equipment for fire-fighting and rescue activities.

NOTE The size and mass of fire appliances is not standardized. The dimensions of access routes and hard-standings will vary according to the fire appliances that are used in a particular fire authority area (see Figure 23). The size and height of a building also has an effect on access facilities. An example of typical access route dimensions for high-reach appliances is shown in Table 22.

The relevant approving authorities should be consulted to ascertain their recommendations relating to access roads and hard-standings, in terms of load-bearing capability, turning circles, widths, lengths, headroom, proximity to dry riser inlets, etc.

Turning facilities should be provided in any dead-end access route that is more than 20 m long. This can be by a hammer-head or turning circle (see Table 22).

Overhead obstructions, e.g. cables and branches, that would interfere with the operation of high-reach appliances, should be avoided in the zone shown in Figure 23.

22.4 Buildings fitted with fire mains

NOTE For shopping complexes, see Annex E.

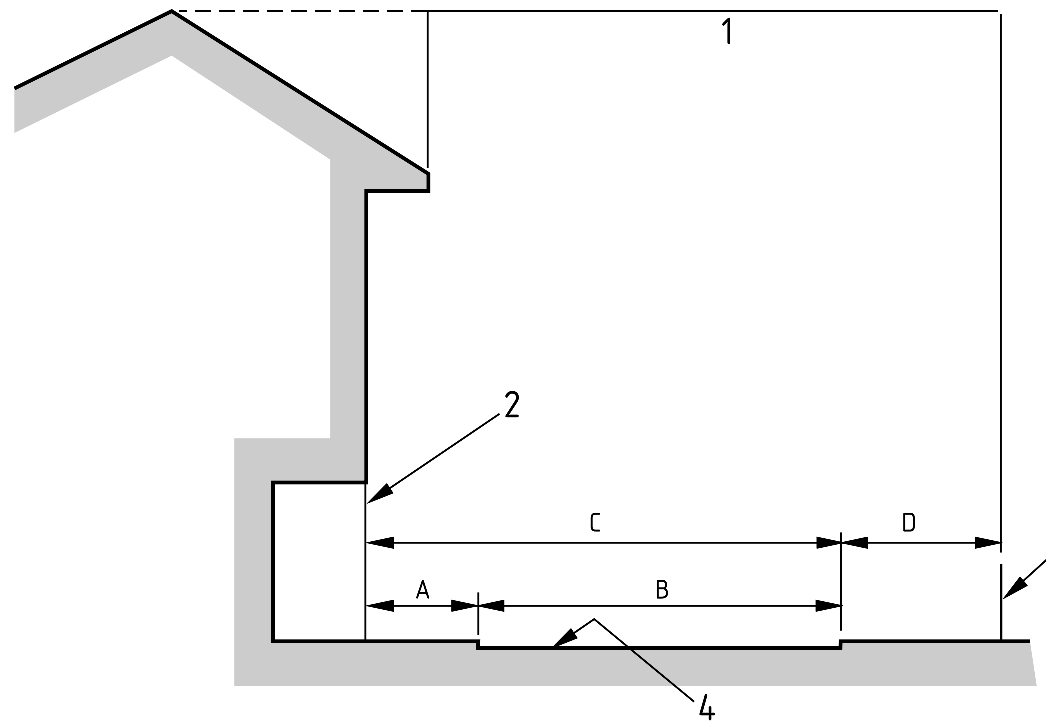
Fire mains enable fire-fighters within a building to connect their hoses to a water supply. In buildings fitted with fire mains, pumping appliances need access to the perimeter at points near the mains, where fire-fighters can enter the building to make a hose connection from the appliance to pump water into the main. Fire mains should be provided in accordance with **23.1**.

Table 22 **Example of measurements for a typical vehicle access route**

Appliance type	Min. width of road between kerbs m	Min. width of gateways m	Min. turning circle between kerbs m	Min. turning circle between walls m	Min. clearance height m	Min. carrying capacity tonnes
Pump	3.7	3.1	16.8	19.2	3.7	12.5
High-reach	3.7	3.1	26.0	29.0	4.0	17.0

NOTE Because the weight of high-reach appliances is distributed over a number of axles, it is considered that their infrequent use of a carriageway or route designed to 12.5 tonnes is not likely to cause damage. It would therefore be reasonable to design the road base to 12.5 tonnes, although structures such as bridges should have the full 17 tonnes capacity.

Figure 23 **Relationship between building and hard-standing/access road for high-reach fire appliances**



Key

1 Overhead obstructions should be avoided in this zone
2 Face of building at ground level or vertical plane of projecting upper storey
3 Obstruction
4 Hard-standing or access road
A 2.0 m – Maximum distance of near edge of hard-standing from building
B 8.0 m – Minimum width of hard-standing
C 10.0 m – Minimum distance of further edge of hard-standing from building
D 2.3 m – Minimum width of unobstructed space (for swing of appliance platform)

NOTE Hard-standing for high-reach appliances should be as level as possible and should not exceed a gradient of 1 in 12.

In the case of a building fitted with dry fire mains, there should be access for a pumping appliance to within 18 m of each fire main inlet connection point, typically on the face of the building, and the inlet should be visible from the appliance.

In the case of a multi-storey building fitted with a wet fire main, the pumping appliance access should generally be:

a) within 18 m of, and within sight of, a suitable entrance giving access to the main; and;

b) in sight of the inlet for the emergency replenishment of the suction tank for the main.

In the case of a single-storey building fitted with a wet fire main, fire appliance access should be provided to within 45 m of each of a sufficient number of outlet valves such that no point in the building is more than 60 m from an outlet valve, measured along a route suitable for laying hose.

Access roadways should generally be positioned to allow pumping appliances to be positioned within 18 m of, and in sight of, any inlet points.

23 Water supplies for fire and rescue service use

23.1 Fire mains

Fire mains should be designed and installed in accordance with BS 9990.

Fire mains should be installed in buildings where any floor is higher than 18 m above ground level. Where there are no floors higher than 50 m above ground level, wet or dry fire mains may be installed. Where there are floors higher than 50 m above fire-fighting access level, wet fire mains are necessary owing to the pressures required to provide adequate water supplies at the landing valves at upper floors and also to ensure that water is immediately available at all floor levels.

Fire mains should be installed in any building provided with a fire-fighting shaft (see **21.2.1** and Table 19).

23.2 Location and access to external water supply

All premises should be provided with a supply of water for fire-fighting. Fire-fighters have to lay out hose between the water supply and the fire appliance, so these distances should be kept to a minimum. Hydrants should be located in positions that are near to building entry points (including entry points to fire-fighting shafts containing fire mains) and fire appliance parking positions.

Water mains and hydrants should be capable of delivering a sufficient flow of water to enable effective fire-fighting to be undertaken. If the water supply takes the form of a static tank or dam, the capacity should be related to the size of the building and the risk involved. An unlimited and guaranteed natural water source providing the right quantities is also expected to be acceptable, subject to access and hard-standing for fire appliances being provided.

NOTE Attention is drawn to any relevant water legislation for the area.

Early consultation should be undertaken with the water authority, fire and rescue service and building control body on the nature of the water supply and the quantities or capacity to be provided.

The water supply should comprise one or a combination of the following:

a) hydrants provided by the water supply company on the street mains;

b) private hydrants designed and installed in accordance with BS 9990, ideally forming part of a ring main system;

c) a static or natural water supply.

All hydrants should have signage in accordance with BS 3251.

24 Communications systems for fire and rescue service use

In large or complex buildings a a reliable means should be provided of communicating from the fire and rescue service access level to all fire-fighting lobbies.

Full discussions on the specific requirements for the building should be undertaken with the appropriate fire and rescue service.

Any fire telephone system should be in accordance with BS 5839-9.

NOTE This is not the same as the lift communications system described in BS EN 81-72.

25 Fire control centre

A fire control centre should be provided in all buildings designed for phased evacuation, and in large or complex buildings, to enable the fire and rescue service to assist the premises management control an incident immediately on arrival. The fire control centre should be either:

a) a room dedicated solely as a fire control centre; or

b) combined with the management central control room.

The fire control centre should be adjacent to a fire and rescue service access point, or other location agreed with the fire and rescue service, and it should be readily accessible, preferably directly from the open air. If this is not practicable, the route to the fire control centre should be protected.

Because of the possible need for the fire control centre to be operational over an extended period of time, it should be separated from the remainder of the building by 2 h fire-resisting construction and should incorporate facilities to enable it to function as normal during an emergency.

The fire control centre should be provided with a 3 h non-maintained system of emergency lighting supplied from a source independent of the normal lighting, to enable the control centre to operate satisfactorily in the absence of the normal lighting supply.

Throughout the building, a reliable means of communication with the fire control centre (see Clause **24**), either a fire telephone system or a radio telecommunication system acceptable to the fire authority, should be provided for use by the management of the building in conjunction with the fire control system and control of evacuation, and for communications between fire and rescue service personnel.

The fire control centre should contain:

1) all control and indicating equipment for the fire alarm and other fire safety systems for the building. This should include a facility to sound the evacuation signal in each evacuation zone throughout the building, with the ability to signal a total evacuation, unless stairs have been provided to cope only with phased evacuation. A facility to cancel any automatic sequencing of phases of an evacuation procedure except for the initial phase should be provided;
2) control systems showing the location of the incident and status of all automatic fire protection installations and facilities;
3) override provision associated with all automatic fire protection installations and facilities (other than those that have to be located either adjacent to their equipment or elsewhere where local control is needed, e.g. overrides for gaseous fire extinguishing systems or sprinkler system main or floor isolating valves);
4) override provision for air conditioning systems or ventilation systems involving recirculation;
5) a communication system, conforming to BS 5839-9, providing a direct link between the control room and all fire-fighting lobbies, fire and rescue service access points and refuges for disabled people;
6) an exchange telephone with direct dialling for external calls;
7) a facility to sound the alert signal throughout the building;
8) facilities to be able to give information via public address system to occupiers of the building;
9) controls and monitor screens for closed circuit television (CCTV) if it is if provided for the control of evacuation. The use of CCTV can greatly assist in the management of emergency situation;
10) the fire emergency plan for the building;
11) keys or other devices required to facilitate access throughout the building and to operate any mechanical and electrical systems;
12) floor plans of the building as described in Clause **27**;
13) facilities to contact principal staff/building services engineers;
14) a clock to time phases of evacuation;
15) a visual indication which can show the status of evacuation in parts of the building where an evacuation signal has been given;
16) a wall-mounted writing board with suitable writing implements for displaying important information;
17) facilities for the control centre personnel to rest and refresh themselves.

*NOTE 1 Recommendations for fire routines are given in **44.2**.*

*NOTE 2 Management responsibilities in respect of general efficiency, staffing and organization of a control centre are outlined in Clause **44**.*

The control centre should be staffed by a competent person, familiar with the use and operation of the installed equipment, while the building is occupied. Particular attention should be paid to the human factors involved in running a control centre in an emergency. The design should support the interface with the operators so that they are able to take control of the emergency efficiently and effectively.

Building management systems are increasingly being used to control fire and security systems in addition to general building services control. To ensure that the highest standards of security, safety and reliability are achieved where systems have been integrated, it is important that the integrity of the building management systems is at least as good as the integrity of the individual systems that they incorporate. The design of these systems should conform to BS 7807. Clear differentiation should be provided where possible between fire, security and building management systems within the control centre.

26 Fire-fighters' emergency switches for discharge lighting installation

Discharge lighting installations, such as floodlights and neon advertising signs, can operate at voltages that are a hazard to fire-fighters. They should be able to be switched off in the case of a fire.

An exterior or interior lighting installation designed to work at a voltage normally exceeding 1 000 V a.c. or 1 500 V d.c. if measured between any two conductors, or 600 V a.c. or 900 V d.c. if measured between any conductor and earth, should be controlled by a fire-fighter's emergency switch, installed in accordance with BS 7671.

27 Drawings for fire and rescue service use

In large or complex buildings and those having extensive accommodation below ground level, it is essential that the fire and rescue service have available to them suitable and sufficient information on the building layout, escape routes, special hazards and special procedures that might be in operation. Much of this should be available in the emergency pack referred to in **45.7** and detailed in Annex M, but some additional information might also be of assistance.

For example, plans of basement accommodation could be displayed at the fire and rescue service access storey in any stairway (or lobby) leading to the basement and more detailed drawings covering the information given below could be made available. Before assembling this additional information, the issue should be discussed with the fire and rescue service. Where this information is to be made available, it should be located such it can be readily referred to in an emergency – not necessarily in the same place as the emergency pack. Additional copies should be available in any fire control centre and at any other locations agreed with the fire and rescue service.

All drawings and plans should be to a scale agreed with the enforcing authorities, and as a minimum should include:

a) a linear scale bar;

b) the direction of North;

c) a "You are here" indicator;

d) any other relevant information such as geographic location.

Examples of items that should be indicated on the plans include:

1) surrounding streets;
2) exits, stairs, corridors, evacuation lifts and any refuges for disabled people;
3) escape routes;
4) fuel storage areas, gas and oil main controls;
5) electrical main and submain controls, including stand-by generators;
6) ventilation plant and control switches, including controls for any smoke control system using pressure differentials;
7) the location of all relevant fire-fighting equipment, including:
    i) sprinkler valves;
    ii) hose reels;
    iii) hydrants and fire mains;
    iv) pump rooms supplying fire protection systems;
    v) automatic fire extinguishing systems;
    vi) foam inlets;
8) shutters and doors released automatically in the event of fire, and any central control point for release;
9) smoke outlets and control systems;
10) openable windows for smoke ventilation in sealed buildings;
11) main and any secondary fire alarm panels, and zoning of fire alarm systems;
12) fire-fighting stairs and fire-fighting lifts;
13) telephone communication points and any fire control centre.

Additional copies of these drawings should ideally be supplied to the fire authority to enable pre-planning for an emergency.

28 Heat and smoke control

28.1 General

The build-up of smoke and heat as a result of a fire can seriously inhibit the ability of the fire service to carry out rescue and fire-fighting operations within a building.

Means should be provided to ventilate the fire-fighting shaft of smoke. The objective of such ventilation is to minimize the possibility of serious contamination of the fire-fighting stairwell (see **28.2**), although some smoke contamination of the stairwell is possible if natural ventilation is provided.

Products of combustion from basement fires tend to escape via stairways, making access difficult for fire service personnel. Providing outlets for smoke can reduce this problem. Venting can improve visibility and reduce temperatures, making search, rescue and fire-fighting less difficult (see **28.3**).

In addition to any measures that are needed to keep smoke from restricting the use of any fire-fighting shafts, there is also a need to remove smoke from basements, car parks, loading docks and covered roadways (see **28.4** and **28.5**).

28.2 Smoke control for fire-fighting shafts

28.2.1 General

Fire-fighting shafts should be provided with smoke control systems as follows:

a) fire-fighting shafts serving basements more than 10 m below ground level should be provided with a pressure differential system (see **28.2.2**);

b) all other fire-fighting shafts should be provided with a pressure differential system (see **28.2.2**), except that natural ventilation can be used in fire-fighting shafts less than 10 m below ground level or up to 30 m above ground level (see **28.2.3**).

28.2.2 Smoke control using pressure differential systems

Pressure differential systems for fire-fighting purposes should be designed and installed in accordance with BS EN 12101-6:2005, Class B systems.

28.2.3 Venting of fire-fighting shafts by natural means

28.2.3.1 General

All buildings should be provided with openable vents in accordance with Table 23.

28.2.3.2 Smoke shafts

28.2.3.2.1 General

Any smoke shaft which penetrates fire compartments should, as a minimum, maintain the same level of fire compartmentation as that which has been breached.

28.2.3.2.2 Basement smoke shafts

Smoke shafts serving basements should discharge direct to open air at ground level where the exits from the building and fire service access would not be affected by the smoke discharge.

The smoke shaft should only serve a single basement level.

A smoke shaft should be covered with either a metal grille designed to prevent blockage of the shaft by rubbish, or breakable material, easily accessible from the appropriate fire service access level.

Table 23 **Recommendations for fire-fighting shafts ventilated by natural means**

Fire-fighting provisions within building		**Openable vent**		
Fire-fighting stair or lobby	**Position of stair or lobby**	**Geometric free area of vent** m²	**Position of vent**	**Vent control**
Stair	On external wall serving a top floor less than 30 m above ground	1.0	At each storey OR	Manual [A)]
			a remotely openable vent at the head of the stairs	Remote [B)]
Stair	Not external wall serving a top floor less than 30 m above ground	1.0	Remotely openable vent at the head of the stairs	Remote [B)]
Stair	Not external wall serving a top floor less than 30 m above ground	1.0	In accordance with BRE Report 79204	Automatic [C)]
Stair	Serving only basements less than 10 m depth and leading to a final exit	—	None [D)]	
Lobby	Above ground level on an external wall	1.5	Near to ceiling direct to open air	Manual [A)]
Lobby	Above ground level not on an external wall	1.5	At each storey to a smoke shaft	Manual [A)]
Lobby	Above ground level not on an external wall	1.5	In accordance with BRE Report 79204	Automatic [C)]
Lobby	At each basement level	1.0	High level direct to open air or to a smoke shaft only serving that level	Manual [A)]

Smoke shafts should be in accordance with **28.2.3.2** or BRE Report 79204.

NOTE Permanently open vents are not permitted.

A) Manually openable vents should be in accordance with **28.2.3.3.1**.
B) Remotely openable vents should be in accordance with **28.2.3.3.2**.
C) Automatic opening vents should be in accordance with **28.2.3.3.3**.
D) The door to the final exit serves as a vent.

28.2.3.2.3 Above ground smoke shafts in accordance with this British Standard

Smoke shafts serving storeys above ground level should meet the following recommendations.

a) The smoke shaft should be fully open to the external air at top and bottom. The opening at the top of the smoke shaft should not be located where it could be subjected to adverse wind effects (i.e. it should always have negative wind pressure coefficients).

b) The cross-sectional area (geometric free area) of the smoke shaft should be at least 3 m^2, with a minimum dimension of 1 m.

c) The lobby ventilator should have a geometric free area of at least 1.5 m^2.

d) Both the width and the height of the lobby ventilator should be not less than 0.75 m.

e) The top of the lobby ventilator should be located as close to the ceiling of the lobby as is practicable, and should be at least as high as the top of the door connecting the lobby to the stairwell.

f) The lobby ventilator, in the closed position, should have a minimum fire resistance of 30 min and a leakage rate no greater than 200 $m^3/h/m^2$ when tested in accordance with BS EN 1366-2.

28.2.3.2.4 Above ground smoke shafts in accordance with BRE Report 79204

Smoke shafts designed in accordance with BRE Report 79204 should conform fully to all of the recommendations contained in that document.

28.2.3.3 Vents

28.2.3.3.1 Manually openable vents

NOTE Permanently open vents are not permitted.

All manually openable vents provided for smoke control, whether in the stairs, in the lobby or into a shaft should:

a) be outward opening;

b) not be top hung;

c) open a minimum of 30°;

d) be clearly identifiable and accessible;

e) be fitted with:

   1) simple lever handles; or

   2) rotary drives to simple rack or gear operated devices; or

   3) locks that can be readily and easily operated by the fire service.

Openings should be guarded to a height of not less than 1.1 m from floor level.

The top of lobby vents should be located as close to the ceiling of the lobby as is practicable, and should be at least as high as the top of the door connecting the lobby to the stairwell.

28.2.3.3.2 Remotely openable vents

Openable vents situated above a stair should be provided with a remote control located adjacent to the fire service access doorway and clearly marked as to its function and means of operation. The remote control should be capable of opening and closing the vent. All connections between the remote control and actuator mechanism should be within the fire-fighting shaft. Where any part of the remote control mechanism is powered by electricity, a secondary supply should be provided.

28.2.3.3.3 Automatic opening vents

Automatic opening vents should conform to BS EN 12101-2.

Systems designed in accordance with the findings of BRE Report 79204, whether located at the head of the stairs or into a shaft, should be automatically opened by smoke detection within any one of the lobbies or common corridors.

All connections between the smoke detection, vent control panels and actuator mechanisms should be within the fire-fighting shaft or control centre/room. Where any part of the control mechanism is powered by electricity, a secondary supply should be provided.

Only the automatic vent from the lobby into the shaft where the smoke has been detected should open; all other lobby vents should remain closed.

28.3 Venting of smoke and heat from basements

28.3.1 General

NOTE Where basement compartments have external doors or windows they do not need smoke outlets providing the percentage of floor area recommendations, given in ***28.3.2****, are met. It is common for basements to be open to the air on one or more elevations.*

A system of smoke and heat ventilation should be provided from every basement storey, except for any basement storey that has:

a) a floor area of not more than 200 m^2; and

b) a floor not more than 3 m below the adjacent ground level.

Systems may be either natural, using one or more smoke outlets (**28.3.2**), or powered (**28.3.3**). For smoke and heat ventilation systems from basement car parks, see **28.4**.

28.3.2 Natural smoke and heat ventilation

Smoke outlets (also referred to as smoke vents) provide a route for smoke to escape to the open air from the basement level(s). If a basement is compartmented, each compartment should have direct access to venting without having to open doors, etc., into another compartment.

Smoke outlets should:

a) be not less than 2.5% of the floor area of each storey;

b) be sited at high level, either in the ceiling or in the wall of the space they serve;

c) be evenly distributed around the perimeter of the building, to discharge into the open air outside the building;

d) not be placed where they would prevent the use of escape routes from the building.

If an outlet terminates at a point that is not readily accessible, it should be kept unobstructed, and should be covered only with a non-combustible grille or louvre.

If an outlet terminates in a readily accessible position, it may be covered by a panel, stallboard or pavement light that can be broken out or opened. The position of such covered outlets should be suitably indicated.

28.3.3 Powered smoke and heat ventilation

A system of powered smoke and heat ventilation may be provided as an alternative to natural venting, to remove smoke and heat from basements, provided that the basement storey(s) are fitted with a sprinkler system. The sprinkler system should be in accordance with BS EN 12845 (new systems) or BS 5306-2 (existing systems) [it is not considered necessary in this particular case to install sprinklers on the storeys other than the basement(s) unless they are needed for other reasons].

If a powered extract system is used, it should:

a) provide ten air changes per hour;

b) be capable of handling gas temperatures of 300 °C for not less than 60 min;

c) come into operation automatically either on activation of the sprinkler system or by an automatic fire detection system conforming to BS 5839-1:2002+A2:2008 (at least L3 standard). For further guidance refer to BS EN 12101-3.

In addition:

1) replacement air should be provided and open automatically, using the same activation method as that selected in **28.3.3**c);

2) the system should have an independent power supply which would operate in the event of failure of the main supply;

3) the ductwork and fixings should be constructed of materials with an elevated rating of not less than 600 °C or equivalent to the fire resistance rating of any compartment boundary through which it passes, whichever is the greater;

4) all wiring associated with the fans should be in accordance with BS 7346-6.

28.4 Venting of smoke and heat from car parks

A system of smoke and heat ventilation, designed in accordance with BS 7346-7, with the objective of clearance of smoke during the fire and after the fire has been suppressed, should be provided from every car park storey.

*NOTE BS 7346-7:2006 provides guidance on three methods of smoke clearance by horizontal cross-flow through the car park storey: natural cross-ventilation specified as permanent openings (Clause **7**), mechanical cross-ventilation achieved using conventional mechanical ventilation (Clause **8**) and mechanical cross-ventilation using jet fans (Clause **9**).*

28.5 Smoke and heat ventilation from loading docks and covered service roadways

All enclosed loading docks exceeding 200 m^2 and covered service roadways should be provided with a system of smoke and heat ventilation, designed in accordance with BS 7346-7, with the objective of clearance of smoke during the fire and after the fire has been suppressed.

29 Electrical services

NOTE In the case of some residential buildings where regular maintenance of a generator would not be expected, the power supplies may be via two separate intakes into the building from the same external substation and then by two separate routes to the fire-fighting shaft.

Electrical installations, wiring systems, primary and secondary power supplies for fire-fighting lift installations and any other fire-fighting facilities associated with the fire-fighting shaft should be in accordance with both **38.2.3** and the following.

Other lifts in the fire-fighting shaft may be fed from the same primary supply, provided that:

a) the supply is adequate for this purpose; and

b) arrangements are such that a fault occurring in any other lift in the fire-fighting shaft or power supplies will not affect in any way the operation of the fire-fighting lift.

The secondary supply should be of sufficient capacity to:

1) maintain in operation:
   - the fire-fighting lift and its ancillary equipment;
   - normal lighting and other services within the fire-fighting shaft;
   - the fire and rescue service communications system (see Clause **24**);
   - any powered ventilation or pressurization system which operates in conjunction with the operational use of the fire-fighting shaft;
   - any pump(s) required to feed the fire main;
2) permit the automatic recall to fire and rescue service access level of all other lifts in the fire-fighting shaft, if necessary in sequence and at reduced speed.

Lighting, lift and communication circuits and equipment should be safeguarded as appropriate to ensure that the failure, or cause of failure, of any one component of the installation does not lead to the failure of another component.

Cables other than those necessary for the operation of the fire-fighting lift (and any other lifts within the fire-fighting lift well) should be located outside the fire-fighting lift well, although within the fire-fighting shaft.

An indication of the status of any of the following should be provided adjacent to the fire-fighting lift switch and duplicated in any fire control room:

i) the primary and secondary power supplies;

ii) any powered ventilation or pressurization systems;

iii) any pumps feeding fire mains.

The indicators for power supplies should identify which system is supplying the fire-fighting shaft. The indicators for powered ventilation systems, pressurization systems and fire main pumps should indicate whether the equipment is in operation, and not merely whether it is energized.

Section 7: Designing the building structure (load-bearing and non-load-bearing elements)

*NOTE Recommendations for protecting means of escape are given in Section **5**. Guidance on risk levels and risk assessment is given in Section **2**.*

30 Designing the building structure – General

There are a number of ways in which fire can spread from its point of origin throughout a building and to adjacent buildings. It is therefore important for the designer to be able to recognize both the various fire transfer mechanisms and the measures that should be taken in each instance to prevent fire movement. These are discussed in detail in PD 7974-3, which provides a review of the different types of required fire-resisting constructions (products and systems) together with a summary of the applicable fire test standards.

The various modes of fire movement can be particularly crucial in the early stages of fire development, influencing the rate of heat release and smoke production prior to flashover, thereby affecting the conditions for safe means of escape. Progressive fire movement during the post-flashover phase can also further impair the building's resilience in containing fire to the point of origin and within the building envelope. This impairment can occur by a weakening of the building's structure in resisting both the passage of flames and internal pressures caused by structural movement and expansion, as well as by thermal degradation of the building's fabric from heat transfer by radiation, convection and conduction leading to critical deterioration of material properties. Appropriate structural fire protection can help mitigate these effects.

Fire protection and fire safety considerations affect the design of the building in the following areas, which are dealt with in more detail in the subclauses referred to:

a) the fire resistance, in terms of load-bearing capacity, insulation, and integrity of elements of structure (see Clause **31**);

b) compartmentation, including compartmentation of areas of ancillary accommodation (see Clause **32**);

c) measures to prevent openings between different parts of a building offering routes for uncontrolled fire or smoke spread (see Clause **33**);

d) measures to prevent fire and smoke spread via cavities (see Clause **34**);

e) reaction to fire properties of roof covering, the external wall surface, the internal wall and ceiling lining materials used in the building and within certain voids where fire spread might pose a threat (see Clause **35**);

f) the provision of fire-resisting elements in the external walls to reduce the risk of fire spreading from one building to another (see Clause **36**).

Where a building has two or more different uses that are not ancillary to one another, each should be considered as belonging to a different risk profile. A use that is ancillary to another need not be compartmented from it, unless the ancillary use is:

1) a flat (see also **32.4.3**); or
2) at least one fifth of the total area of a building or compartment that is more than 280 m^2; or
3) a storage area in a building of occupancy characteristic B or compartment (of at least 280 m^2), and is at least one third of the total area.

Where there is a complex mix of uses the possible effects of one use on another should be considered.

In a building or part of a building intended to be used for a variety of purposes at the same time, compartments should be provided to separate accommodation with different risk profiles. A building or part of a building intended to be used for a variety of purposes at different times should meet the most onerous recommendations relevant to those purposes.

31 Fire resistance

31.1 Elements of structure

31.1.1 General

The life safety role of structural fire resistance is threefold:

a) to minimize the risk to occupants, some of whom might have to remain in the building for some length of time while evacuation proceeds (see also Section **5**);
b) to reduce the risk to fire-fighters who might be engaged in search or rescue operations (see also Section **6**); and
c) to reduce the danger to people in the vicinity of the building, who might be hurt by falling debris or as a result of the impact of the collapsing structure on other buildings.

In addition to any load-bearing function, separating elements need to provide an adequate standard of:

1) insulation, to avoid the unexposed side of the element becoming hot enough to ignite material in contact with it; and
2) integrity, to avoid the formation of openings or cracks in the element that allow flame or hot gases to pass through it, to ignite the unexposed surface or materials on the unexposed side of the element.

31.1.2 Load-bearing elements of structure needing fire resistance

The load-bearing parts of a building should be able to withstand the effects of fire to an appropriate degree without loss of load-bearing capacity.

The appropriate degree depends on the risk profile, the time needed for the evacuation of the occupants, the level of protection needed for fire-fighters, and the threat to the area around the building that structural failure could present.

The appropriate degree is also a reflection of the severity of fire that the structure is designed to withstand. The severity is governed by the fire load in the building, the building fabric and the ventilation conditions. It can be modified by intervention of an automatic sprinkler system, or other suppression system (see Clause **39**).

31.1.3 Non-load-bearing elements of structure requiring fire resistance

Certain elements of structure that are not load-bearing require fire resistance, e.g. a non-load-bearing partition enclosing a protected escape route.

31.1.4 Load-bearing elements not requiring fire resistance

Certain parts of the structure of a building might not need fire resistance for life safety purposes. They include:

a) roof structure and structure that only supports a roof, except if the stability of the building depends on it, or unless the roof serves as a floor, e.g. a rooftop car park or the roof is used as an escape route;

b) structure in a single-storey building unless it supports a compartment wall;

c) external walls more than 1 m from the relevant boundary which transmit only self weight and wind loads (however, for life safety, any part of an external wall that is a protected area for the purpose of avoiding fire spread between buildings needs fire resistance);

d) structure in an open-sided car park, which needs only nominal fire resistance because the low fire load and ventilation restrict the temperature of any fire;

e) external structural members at least 1 m from the façade (these are outside the scope of this British Standard; refer to BS EN 1991-1-2 and BS EN 1993-1-2 for guidance).

In many structural systems there is a degree of redundancy and, in fire, the loss of one element might not be important.

31.2 Minimum levels of fire resistance

31.2.1 General

NOTE 1 The fire resistance periods given in Table 25 are based on the minimum levels required for life safety given in the Building Regulations 2000, Approved Document B [33], and will not necessarily be adequate for property and business continuity protection.

NOTE 2 Table 25 gives recommendations for fire resistance of elements of structure for basement storeys, occupancy characteristic A buildings used for storage, or car parks. These elements are not covered in Table 26.

*NOTE 3 Minimum levels of fire resistance for fire doors are given in **33.1**.*

When tested in accordance with the relevant part of BS 476, BS EN 1363, BS EN 1364, BS EN 1365 or BS EN 1366, the elements of structure identified in Table 24 should have a fire resistance not less than the minimum values recommended in Table 25 or Table 26. To use these tables, the fire resistance (load-bearing capacity, integrity and insulation) should first be determined from Table 24; then the fire resistance periods should be determined either from Table 24 if a specific recommendation is given, or from Table 25 or Table 26, depending on whether or not ventilation conditions are to be taken into account.

Table 25 gives recommendations for fire resistance of elements of structure and other parts of a building based upon the fuel load density and assuming an unventilated fire. Table 26 gives recommendations for fire resistance of elements of structure based upon the ventilation conditions given in Table 27. Table 26 should be used only if the ventilation conditions given in Table 27 can be met. If these conditions cannot be met then Table 25 should be used.

Fire loads are built into Tables 25 and 26, which reflect the typical risk profiles provided in Table 5.

COMMENTARY ON TABLE 25 AND TABLE 26

Background to Table 25

*Table 25 has been derived by considering the risk assessment and risk profiles of the building and occupants described in Section **2**. It largely follows the guidance given in the Building Regulations 2000, Approved Document B [33], but splits several occupancies into more discrete groups where the risks can be better defined. Since there are a number of factors to consider, in some cases it is possible that certain combinations of building and occupancy characteristic might initially appear inconsistent.*

Background to the derivation of Table 26

Table 26 has been developed using fundamental fire safety engineering principles which use a combination of deterministic analysis combined with a risk and consequence evaluation to reflect the severity of a real fire and the threat to life safety in the various occupancy groups.

The deterministic analysis employed a time equivalent approach based upon the validated parametric expressions given in BS EN 1991-1-2, for post-flashover fires. This considers basic factors such as the fire load density, ventilation, the thermal properties of the enclosure, compartment size and geometry. In order to cover a wide range of variables for the parametric fire, a Monte Carlo analysis was carried out for each occupancy group involving many thousands of fires to ensure the extreme combination of variables were captured. The analysis assumes a total burn-out of the fire.

The effectiveness of sprinklers in reducing the fire severity was considered in the form of applying a multiplication factor based upon risk, to the fire load density.

From the Monte Carlo analysis, the cumulative distributions of time equivalent were subsequently analysed based upon the fundamental premise that risk = frequency × probability × consequence of failure. The frequency was linked with the height of the building following the principles of the Building Regulations 2000 [19], and consequence of failure was linked to both the building height and risk profile of the occupancy taking account of the familiarity and mobility of the occupants within the building and whether there is a sleeping risk. The probability of failure is directly related to the cumulative distribution curves that resulted from the Monte Carlo analysis.

The occupancy characteristics were finally determined in accordance with Clause ***6*** *and the benefit of sprinklers was applied in accordance with* ***6.5****.*

The provision of an automatic sprinkler system significantly reduces the severity of a fire. The fire resistance of compartment walls and floors, and the size of compartments, can be changed if sprinklers are provided. This is reflected in Table 25 and Table 26; see also **32.2** and **32.3**.

Traditionally, standards of fire resistance have been based upon the fire load or the fuel load density. However, there are other factors which may be taken into account.

The level of heating that an element will experience is influenced primarily by the fuel load density in the compartment, the insulation properties or thermal inertia, the geometry and ventilation conditions of the fire compartment. These variables, which determine the level of heating in a real fire, can be linked to the standard fire resistance test conditions by the concept of time equivalency (*t*-equivalency).

The *t*-equivalent period of fire resistance is a means of calculating a time for which an element in a compartment subject to a real fire would undergo a heating equivalent to the same time period in a standard furnace test. This approach models the heating effects of a real fire by taking into account the actual fuel load density, the thermal inertia of the lining materials, the compartment geometry and ventilation conditions within the compartment.

In order to determine an appropriate fire resistance period for elements of structure, the *t*-equivalent values can be used as a basis. The values obtained in this way are then factored to take into account the three purposes of structural fire resistance listed in **31.1.1**.

Table 24 **Minimum fire resistance performance**

Part of building	Minimum provisions when tested to the relevant parts of BS 476, in minutes [A]			Minimum provisions when tested to the relevant European standard, in minutes [B]			Method of exposure
	Load-bearing capacity [C]	Integrity	Insulation	Load-bearing capacity [C]	Integrity	Insulation	
Structural frame, beam or column	See Table 25 or Table 26	Not applicable	Not applicable	See Table 25 or Table 26	Not applicable	Not applicable	Exposed faces
Load-bearing wall element	See Table 25 or Table 26	Not applicable	Not applicable	See Table 25 or Table 26	Not applicable	Not applicable	Each side separately
Floor [D]							
Between a shop and a flat above	60 or see Table 25 or Table 26 [F]	60 or see Table 25 or Table 26 [F]	60 or see Table 25 or Table 26 [F]	60 or see Table 25 or Table 26 [F]	60 or see Table 25 or Table 26 [F]	60 or see Table 25 or Table 26 [F]	From underside [E]
Any other floor, including compartment floors	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	From underside [E]
Roof							
Any part forming an escape route	30	30	30	30	30	30	
Any roof that performs the function of a floor	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	From underside [E]
External wall							
Any part less than 1 m away from any point on the relevant boundary	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	Each side separately
Any part 1 m or more from the relevant boundary [G]	See Table 25 or Table 26	See Table 25 or Table 26	15	See Table 25 or Table 26	See Table 25 or Table 26	15	From inside the building
Any part adjacent to an external escape route	30	30	No provision [H), I]	30	30	No provision [H), I]	From inside the building

Table 24 **Minimum fire resistance performance** (*continued*)

Part of building	Minimum provisions when tested to the relevant parts of BS 476, in minutes A)			Minimum provisions when tested to the relevant European standard, in minutes B)			Method of exposure
	Load-bearing capacity C)	Integrity	Insulation	Load-bearing capacity C)	Integrity	Insulation	
Compartment wall							
Walls separating occupancies other than occupancies in occupancy characteristic A (office)	60 or see Table 25 or Table 26 J)	60 or see Table 25 or Table 26 J)	60 or see Table 25 or Table 26 J)	60 or see Table 25 or Table 26 J)	60 or see Table 25 or Table 26 J)	60 or see Table 25 or Table 26 J)	Each side separately
Any other compartment walls	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	Each side separately
Protected shaft, excluding any fire-fighting shafts							
Glazed screen separating protected shaft from lobby or corridor	Not applicable	30	No provision K), L)	Not applicable	30	No provision K), L)	Each side separately
Any other part between the shaft and a protected corridor/lobby	30	30	30	30	30	30	Each side separately
Any other part not described above	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	See Table 25 or Table 26	Each side separately
Fire-fighting shaft							
Construction separating fire-fighting shaft from rest of building	120	120	120	120	120	120	From side remote from shaft
	60	60	60	60	60	60	From shaft side
Construction separating fire-fighting stair, fire-fighting lift shaft and fire-fighting lobby	60	60	60	60	60	60	Each side separately

Table 24 **Minimum fire resistance performance** (*continued*)

Part of building	**Minimum provisions when tested to the relevant parts of BS 476**, in minutes [A)]			**Minimum provisions when tested to the relevant European standard**, in minutes [B)]			**Method of exposure**
	Load-bearing capacity [C)]	**Integrity**	**Insulation**	**Load-bearing capacity** [C)]	**Integrity**	**Insulation**	
Enclosure							
Not forming part of a compartment wall or a protected shaft, to a protected lobby or a protected corridor	30	30	30 [K)]	30	30	30 [K)]	Each side separately
In a flat, to a protected entrance hall or a protected landing	30	30	30 [K)]	30	30	30 [K)]	Each side separately
Subdivision of a corridor	30	30	30 [K)]	30	30	30 [K)]	Each side separately
Fire-resisting construction							
Enclosing communal areas in sheltered housing	30	30	30 [K)]	30	30	30 [K)]	Each side separately
Enclosing places of special fire hazard	30	30	30	30	30	30	Each side separately
Between store rooms and sales area in shops	30	30	30	30	30	30	Each side separately
Cavity barrier	Not applicable	30	15	Not applicable	30	15	Each side separately
Duct [M)]	Not applicable	30	No provision	Not applicable	30	No provision	From outside
Casing around a drainage system [N)]	Not applicable	30	No provision	Not applicable	30	No provision	From outside
Flue walls [O)]	Not applicable	Half the period given in Table 25 or Table 26 for compartment wall/floor	Half the period given in Table 25 or Table 26 for compartment wall/floor	Not applicable	Half the period given in Table 25 and Table 26 for compartment wall/floor	Half the period given in Table 25 and Table 26 for compartment wall/floor	From outside

Table 24 **Minimum fire resistance performance** (*continued*)

Part of building	**Minimum provisions when tested to the relevant parts of BS 476**, in minutes [A)]			**Minimum provisions when tested to the relevant European standard**, in minutes [B)]			**Method of exposure**
	Load-bearing capacity [C)]	**Integrity**	**Insulation**	**Load-bearing capacity** [C)]	**Integrity**	**Insulation**	
Fire door	See Table 30	See Table 30	See Table 30	See Table 30	See Table 30	See Table 30	
Construction enclosing a roadway	120	120	120	120	120	120	From the roadway side

A) Part 21 for load-bearing elements, Part 22 for non-load-bearing elements, Part 23 for fire-protecting suspended ceilings, and Part 24 for ventilation ducts. BS 476-8 results are acceptable for items tested or assessed before 1st January 1988.
B) The national classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly.
C) Applies to load-bearing elements only.
D) Guidance on increasing the fire resistance of existing timber floors is given in DG 208 [34].
E) If a suspended ceiling is used it should conform to **31.2.5** and **35.1.4**.
F) Whichever is greater.
G) The guidance in Clause **36** allows such walls to contain areas which need not be fire-resisting (unprotected areas).
H) Unless needed to meet the recommendations given in Clause **36**.
I) Except for any limitations on glazed elements given in **31.3**.
J) Whichever is less.
K) See **31.3.1** for permitted extent of uninsulated glazed elements.
L) See **31.3.2**.
M) See **34.4**v).
N) See Figure 31.
O) See Figure 30.

Table 25 **Fire resistance periods for elements of structure (independent of ventilation conditions)**

OC [A)]	Use	Sprinklered or unsprinklered [B)]	Minimum periods of fire resistance, in minutes					
			Depth below access level of lowest basement		Height [C)] of top occupied storey above access level			
			More than 10 m	Not more than 10 m	Not more than 5 m	Not more than 18 m	Not more than 30 m	More than 30 m
A	Office	Unsprinklered	90	60	30	60	90	Not allowed
		Sprinklered	60	60	30	30	60	120
A	Industrial: high hazard	Unsprinklered	N/A [D)]	120	90	120	150	Not allowed
		Sprinklered	150	90	60	90	90	120
A	Industrial: ordinary hazard	Unsprinklered	N/A [D)]	120	60	90	120	Not allowed
		Sprinklered	90	60	30	60	60	90
A	Industrial: low hazard	Unsprinklered	90	60	30	60	90	Not allowed
		Sprinklered	60	30	30	30	60	60
A	Storage: low hazard	Unsprinklered	90	60	30	60	90	Not allowed
		Sprinklered	60	30	30	30	60	60
A	Car parks:							
	– open-sided car park	Unsprinklered	—	—	15 [E)]	15	30	30
	– any other car park	Unsprinklered	90	60	30	60	90	120
B	Shops and commercial	Unsprinklered	90	60	60	60	90	Not allowed
		Sprinklered	90	60	30	60	60	120
B	Assembly: high hazard	Unsprinklered	N/A [D)]	90	60	90	120	Not allowed
		Sprinklered	120	60	60	60	90	120
B	Assembly: ordinary hazard	Unsprinklered	90	60	60	60	90	Not allowed
		Sprinklered	60	30	30	60	60	120
Ci	Individual residential	Unsprinklered	90	60	30	60	Not allowed	Not allowed
		Sprinklered	90	60	30	60	90	120
Cii and Ciii	Other residential	Unsprinklered	90	60	30	60	90	Not allowed
		Sprinklered	60	30	30	30	60	120

A) Occupancy characteristic, as defined in Table 2.
B) "Sprinklered" indicates sprinkler systems conforming to BS EN 12845 or BS 5306-2, with the exception of occupancy characteristic Ci and Cii, for which it indicates sprinkler systems conforming to BS 9251.
C) Refers to height of occupied floor, therefore does not apply to high single-storey buildings.
D) Floors below this level may be used for other occupancy characteristic given an appropriate fire resistance rating.
E) Provided that arrangements are made for natural ventilation equivalent to an open-sided car park above ground level.

Table 26 **Fire resistance periods for elements of structure (based on the ventilation conditions given in Table 27 A))**

Risk profile	**Minimum periods of fire resistance**, in minutes B)					
	Height C) of top occupied storey above access level					
	Not more than 5 m	**Not more than 11 m**	**Not more than 18 m**	**Not more than 30 m**	**Not more than 60 m**	**More than 60 m**
A1	15	30	30	60	75	90
A2	30 D)	30	60	90	120	150
A3	60	60	90	120	300	300
A4 E)	—	—	—	—	—	—
B1	30	30	30	60	60	75
B2	30	30	60	75	90	120
B3	30	45	75	105	135	180
B4 E)	—	—	—	—	—	—
Ci1 F)	45 G)	60	75	75	90	105
Ci2 F)	60 G)	90	105	120	—	—
Cii1 or Ciii1	30	30	30	45	60	60
Cii2 or Ciii2	30	45	60	75	90	105
C3 E)	—	—	—	—	—	—
C4 E)	—	—	—	—	—	—

NOTE 1 For occupancy characteristic A covering storage and car parks, and all basements, the fire resistance periods are as given in Table 25.

*NOTE 2 Variation of the risk profile by the addition of sprinklers conforming to BS EN 12845 (new systems) or BS 5306-2 (existing systems) can be used to reduce the fire resistance as described in **6.5**.*

A) If the ventilation conditions in Table 27 cannot be met then Table 25 should be used instead.
B) Where a product or system is not available to meet the specific classification recommended in this table, then a product or system should be used that has the next highest available classification category. The classification periods 75, 105 and 135 do not exist in European classification system BS EN 13501-2.
C) Height of top occupied floor above access level.
D) Reduced to 15 min when ground floor area is less than 1 000 m^2.
E) See Table 4.
F) 15 min reduction when compartment size is limited to 10% of the floor area on each floor (cannot be used in combination with the reduction in footnote G).
G) Reduced to 30 min for single owner occupancy (cannot be used in combination with the reduction in footnote F).

Table 27 **Ventilation conditions for application of Table 26**

Occupancy characteristic [A)]	Use	Ventilation parameter	
		Minimum potential area as a percentage of the floor area %	Height of opening [B)] as a percentage of the compartment height (i.e. from floor to ceiling) %
A	Office	5	30 to 90
A	Industrial: low hazard	2.5	30 to 80
A	Industrial: high hazard	2.5	30 to 80
B	Shops and commercial	5	50 to 100
B	Assembly: low hazard	2.5	30 to 80
B	Assembly: medium hazard	2.5	30 to 80
B	Assembly: high hazard	2.5	30 to 80
Ci	Individual residential	10	30 to 90
Cii and Ciii	Other residential	10	40 to 90

A) As defined in Table 2.

B) This is the weighted mean height (by ventilation area) of the potential openings. If a compartment has openings each with an area of A_1, A_2, A_3,...A_n and heights of h_1, h_2, h_3,...h_n, then the total area of the openings $A = A_1 + A_2 + A_3 + \ldots A_n$, and the weighted mean height, h, is given by:

$$h = \frac{A_1 h_1 + A_2 h_2 + A_3 h_3 + \ldots\ldots. A_n h_n}{A}$$

NOTE In the calculation of the weighted mean height it is also acceptable to selectively consider only the height(s) of the openings that achieve the minimum ventilation area.

If h is the weighted mean height of all the openings and H is the height of the compartment then h/H should be between the values given in the end column.

31.2.2 Buildings over 30 m high

All buildings with an occupied storey over 30 m above access level should be sprinkler-protected.

31.2.3 Single-storey buildings

In single-storey buildings the need for structural fire resistance arises only where there are compartment walls, or where an external wall is close enough to the relevant boundary to require it.

31.2.4 Roof structure

The structure of a roof, and structure that supports only a roof, does not generally require fire resistance, unless the roof forms part of an escape route or functions as a floor, e.g. as a car park, or is part of a portal frame structure where the roof and the supporting stanchions form a single structural element.

31.2.5 Suspended ceilings

A suspended ceiling can contribute to the overall fire resistance of a floor/ceiling assembly. If a suspended ceiling is used it should conform to Table 28.

Table 28 **Limitations on fire-protecting suspended ceilings**

Height of building or separated part m	Type of floor	Provision for fire resistance of floor min	Description of suspended ceiling [A)]
<18	Not compartment	⩽60	Type W, X, Y or Z
<18	Compartment	<60	Type W, X, Y or Z
<18	Compartment	60	Type X, Y or Z
⩾18	Any	⩽60	Type Y or Z
No limit	Any	>60	Type Z

Any access panels provided in fire protecting suspended ceilings of type Y or Z should be secured in position by releasing devices or screw fixings, and they should be shown to have been tested in the ceiling assembly in which they are incorporated.

NOTE 1 The national classifications do not automatically equate with the equivalent European classifications, therefore products cannot typically assume a European class unless they have been tested accordingly.

NOTE 2 When a classification includes "s3, d2" this means that there is no limit set for smoke production and/or flaming droplets/particles.

A) Ceiling type and description:

W = Surface of ceiling exposed to the cavity should be Class 0 or Class 1 (national) or Class C-s3, d2 or better (European).
X = Surface of ceiling exposed to the cavity should be Class 0 (national) or Class B-s3, d2 or better (European).
Y = Surface of ceiling exposed to the cavity should be Class 0 (national) or Class B-s3, d2 or better (European). Ceiling should not contain easily openable access panels.
Z = Ceiling should be of a material of limited combustibility (national) or of Class A2-s3, d2 or better (European) and not contain easily openable access panels. Any insulation above the ceiling should be of a material of limited combustibility (national) or Class A2-s3, d2 or better (European).

31.2.6 Portal frames

NOTE Extended fire protection measures might be needed for property and business continuity protection; see Annex A for details.

Portal frames for single-storey buildings do not necessarily need fire resistance, when regarded as structure only supporting a roof. However, portal frames need to be fire-protected where they are part of a compartment wall. Additionally, where a portal framed building is near a relevant boundary, the external wall near the boundary might need fire resistance to restrict the spread of fire between buildings (see **36.3.4**).

31.2.7 Supporting structure in different compartments

The recommended level of fire resistance varies according to the risk profile. Compartments in buildings containing different risk profiles may therefore have different structural fire resistance levels.

Provided that the element(s) separating two compartments are constructed to the higher of the two fire resistance levels, elements of structure within each compartment may be constructed to the level appropriate to its particular risk profile.

31.3 Glazed fire-resisting elements

31.3.1 General

The fire resistance performance of a fire-resisting glazed assembly is influenced by a number of factors, e.g.:

- type of glass and function;
- pane size and shape;
- glazing layout and number of panes;
- orientation of the glazed element;
- framing and framing junctions;
- glazing seal;
- beads and bead fixings;
- fixing of the assembly to the support structure.

Glazed elements, when incorporated into fire-resisting internal walls, partitions and screens, should provide a level of fire resistance equivalent to that of the structure into which they are installed. The level of fire resistance of a representative example of the glazed element should be demonstrated by testing in accordance with BS 476-22 or classification in accordance with BS EN 13501-2. Where the test evidence is not exactly the same as the glazed element to be installed – e.g. where the proposed glass size is greater than that tested – then a Notified Body, or an otherwise appropriately qualified body, might be able to undertake an assessment based on test evidence, or an extended application in accordance with the relevant CEN EXAP standard. Assessments should only be based on relevant and applicable test evidence for the system under consideration. The proposed glazing design should be within the scope of the available test evidence and the system should be specified and installed as tested and classified. There should be no changes in tested components unless authorized by the responsible glazing manufacturer.

For façade design, fire-resisting glazed elements may be used at appropriate locations to minimize the risk of fire spread in the same building from floor to floor, or on the same floor across re-entrant corners, by preventing flame break-out and break-in. The recommended distance for the application of fire-resisting glazing either side of such a re-entrant corner, or on either side of a protected stair with an external glazed wall, is 1 800 mm (see **18.2.3**). Specific guidance for all-glass constructions in atria is given in Annex B.

Where applicable, glass in fire-resisting glazed elements should conform to BS 6262-4 for impact safety, BS 6180 if used in a barrier, and BS 5234 if used in a partition.

All fire-resisting glass should be marked, as a minimum, with an identifiable name or trademark, or other mark, capable of unambiguous identification to the manufacturer or supplier. For example, this could be a product name, manufacturer's name or code. Installations should follow glazing guidelines provided by the manufacturer, and the glass should be installed in such a way that the identification mark is visible after installation. Appropriate documentation to confirm the system level of fire resistance should be provided on completion of the installation.

31.3.2 Limitations of non-insulating fire-resisting glazing

Restrictions apply to the use of non-insulating fire-resisting glazed elements because of the risks that they pose from their relative inability to afford adequate protection against transmitted heat (see Table 29). In this respect there are four possible hazards to consider, even if the integrity of the glazed element as a flame and smoke barrier is maintained. These are:

- direct exposure to potentially high levels of radiant heat with the risk of burns to exposed skin;
- convective heating of the atmosphere in the escape way;
- smouldering smoke generation (before ignition) from floor coverings, fixtures and fittings in the corridor;
- secondary ignition and flaming of fixtures and fittings in the escape way.

To minimize the risk of ignition of adjacent floorings or floor coverings, non-insulating glazed areas in fire-resisting structures should be at least 100 mm above floor level. The risk of smouldering combustion before flaming occurs can also be heightened on the nominally protected side of non-insulated glazing under developed fire conditions. It might therefore be appropriate to raise the limiting height above floor level for non-insulated fire-resisting glass – e.g. from 100 mm to at least 500 mm – to minimize the risk of smoke generation in the escape way affecting safe escape or fire-fighter access, depending on the anticipated fire load and escape conditions.

Glazed elements that are fire-resisting in terms of integrity only (i.e. non-insulating) should be in accordance with the limitations given in Table 29 for the appropriate position and number of escape stairs.

Glazed elements that are fire-resisting in terms of both integrity and insulation to the required level may be used without restriction (but see **21.2** regarding fire-fighting shafts).

Similar considerations also govern the use of integrity with insulation fire-resisting glazed elements, instead of integrity only fire-resisting glazed elements, for the protection of property against fire, when fire exposure may be prolonged.

31.3.3 Glazed screen separating protected shaft from lobby or corridor

A non-insulated fire-resisting glazed screen may be incorporated in the enclosure to a protected shaft between a stair and a lobby or corridor which is entered from the stair if the following conditions are satisfied:

a) the standard of fire resistance for the stair enclosure is not more than 60 min; and

b) the glazed screen:

   1) has at least 30 min fire resistance in terms of integrity; and

   2) meets the limits on areas of non-insulated glazing given in Table 29;

c) the lobby or corridor is enclosed to at least a 30 min standard.

Table 29 **Limitations of non-insulating fire-resisting glazed elements**

Position of glazed element	**Maximum total non-insulating fire-resisting glazed area**			
	For risk profiles A1, A2, A3, B1, B2, C1 and C2: premises or parts of premises with access to more than one stairway A), B)		**For all risk profiles: premises or parts of premises served by a single stairway; also for risk profiles B3, C3 served by more than one stairway** A)	
	Fire-resisting walls C), D)	**Any leaf of a fire door** D), E)	**Fire-resisting walls** C), D)	**Any leaf of a fire door** D), E)
Directly between a protected stairway and the floor area or a non-fire-resisting corridor	Unlimited above 1.1 m height F)	50% of door area	Nil	25% of door area
Between a protected stairway and an enclosed car park	Nil	50% of door area	Nil	25% of door area
Between a protected stairway and a protected lobby or protected corridor	Unlimited above 0.1 m height	Unlimited above 0.1 m height	Unlimited above 1.1 m height	Unlimited above 0.1 m height
Between a protected lobby and the accommodation (except residential buildings)	Unlimited above 0.1 m height	Unlimited above 0.1 m height	Unlimited above 1.1 m height	Unlimited above 0.1 m height
Between a protected corridor forming a dead end and the accommodation (except residential buildings)	Unlimited above 1.1 m height	Unlimited above 0.1 m height	Unlimited above 1.1 m height	Unlimited above 0.1 m height
Between a protected corridor not forming a dead end and the accommodation	Unlimited above 0.1 m height	Unlimited above 0.1 m height	Not applicable	Not applicable
Subdividing corridors	Unlimited above 0.1 m height	Unlimited above 0.1 m height	Not applicable	Not applicable
Between any escape route and ancillary accommodation	Nil	0.1 m^2 maximum	Nil	0.1 m^2 maximum
Refuge areas (see **G.3.1**)	Unlimited above 2.0 m height	0.1 m^2 maximum	Unlimited above 2.0 m height	0.1 m^2 maximum
Fire-fighting shafts	Unlimited above 2.0 m height	0.1 m^2 maximum	Unlimited above 2.0 m height	0.1 m^2 maximum
Adjacent to an external stair (see Section **5**)	Unlimited above 1.1 m height F)	Unlimited above 1.1 m height F)	Nil	25% of door area

A) For risk profiles A4, B4 and C4, see Table 4.
B) Limits may be relaxed for risk profiles A1 and B1 where it is clear that escape can take place during the early stages before significant fire development occurs, provided that there is no detriment to fire-fighter safety.
C) The size of individual panes of glass making up the permitted total glazed area should be limited to sizes that have been satisfactorily demonstrated to conform to the relevant criteria for an appropriate duration under test. Similarly, any mullions or transoms, especially between adjacent glazed elements, should also be proven.
D) The limits on the use of non-insulated fire-resisting glass may be increased where it is considered that the door or wall heightens the risks of safe escape or safe fire-fighter access during the developed stages of a fire, e.g. raising the allowed height from 0.1 m to 0.5 m.
E) The suitability of any door with respect to incorporating fire-resisting glass should be established before glazing. Moreover, not all doors can be glazed without affecting the integrity of the door assembly.
F) Measured vertically from the landing floor level or the stair pitch line.

32 Compartmentation

32.1 General

The spread of fire within a building can be restricted by subdividing the building into compartments, separated from one another by walls and/or floors of fire-resisting construction. The same approach can be applied to prevent fire spread between buildings that are close together. Compartmentation, horizontal or vertical, can also be used as part of an escape strategy to create areas of relative safety (see Section **5**).

On any one storey in a building, compartmentation can be necessary in the interests of occupant safety:

a) to meet travel distance limits;

b) to enclose a special fire hazard;

c) to support a progressive horizontal evacuation strategy;

d) to support a phased evacuation strategy;

e) to separate areas having different risk profiles if different standards of fire resistance, or different means of escape, apply;

f) if the compartment size would otherwise exceed the prescribed limit for the standard of fire resistance proposed;

g) if there are occupants who need to stay in the building for as long as possible despite the fire, usually for operational safety reasons, e.g. an air traffic control centre.

In tall multi-storey buildings, it can be advisable for each storey to be a separate compartment capable of resisting burn-out. This can protect occupants who might have to exit past the fire storey when a fire is well developed, and can also protect fire-fighters who might have to work on storeys immediately above or below a fire when it is well developed.

Compartmentation also contributes to business continuity protection by limiting the extent of fire damage, which can have direct and consequential benefits for post-fire recovery.

Elements that have a fire-separating function include:

1) enclosures protecting means of escape (see Clause **18**);

2) compartment walls and floors (see **32.4**);

3) walls common to two buildings (see **32.4.1.2**);

4) ground floors over basements (see **32.4.1.3**);

5) basement floors, other than the lowest, in any building with a floor at more than 10 m below ground level (see **32.4.1.3**);

6) any part of a roof forming an escape route (see **17.3.12** and **32.5.5**);

7) elements provided to separate areas occupied by different owners or tenants in the same occupancy characteristic other than in occupancy characteristic A buildings (see **6.2** and **32.4.1.5**);

8) elements separating areas occupied for different purposes (unless the different purpose is ancillary to the main one) (see **18.3.4**);

9) floors in occupancy characteristic Ci, Cii and Ciii, and in any building with a floor at more than 30 m above ground level (see **32.4.3** and **32.4.4**);
10) elements separating dwellings from the common parts of a block of flats (see **32.4.3**);
11) enclosures to protected shafts (see **32.5.6.2** and Clause **33**);
12) elements enclosing a fire-fighting shaft (see **32.5.6.2**, Clauses **33** and **34**);
13) elements such as doors that protect openings in compartment walls (see Clause **33**);
14) fire dampers (see Clause **33**);
15) fire-resisting ductwork (see Clause **33**);
16) cavity barriers (see Clauses **33** and **34**);
17) fire-resisting ceilings (see Clauses **31** and **34**);
18) fire-protected air transfer grilles (see **33.4.9**);
19) parts of external walls forming protected areas for space separation purposes (see Clause **36**).

32.2 Fire resistance of compartments

NOTE The fire-resistance classification periods are not a measure of the actual time for which an element will function in a real fire.

The fire resistance periods given in Table 25 and Table 26 are based upon the elements of structure surviving a burn-out.

For property protection purposes, the construction separating one compartment from another is usually expected to withstand the burn-out of the contents of the compartment. This applies to the integrity, insulation, and if relevant the load-bearing functions of the separating elements. The size and relationship of compartments should be based on the maximum acceptable loss, and the criticality of items or activities in the building. The risk management strategy may focus on contingency rather than physical forms of protection.

A sprinkler system, suitably designed and installed for the hazard to be protected, can be expected to prevent the rate of heat release from significantly exceeding that at the time of sprinkler operation. In most instances it will assist in controlling the fire. The fire resistance of the compartment walls and floors can therefore be reduced in a sprinklered building or compartment.

32.3 Size of compartments

Compartment sizes should be not more than the maximum sizes given in Table 30 for the appropriate risk profile.

Compartment sizes can be increased in a sprinklered building or compartment (see **6.5**).

Table 30 **Maximum dimensions of compartments**

Risk profile	**Single storey**	**Multi storey**	
	Maximum floor area m^2	**Height of top floor** m	**Maximum floor area** m^2
A1	No limit	No limit	No limit
A2	No limit	<30	No limit
		>30	Not applicable
A3	No limit	<18	14 000
		18 to 30	4 000
A4 [A)]	Not applicable [A)]	Not applicable [A)]	Not applicable [A)]
B1	No limit	<30	No limit
		>30	Not applicable
B2	No limit	<18	8 000
		No limit	4 000
B3	2 000	No limit	2 000
B4 [A)]	Not applicable [A)]	Not applicable [A)]	Not applicable [A)]
C1	No limit	No limit	No limit
C2	No limit	<30	No limit
C3 [A)]	No limit	Not applicable	Not applicable
C4 [A)]	Not applicable [A)]	Not applicable [A)]	Not applicable [A)]

[A)] See Table 4.

32.4 Provision of compartmentation

32.4.1 All occupancy characteristics

32.4.1.1 Atria

NOTE Recommendations for and guidance on the treatment of openings in compartment walls and floors are given in Clause ***33****.*

Where a building contains an atrium, the effect of the atrium on compartmentation between storeys can be disregarded if the recommendations of Annex B are met.

32.4.1.2 Party walls

A wall common to two or more buildings should be constructed as a compartment wall.

32.4.1.3 Basements

Each basement storey should be a separate compartment if there is a basement floor more than 10 m below ground level (the floor level of lift shafts, sumps or service ducts can be ignored).

The ground floor over a basement should be a compartment floor unless:

a) the building is in occupancy characteristic Ci; or

b) the building comprises one basement storey and not more than two other storeys, and no storey is more than 280 m^2 in area; or

c) the basement and ground storeys are part of a small shop having no more than three storeys, none of which is more than 280 m^2 in area; or

d) the ground floor is penetrated by an atrium that conforms to the relevant recommendations of Annex B.

32.4.1.4 Buildings designed for a phased evacuation strategy

Floors in a building designed for a phased evacuation strategy (see Section **5**) should be constructed as compartment floors.

32.4.1.5 Multi-tenancy buildings

Where walls are provided to separate different tenancies in a building or part of a building, they should be constructed as compartment walls, even if the tenancies are in the same occupancy characteristic, except in office buildings in occupancy characteristic A.

32.4.2 Occupancy characteristic A and B

The following walls and floors should be constructed as compartment walls and compartment floors (see Figure 24):

a) every wall needed to subdivide the building to observe the size limits on compartments in multi-storey buildings given in Table 30;

b) every floor above ground level, if the building, or separated part of the building, has a storey with a floor at a height of more than 30 m above ground level;

c) the floor of the ground storey, if the building has one or more basements (with the exception of small basements and shops; see **32.4.1.3**);

d) the floor of every basement storey, except the lowest floor, if the building or separated part of the building has a basement depth of more than 10 m below ground level.

32.4.3 Occupancy characteristic Ci

32.4.3.1 Compartment floors

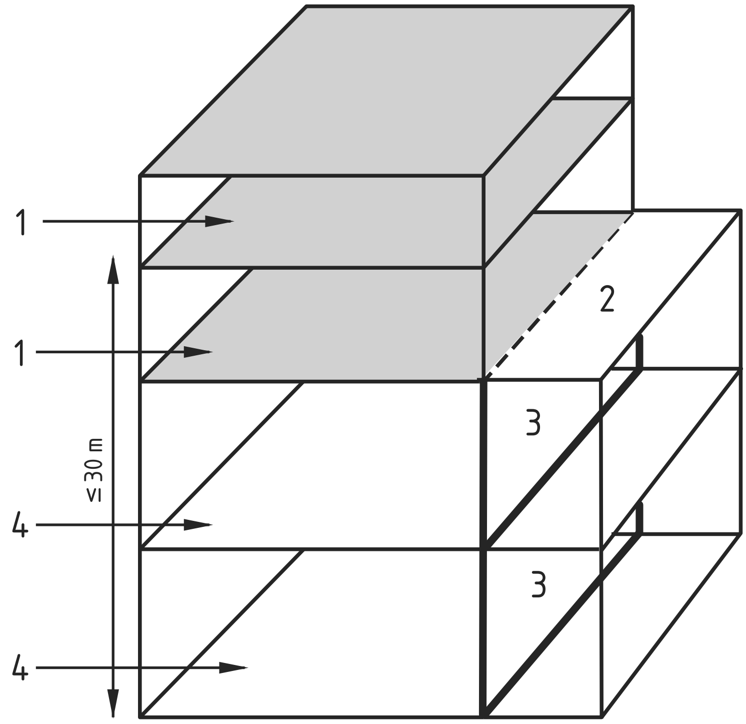
All floors should be constructed as compartment floors, except a floor between one level and another within one flat.

32.4.3.2 Compartment walls

Any wall separating a flat from any other part of the building (excluding external access balconies or access decks) should be a compartment wall.

Walls separating a refuse storage chamber or the access point to a refuse chute from other parts of the building should be compartment walls.

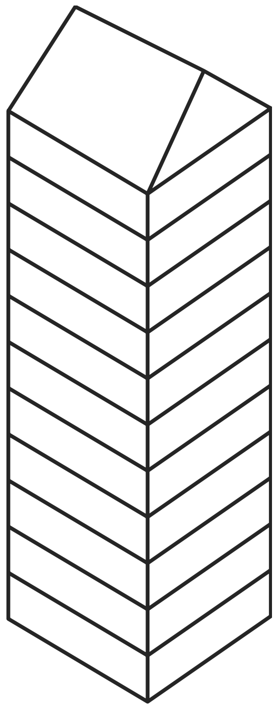
Figure 24 **Compartment floors**



None of the floors in this case would need to be compartment floors, but the two storeys exceeding 2 000 m^2 would need to be divided into compartments not more than 2 000 m^2 by compartment walls.

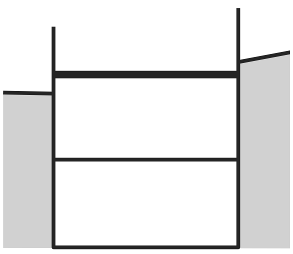
NOTE The compartment walls in this example do not need to be in one vertical plane.

a) Example of compartmentation in an unsprinklered shop



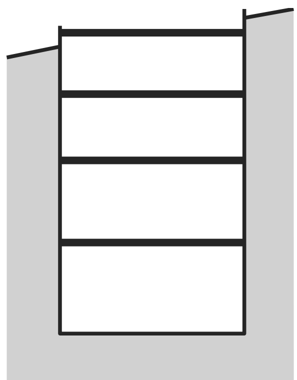
In a building over 30 m in height, all storeys should be separated by compartment floors. For advice on the special conditions in atrium buildings see Annex B.

b) Compartmentation in tall buildings



Only the floor of the ground storey need be a compartment floor if the lower basement is at a depth of not more than 10 m.

c) Shallow basements



All basement storeys should be separated by compartment floors if any storey is at a depth of more than 10 m.

d) Deep basements

Key

1 Storey not exceeding 2 000 m^2
2 Roof
3 Compartment wall
4 Storey exceeding 2 000 m^2 divided by compartment wall

32.4.4 Occupancy characteristic Cii and Ciii

All floors in occupancy characteristic Cii and Ciii buildings should be compartment floors.

32.5 Construction of compartment walls and compartment floors

NOTE Recommendations for openings in construction are given in Clause ***33****. Recommendations for the use of glazing in fire-resisting elements are given in* ***31.3****.*

32.5.1 General

Every compartment wall and floor should:

a) form a complete barrier to fire spread between the compartments; and

b) have the appropriate fire resistance indicated in Table 25 or Table 26.

Timber beams, joists, purlins and rafters may be built into or carried through a masonry or concrete wall if the openings for them are kept as small as practicable and fire-stopped. If trussed rafters bridge the wall they should be designed such that the failure of part of the truss in one compartment would not cause the failure of the part in the other compartment.

Compartment walls should run the full height of the storey in which they are situated (see **32.5.5**). Where a compartment floor projects beyond the face of a lower storey, the fire resistance should be maintained over the full extent of the floor.

32.5.2 Compartment walls between buildings

NOTE This does not apply to compartment walls that are used to divide a single building into separate occupancies or tenancies.

Compartment walls that are common to two or more buildings (e.g. party walls) should run the full height of the building in a continuous vertical plane. Thus adjoining buildings should be separated only by walls, not by floors.

32.5.3 Separated parts of buildings

Compartment walls used to form a separated part of a building, so that the separated parts can be assessed independently for determining the appropriate fire resistance, should run the full height of the building in a continuous vertical plane. The two separated parts may have different standards of fire resistance.

32.5.4 Junction of compartment wall or compartment floor with other walls

Where a compartment wall or compartment floor meets another compartment wall, or an external wall, the junction should maintain the fire resistance of the compartmentation.

NOTE Where compartment walls are located within the middle half of a floor between vertical supports, the predicted deflection may be assumed to be 40 mm unless a smaller value can be justified by assessment. Outside this area the limit can be reduced linearly to zero at the supports. For steel beams that do not have the required fire resistance, see the Steel Construction Institute publication P288 [35].

Compartment walls should be able to accommodate the predicted deflection of the floor above by either:

a) having a suitable head detail between the wall and the floor, which can deform but maintains integrity when exposed to a fire; or

b) designing the wall to resist the additional vertical load from the floor above as it sags under fire conditions, and thus maintain integrity.

32.5.5 Junction of compartment wall with roof

A compartment wall should be taken up to meet the underside of the roof covering or deck, with fire-stopping where necessary at the wall/roof junction to maintain the continuity of fire resistance.

If a fire penetrates a roof near a compartment wall, there is a risk that it could spread over the roof to the adjoining compartment. To reduce this risk, a zone of roof 1.5 m wide on either side of the wall should have a covering of designation AA, AB or AC (see **36.5.2**) on a substrate or deck of a material of limited combustibility, as set out in Figure 25.

In buildings not more than 11 m high, in occupancy characteristic A, B, Ci and Cii buildings, combustible boarding used as a substrate to the roof covering, wood wool slabs, or timber tiling battens, may be carried over the compartment wall provided that they are fully bedded in mortar or other suitable material over the width of the wall (see Figure 25).

32.5.6 Continuity of compartment construction

32.5.6.1 General

The continuity of compartmentation should be maintained at the junctions of the fire-resisting elements and at the junctions of external walls with compartment walls and floors.

*NOTE Recommendations for and guidance on the protection of openings in fire-resisting construction, including compartment walls and floors, are given in Clause **33**.*

Openings between compartments should be protected so that they do not represent a weakness.

32.5.6.2 Protected shafts

32.5.6.2.1 General

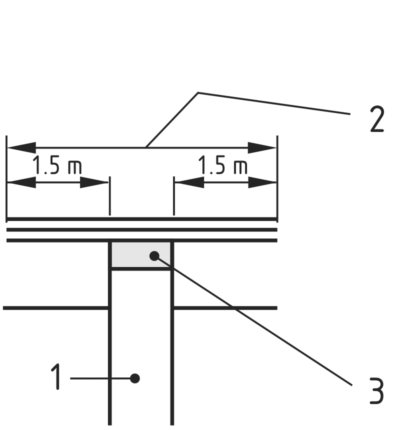
Spaces that connect compartments, such as stairways and service shafts, should be protected to restrict fire and smoke spread between the compartments.

Any walls or floors bounding a protected shaft are deemed to be compartment walls or floors.

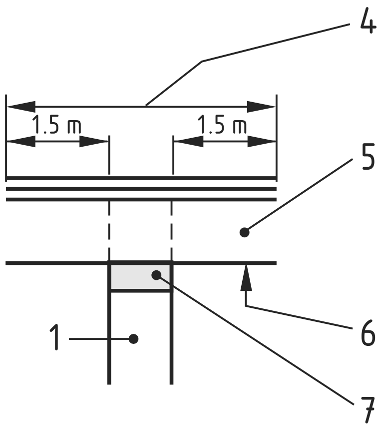
Any external wall to a protected shaft does not need to be a compartment wall, but some fire resistance might be needed (see **32.5.6.2.2**).

A section of roof over a protected shaft does not need to be a compartment floor.

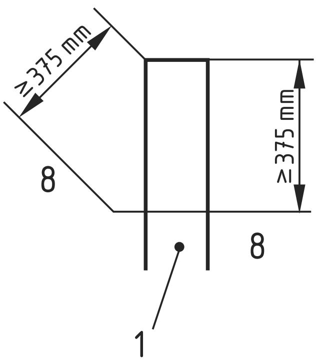
Figure 25 **Junction of a compartment wall with a roof**



a) Building or compartment of any height or any use – roofs at same level



b) Building or compartment in residential (not institutional) office or assembly, not more than 15 m high



c) Building or compartment of any height or any use – roofs at different levels

Key

1 Wall
2 Roof covering this distance to be designated AA, AB or AC on deck of material of limited combustibility. Roof covering and deck could be composite structure, e.g. profiled steel cladding. Double-skinned insulated roof sheeting should incorporate a band of material of limited combustibility of at least 300 mm wide, centred over the wall.
3 Resilient fire-stopping to be carried up to underside of roof covering
4 Roof covering to be designated AA, AB or AC for at least this distance
5 Boarding (used as substrate) wood wool slabs or timber battens may be carried over the wall provided that they are fully bedded in mortar (or other no less suitable material) where over the wall
6 If roof support members pass through the wall, fire protection to these members for a distance of 1.5 m on either side of the wall might be needed to delay distortion at the junction
7 Fire-stopping to be carried up to underside of roof covering, boarding or slab
8 Roof covering

32.5.6.2.2 Fully enclosed or partially enclosed courtyard spaces

Some fully enclosed or partially enclosed vertical courtyard spaces or voids, such as light-wells or external facing walls of a single building (e.g. recesses), may also incorporate vertical or horizontal compartment boundaries. A fire in one compartment which breaks out into the void (e.g. from a window or other non-fire resisting element) can therefore spread fire across or over the vertical or horizontal compartment boundaries, where facing or adjoining re-entrant walls are close to each other.

NOTE For more complex geometries refer to BR 187 [36] or CIBSE Guide E [37].

Any fully enclosed or partially enclosed vertical courtyard spaces with facing walls within 5 m of each other and where vertical or horizontal compartmentation is bounded by the space, should be treated as protected shafts unless the building is sprinkler-protected throughout.

Any fully enclosed or partially enclosed vertical courtyard spaces with adjoining re-entrant walls where vertical or horizontal compartmentation lines within 5 m of each other are bounded by the space, should be treated as protected shafts unless the building is sprinkler-protected throughout.

32.5.6.3 Protected stairways

A stair linking one compartment to another should be in a protected shaft. A stair between two or more storeys in the same compartment should be a protected stairway, if the entrances to it at each level are to be treated as storey exits.

Where a protected stairway projects beyond, or is recessed from, or is an internal angle of, the adjoining external wall of the building, then the distance between any unprotected area in the external enclosures to the building and any unprotected area in the enclosure to the stairway, should be at least 1.8 m (see **36.4**).

The enclosure of a protected stairway should have a fire resistance of not less than 30 min when tested in accordance with BS 476-21 or BS 476-22, or the European equivalents BS EN 1363, BS EN 1364 or BS EN 1365. The fire resistance performance of the enclosure of a protected shaft containing a stairway should be the same as the fire resistance performance of the compartment.

32.5.6.4 Lift shafts

Lift shafts linking compartments should be in protected shafts having the same standard of fire resistance as the floors through which they pass. In buildings designed for phased evacuation, where a lift well is not contained in a protected stair, there should be smoke-retarding construction between the lifts and the accommodation. This could be a lobby with self-closing smoke-sealed doors.

32.5.7 Areas of ancillary accommodation

Ancillary accommodation should be separated from other parts of the building in accordance with Table 31.

Table 31 **Structural fire protection of areas of ancillary accommodation**

	Area of ancillary accommodation	Type of construction needed to separate ancillary accommodation from other parts of the building
1	Storage areas not greater than 450 m^2 (other than refuse storage areas)	Robust construction having a minimum standard of fire resistance of 30 min [A)]
2	Repair and maintenance workshops where flammable or highly flammable liquids are not used or stored	
3	Kitchens (separately or in conjunction with an associated staff restaurant or canteen)	
4	Transformer, switchgear, and battery rooms for low-voltage or extra-low-voltage equipment	
5	Engineering services installation rooms (other than those covered by items 8, 15 and 19)	
6	Dressing rooms or changing rooms	
7	Cinema projection rooms [B)]	
8	Storage areas greater than 450 m^2 (other than refuse storage areas)	Robust solid non-combustible construction having a minimum standard of fire resistance of 60 min [A)]
9	Car parks within or adjoining the building and not greater than 450 m^2 in area	
10	Service installation rooms (other than those covered by items 4, 16, 19, 18, 19)	
11	Places classified as high fire risk areas	
12	Repair and maintenance workshops where flammable or highly flammable liquids are used or stored	
13	Covered loading bays and storage areas other than those covered in items 1 and 8	Robust solid non-combustible construction having a minimum standard of fire resistance equivalent to that required for the elements of construction of the building and in no case less than 60 min [A)]
14	Car parks within or adjoining the building and greater than 450 m^2 in area	
15	Refuse storage areas	
16	Boiler rooms	
17	Fuel storage spaces	
18	Transformer and switchgear rooms for equipment above low voltage	
19	Rooms housing fixed internal combustion engine(s)	
20	Scene docks	

A) Any openings in the required construction should be protected by doors having a similar standard of fire resistance.

B) Attention is drawn to the Cinematograph (Safety) Regulations 1955 [38] in particular in respect of cellulose nitrate film.

33 Openings

*NOTE The use of fire-resisting elements to separate the building into compartments and to protect escape routes is an important feature of the guidance in Clauses **31** and **32**. This clause gives recommendations for the provision of openings in such separating elements and the avoidance of fire and smoke spread through them.*

33.1 Fire doors

33.1.1 General

Doors in fire-separating elements (see **32.1**) are one of the most important features of a fire protection strategy, and it is important to select a fire door that is suitable for its intended purpose. They are normally self-closing unless they give access to cupboards or service risers, in which case they should be kept locked. The reliability of a fire door, especially in heavily-trafficked places, can be improved by hold-open devices that release the door automatically in response to a fire.

Fire doors have at least one of two functions:

a) to protect escape routes from the effects of fire so that occupants can reach a final exit;

b) to protect occupants, fire-fighters and the contents and/or structure of a building by limiting the spread of fire.

In a closed room a fire sets up pressure differences that cause leakage of gaseous products of combustion through door and window leakage paths in the upper part of the room, and draw in air through leakage paths in the lower part of the room.

Fire doors need to have a certain level of integrity and, in many cases, smoke control (see **33.1.7**), but they do not usually need to be insulated, as there is no fire load immediately next to a door (it is normally part of a circulation route) for fire to spread by contact with the door surface. However, if fire doors are not insulated there needs to be some limitation on the proportion of doorway openings in compartment walls and, except for walls less than 5 m in length, no more than 25% of the length of a compartment wall should consist of door openings.

33.1.2 Installation

NOTE Recommendations for the specification, installation and maintenance of hinged or pivoted pedestrian fire doors are given in BS 8214.

The failure of doors under fire conditions usually occurs either at the gap between the door and the frame, or at one or more of the points where building hardware is fixed (particularly at the hinges or lock positions) or, in the case of glazed doors, at the line of the junction between the glazed area and the rest of the door. For this and other reasons, it is particularly important to ensure that doors installed on site conform, in dimensions and workmanship, to the manufacturer's specification for the appropriate fire resistance test report/assessment. Doors should be hung to ensure a good fit to the frame when closed and the junction between door assembly and surrounding structure should be adequately sealed.

33.1.3 Fire resistance

NOTE 1 Fire authorities and insurance companies might require higher fire performance than that recommended in this British Standard.

NOTE 2 Guidance of performance appropriate to insurance requirements can be found in the LPC Design guide for the fire protection of buildings *[39]. This addresses the use of uninsulated doors and criteria for longevity and robustness in normal usage.*

NOTE 3 In Table 32, where a fire door also needs to provide smoke control it has the suffix "S".

The fire resistance of fire doors should be not less than the value given in Table 32 for the appropriate location. Unless otherwise recommended, the fire resistance should in all cases be not less than 30 min from either side, except in the case of doors to lift wells, where the fire resistance only needs to be from the landing side.

Table 32 **Provisions for fire doors**
Values in minutes

Position of door		**Minimum fire resistance of door in terms of integrity** A)	
		When tested in accordance with BS 476-22 B)	**When tested in accordance with BS EN 1634-1**
1	In a compartment wall separating buildings	As for the wall in which door is fitted, but not less than 60 min	As for the wall in which the door is fitted, but not less than 60 min
2	In a compartment wall:		
a	if it separates a flat from a space in common use	FD 30S C)	E 30 S_a C)
b	enclosing a protected shaft forming a stairway situated wholly or partly above the adjoining ground in occupancy characteristic A (office only), B, Ci, Cii and Ciii buildings	FD 30S C)	E 30 S_a C)
c	enclosing a protected shaft forming a stairway not described in 2b)	Half the period of fire resistance of the wall in which it is fitted but not less than 30 min and with suffix S C)	Half the period of fire resistance of the wall in which it is fitted but not less than 30 min minimum and with suffix S_a C)
d	enclosing a protected shaft forming a lift or service shaft	Half the period of fire resistance of the wall in which it is fitted but not less than 30 min	Half the period of fire resistance of the wall in which it is fitted but not less than 30 min
e	not described in 2a), 2b), 2c) or 2d)	As for the wall it is fitted in, but with suffix S if the door is used for progressive horizontal evacuation	As for the wall it is fitted in, but add S_a C) if the door is used for progressive horizontal evacuation
3	In a compartment floor	As for the floor in which it is fitted	As for the floor in which it is fitted
4	Forming part of the enclosure of:		
a	a protected stairway (except where described in item 10)	FD 30S C)	E 30 S_a C)
b	the separation between upward and downward flights of a basement stair (see Section **5**)	FD 30S C)	E 30 S_a C)
c	lift shaft, which does not form a protected shaft in 2b), 2c) or 2d)	FD 30	E 30

Table 32 **Provisions for fire doors** (*continued*)
Values in minutes

Position of door		Minimum fire resistance of door in terms of integrity A)	
		When tested in accordance with BS 476-22 B)	**When tested in accordance with BS EN 1634-1**
5	Forming part of the enclosures of:		
a	a protected lobby approach (or protected corridor) to a stairway, except for a fire-fighting stair	FD 30S C)	E 30 S_a C)
b	any other protected corridor, or	FD 20S C)	E 20 S_a C)
c	a protected lobby approach to a lift shaft	FD 30S C)	E 30 S_a C)
6	Forming part of the enclosures of:		
a	evacuation lifts or refuges, except for lift landing doors	FD 30S C)	E 30 S_a C)
b	evacuation lifts, where the door is a lift landing door	FD 30	E 30
7	Affording access to an external escape route	FD 30	E 30
8	Subdividing:		
a	corridors connecting alternative exits	FD 20S C)	E 20 S_a C)
b	dead-end portions of corridors from the remainder of the corridor	FD 20S C)	E 20 S_a C)
9	Any door:		
a	within a cavity barrier	FD 30	E 30
b	forming part of the enclosure to a communal area in sheltered housing	FD 30S C)	E 20 S_a C)
10	Any door:		
a	forming part of the enclosure to a protected entrance hall or protected landing in a flat	FD 20	E 20
b	within any other fire-resisting construction in dwelling accommodation not described elsewhere in this table	FD 20	E 20

NOTE 1 For fire-fighting shafts, see ***21.2****.*

NOTE 2 The national classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly.

A) Fire doors are designated by reference to their recommended performance (in minutes) for integrity only, and whether they need to retard the passage of smoke at ambient temperature. The need to include insulation as part of the specification is dependent on the function of the door. For example, reference FD 60 is to a door that should achieve not less than 60 min integrity when tested in accordance with BS 476-22 or BS EN 1634-1.

B) Or with BS 476-8, in respect of items tested or assessed prior to 1 January 1988.

C) See **33.1.7**.

Two doors in series of half the level of fire resistance of a compartment wall may be used instead of a single door, provided that neither of the two doors has a fire resistance of less than 30 min and each door is capable of closing the opening. In such a case, if the opening is provided as a means of escape, both doors should be self-closing and neither should be a shutter, but one of them may be fitted with an self-closing device and be held open by a fusible link if the other door is capable of being easily opened by hand.

Where a fire resistance period in excess of 60 min is to be achieved by the use of two doors in series, the incorporation of materials sensitive to thermal shock, such as glass, should be avoided unless test evidence is available to support the use of these materials.

33.1.4 Glazing in fire doors

Where glazed elements in fire-resisting enclosures and doors are only able to meet the relevant performance in terms of integrity (i.e. they are unable to meet the relevant performance in terms of insulation), the use of glass should be limited in accordance with **31.3**.

33.1.5 Lift landing doors

Where lift landing doors need to be fire doors, they should achieve the appropriate level of fire resistance in terms of integrity (see Table 24 and Table 32) when tested in accordance with BS 476-22 or BS EN 1634-1.

Imperforate steel panel lift landing doors are acceptable provided that all of the following criteria are met:

a) they are not directly exposed to the effects of fire through a fire-resisting lobby doorway to the accommodation; and

b) the structure of the lift lobby, including its floor, is of non-combustible construction; and

c) the lobby contains no significant fire load and its wall and ceiling linings are classified as Class 1 when tested in accordance with BS 476-7 or European Class C-s3, d2; and

d) the lift car is of substantially non-combustible construction.

33.1.6 Closure systems

33.1.6.1 Self-closing devices

Fire doors can only operate correctly if they are fully closed at the time of fire. It is, therefore, normally necessary for them to be fitted with a self-closing device. Fire doors, except to a cupboard or service duct (both of which are normally kept locked shut) and except lift landing doors, should be fitted with a self-closing device (other than rising-butt hinges) that should:

a) be of a type that cannot readily be disconnected or immobilized and does not embody a mechanical hold-open facility unless it automatically releases the door in a fire situation (see **33.1.6.2**); and

b) override any latches fitted to the door, or in the absence of a suitable latch or other positive device for holding the door shut in its frame, be of a type that when tested in accordance with BS 476-8 or BS 476-22 or BS EN 1634-1 is shown to be able to hold the door closed in the frame for a sufficient period of time for the closing role to be taken over by a thermally activated sealing device (e.g. an intumescent seal), or throughout the full period of exposure if such seals are not incorporated; and

c) for swing doors, conform to BS EN 1154.

Self-closing fire doors are more likely to be propped open, and thus rendered ineffective, by the occupants of a building if the doors are regarded as an impediment to access. Poorly specified self-closing devices can make fire doors virtually impassable to some people, e.g. wheelchair users and those with limited upper body strength. Door closer forces should be limited to the minimum necessary to close the door reliably and effectively.

If the force needed to open a door on a circulation route exceeds 30 N, or if an automatic self-closing device would be considered a hindrance to the occupants of the building, then hold-open devices conforming to **33.1.6.2** should be used.

NOTE 1 BS 8300 states that, for most disabled people to have independent access through single or double swing doors, the opening force, when measured at the leading edge of the door, should be not more than 30 N from 0° (the door in the closed position) to 30° open, and not more than 22.5 N from 30° to 60° of the opening cycle. BS 8300 also gives more detailed guidance on the design of buildings and their approaches to meet the needs of disabled people.

NOTE 2 The opening force can be checked using a plunger-type force measuring instrument. Where measurements cannot be taken at the leading edge, they may be taken at a point on the face of the door up to 60 mm from the leading edge, a position approximately in line vertically with the spindle of a lever handle or the centre line of a pull handle or push plate, in which case the opening force limits can be increased by approximately 2 N. The accuracy of force measuring instruments available on the market varies and there are inherent difficulties in measuring forces on site. It is recognized, therefore, that any measurements are subject to a degree of imprecision which could give rise to variations of between 2 N and 3 N.

A fire door to a cupboard or refuse chamber or service duct, if it is not self-closing, should have means to enable it to be kept locked shut when not in use and should be so marked on the outside with the appropriate sign conforming to BS 5499-1.

33.1.6.2 Hold-open devices

NOTE 1 BS EN 1155 specifies requirements for separate hold-open devices and also for hold-open mechanisms incorporated in a door closer. Devices manufactured in accordance with BS EN 1155 can hold a swing door at a fixed position or can allow the door to swing freely. BS 5839-3 specifies requirements for certain automatic release mechanisms intended to hold open (or closed) fire protection equipment, such as fire doors, fire shutters, fire dampers, etc., which are outside the scope of BS EN 1155.

NOTE 2 BS 7273-4 gives recommendations for the design, installation, commissioning and maintenance of electrical control arrangements for actuation of mechanisms that unlock, release or open doors in the event of fire.

Hold-open devices are used either to hold a fire door in the open position, against the action of a door closer, or to allow it to swing freely, automatically releasing the closing mechanism in a fire situation. Fire doors may be held open by one of the following:

a) a fusible link or heat detector (unless the door is fitted in an opening provided as a means of escape, or to protect a means of escape);

b) an automatic release mechanism actuated by an automatic fire detection and alarm system;

c) a delayed closing device with the delay adjusted not to exceed 25 s.

The automatic release mechanism should allow the door closing device to resume its self-closing function in the event of one or more of the following:

- the detection of smoke by suitable automatic apparatus;
- the detection of heat or smoke by any in-built sensing device;
- failure of the power supply;
- operation of the fire alarm system;
- local manual operation;
- if the facility is provided, a manual operation at a central control point.

Such doors should be marked on both sides, at approximately eye level, with the appropriate sign conforming to BS 5499-1.

33.1.7 Smoke sealing of fire doors

NOTE 1 When other methods of smoke control are provided in buildings, e.g. pressurization, the smoke control criteria for doors might not be applicable, depending on the design of the system, and in particular the air flow path(s).

NOTE 2 Smoke leakage control can be applied to non-fire-resisting doorsets.

A fire door that is needed to resist the passage of smoke at ambient temperature conditions, i.e. fire doors having suffix S (see **33.1.3** and Table 32), should either:

a) have a leakage rate not exceeding 3 m^3/h per metre, when tested in accordance with BS 476-31.1 with the threshold taped and subjected to a pressure of 25 Pa; or

b) meet the classification requirement of Sa when tested in accordance with BS EN 1634-3.

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

33.1.8 Building hardware

NOTE Specific guidance is available in the DHF/GAI code of practice Hardware for fire and escape doors [40]. General guidance is given in BS 8214. Guidance on fire-resisting metal doorsets is given in DHF publication CP 101/2 [41].

Building hardware used on fire-resisting doors can significantly affect their performance in the event of a fire.

Unless shown to be satisfactory when tested in accordance with BS 476-22 or BS EN 1634-1, no part of a hinge on which any fire door is hung, and which provides the means of support at the hanging edge, should be made either of combustible material or of non-combustible material having a melting point of not less than 800 °C.

All items of hardware for use on fire doors should be suitable for the type of door to which they will be fitted.

33.1.9 Fire door signage

All fire doors other than lift entrance doors should be marked with the appropriate fire safety sign conforming to BS 5499-1 according to whether the door is:

a) to be kept closed when not in use;

b) to be kept locked when not in use; or

c) held open by an automatic release mechanism.

Fire doors to cupboards and to service ducts should be marked on the outside. All other fire doors should be marked on both sides.

Lift entrance doors do not need to be marked.

33.2 Shutter assemblies

Shutter assemblies across a means of escape should be released only by a heat sensor, such as a fusible link or electric heat detector, in the immediate vicinity of the door. Closure of shutters in such locations should not be initiated by smoke detectors or a fire alarm system, unless the shutter is also intended to act as a smoke curtain.

Shutter assemblies should achieve the appropriate level of fire resistance in terms of integrity (see Table 24 and Table 32) when tested in accordance with BS 476-22 or BS EN 1634-1.

33.3 Access panels

Access panels should be of a construction that has at least the same fire resistance as the element they fit into. This can be achieved by having:

a) the recommended fire resistance from the outside; or

b) at least half the recommended fire resistance from each side; or

c) an automatic heat activated sealing device, which in the event of fire will close the opening to maintain the fire resistance recommended for the compartment wall or floor.

33.4 Service ducts, pipes and shafts

33.4.1 General

If an element that is intended to provide fire separation (and therefore has fire resistance in terms of integrity and insulation) is to be effective, then every joint, or imperfection of fit, or opening to allow services to pass through the element, has to be adequately protected by sealing or fire-stopping so that the fire resistance of the element is not impaired.

Fire, heat and smoke can spread by way of:

a) service openings, e.g. ductwork, pipework openings, chutes and ventilation trunking; or

b) horizontal or vertical voids between floors and ceilings.

It is therefore necessary to protect against fire and smoke spread using such measures as encasement, fire/smoke dampers, fire/smoke stopping, cavity barriers and fire resistance to service shafts. This is particularly important where services pass through compartment walls and compartment floors.

Tests on services and penetration seals should be carried out on the entire system. For example, the fire resistance of fire-stopping around ducts should be made on the duct and fire-stop all tested together, in accordance with BS 476-24.

More generally, fire resistance classifications from tests involving building services are made according to BS EN 1366-1 to BS EN 1366-11, and the relevant part of European classification systems BS EN 13501-2, BS EN 13501-3 and BS EN 13501-4.

33.4.2 Installation of ductwork systems

When ductwork systems are installed within a building it is important that the ductwork does not assist in transferring fire and smoke through the building and put at risk the protected means of escape from the accommodation areas.

Any exhaust points should be sited so as not to further jeopardize the building in the event of a fire, i.e. away from final exits, combustible building cladding or roofing materials, and openings into the building.

Ventilation ducts, and their associated plant supplying or extracting air directly to or from a protected escape route, should not also serve other areas. A separate ventilation system should be provided for each protected stairway.

Where a ductwork system serves more than one part of a compartmented or fire separated protected escape route, smoke detector operated fire dampers should be provided where ductwork enters each fire separated or smoke separated section of the escape route (see **33.4.5**).

The smoke detector operated fire dampers should be caused to close if smoke is detected. Any ductwork passing through an accommodation space should be fire-resisting, i.e. the ductwork should be constructed in accordance with method 2 or method 3 (see **33.4.3.3** and **33.4.3.4**).

Any ductwork passing through a protected stairway, lobby or corridor without an opening into that area should be fire-resisting, i.e. the ductwork should be constructed in accordance with method 2 or method 3 (see **33.4.3.3** and **33.4.3.4**).

*NOTE See also **33.4.9** for information and recommendations regarding transfer grilles.*

In single stairway buildings, the ductwork enclosure should be imperforate where it passes through the stairway or any protected lobby or protected corridor.

In multi-stairway buildings, ductwork access panels within protected escape routes should not reduce the fire resistance of the ductwork enclosure from the inside.

Where a service duct enclosure is provided with a level of fire resistance in accordance with BS 8313, and the service duct itself is also used for ventilation purposes, any grille or opening through the enclosure for ventilation purposes should be protected by a fire damper.

Service pipes containing toxic or flammable substances should not be routed in, or through, ductwork provided for ventilation purposes.

33.4.3 Methods for the protection of ductwork

33.4.3.1 General

There are various types of ductwork and functions for such ductwork, such as:

a) mechanical ventilation ductwork, used to introduce fresh/conditioned air into buildings, and remove stale/polluted air;

b) smoke extraction ductwork, used to extract products of combustion such as smoke and toxic gases, to aid escape of occupants from fire;

c) dual ventilation/smoke extract systems, normally used as conventional ventilation systems, but switched over to smoke extract use in event of fire;

d) separate independent extraction systems, due to the polluted nature of the extracted air, e.g. in kitchen extract systems.

Fire protection of ventilation ductwork is needed as an integral part of compartmentation and to ensure that means of escape from the building are not prejudiced. There are three basic methods, which are detailed in **33.4.3.2** to **33.4.3.4**. The three methods are not mutually exclusive and in most ductwork systems a combination of two, and occasionally all three, will best combat the potential fire dangers.

33.4.3.2 Method 1 – Protection using fire dampers

*NOTE 1 See also **33.4.5**.*

NOTE 2 Guidance on fire dampers is provided in the ASFP publication The installation of fire and smoke resisting dampers *[42].*

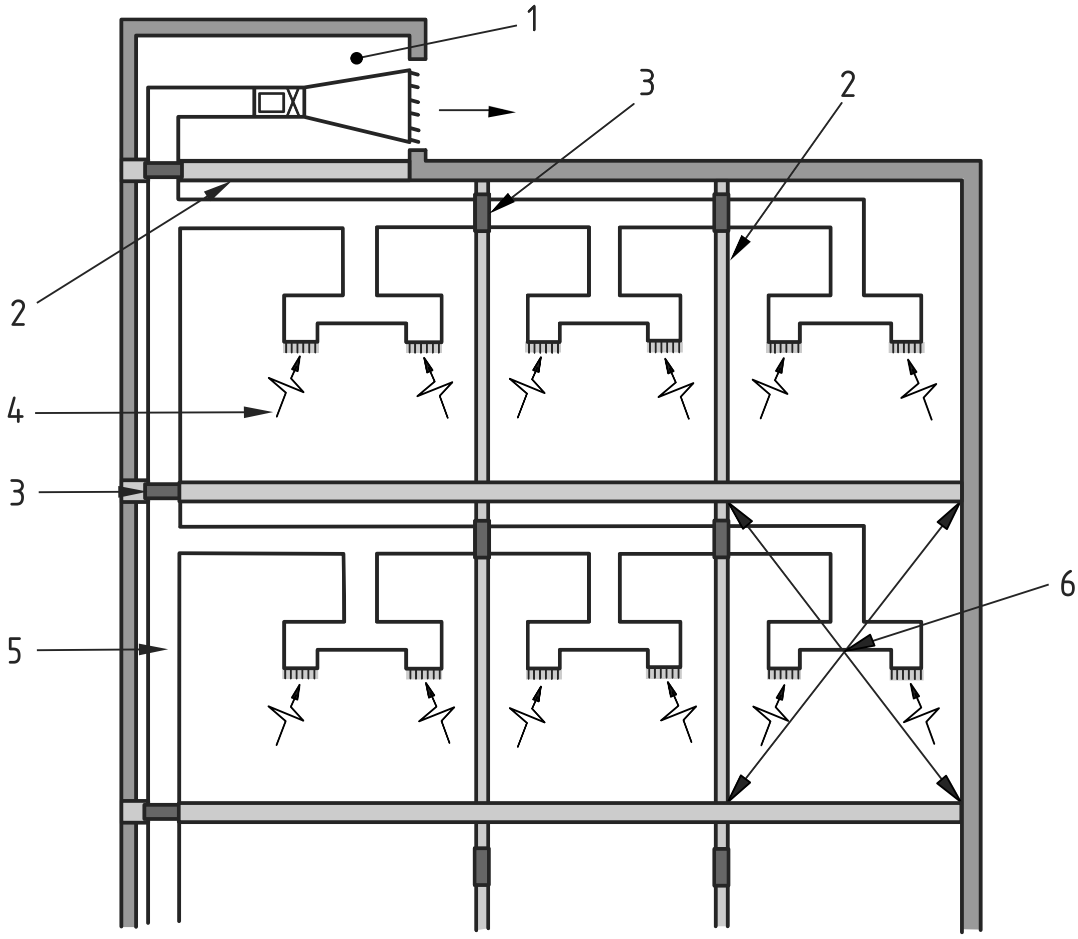
NOTE 3 Fire dampers operate when hot gases pass through them. They can be intumescent or operated by fusible link. Fire/smoke dampers operate automatically on activation of the detection and alarm system. Fire/smoke dampers tend to respond more quickly as they are directly connected to the detection and alarm system. For this reason cold smoke during the early stages of fire, and hot smoke as the fire continues to grow, do not pass as the damper is already closed and has fire resistance.

Method 1 does not require the ductwork to provide any degree of fire resistance, since the fire is isolated in the compartment of origin by the automatic actuation of fire dampers within the ductwork system. Fire dampers should therefore be sited in the duct at the point where it penetrates a fire-separating element. See Figure 26.

Thermally operated fire dampers should not be used to protect escape routes nor in smoke control systems.

Fire dampers should not be used in the extract ductwork for kitchens. Kitchen extract ductwork presents a particular hazard in that combustible deposits such as grease might accumulate on the internal surfaces. Moreover, any fire in an adjacent compartment through which the ductwork passes could initiate a fire within such ductwork. Access provisions for cleaning at spacing not exceeding 3 m should be provided.

Figure 26 **Example of method 1: Protection using fire dampers**



Key

1 Plantroom
2 Fire compartment wall or floor
3 Fire damper
4 Air flow
5 Non-fire-rated ductwork
6 Extent of typical fire compartment

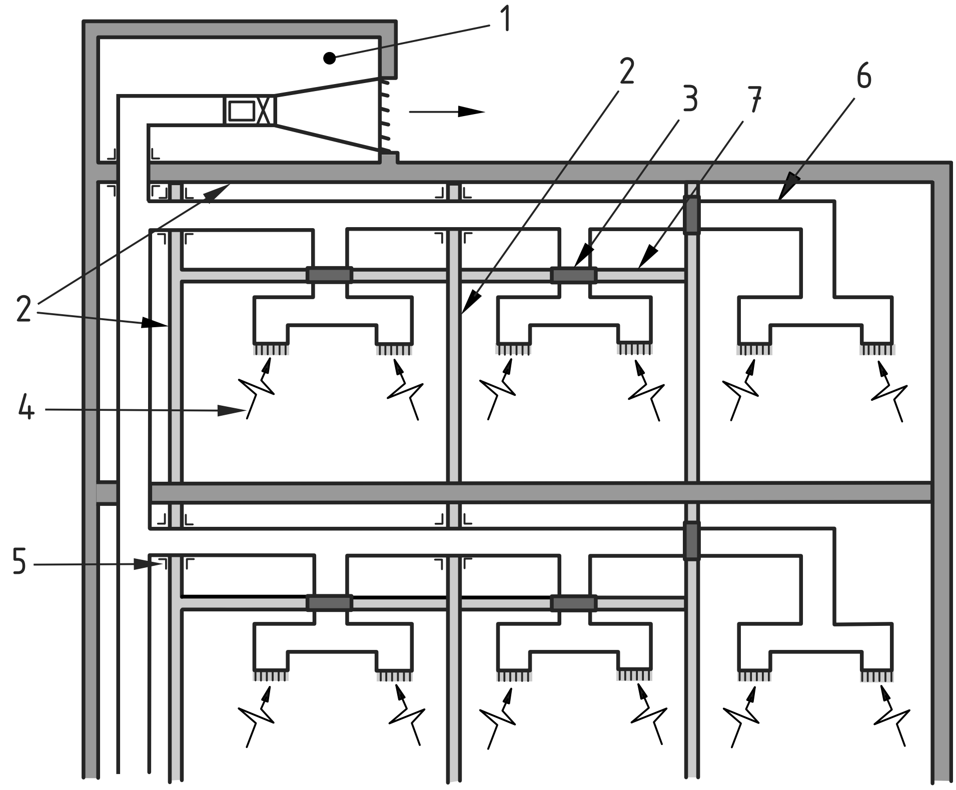
33.4.3.3 Method 2 – Protection using fire-resisting enclosures

NOTE Care in the design of the ductwork system is necessary to ensure that expansion of the ductwork will not cause failure of the fire-resisting enclosure, particularly when formed by a suspended ceiling.

In method 2, a building services duct is provided through which the ventilation ductwork passes and, if the duct is constructed to the highest standard of fire resistance of the structure that it penetrates, it forms a compartment known as a protected shaft. This method allows a multiplicity of services to be transferred together along a duct traversing a number of compartments and reaching remote parts of a building, without the need for further internal divisions along its length. Fire dampers are then needed only at points where the ventilation ductwork leaves the confines of the protected shaft. See Figure 27.

The fire resistance of the ductwork enclosure when tested from either side should be not less than the fire resistance required for the elements of construction in the area through which it passes, unless there are no combustible materials such as insulation between the ductwork and the enclosure and the enclosure facings are constructed of materials of limited combustibility, in which case the fire resistance of the ductwork when tested from either side should be not less than one half of the fire resistance required for elements of construction in the area through which it passes (and in no case less than 30 min).

Figure 27 **Example of method 2: Protection using fire-resisting enclosures**



Key

1 Plantroom
2 Fire compartment wall or floor
3 Fire damper
4 Air flow
5 Fire-resisting penetration seals tested to BS 476-24
6 Non-fire-resisting ductwork
7 Fire-resisting ceiling

33.4.3.4 Method 3 – Protection using fire-resisting ductwork

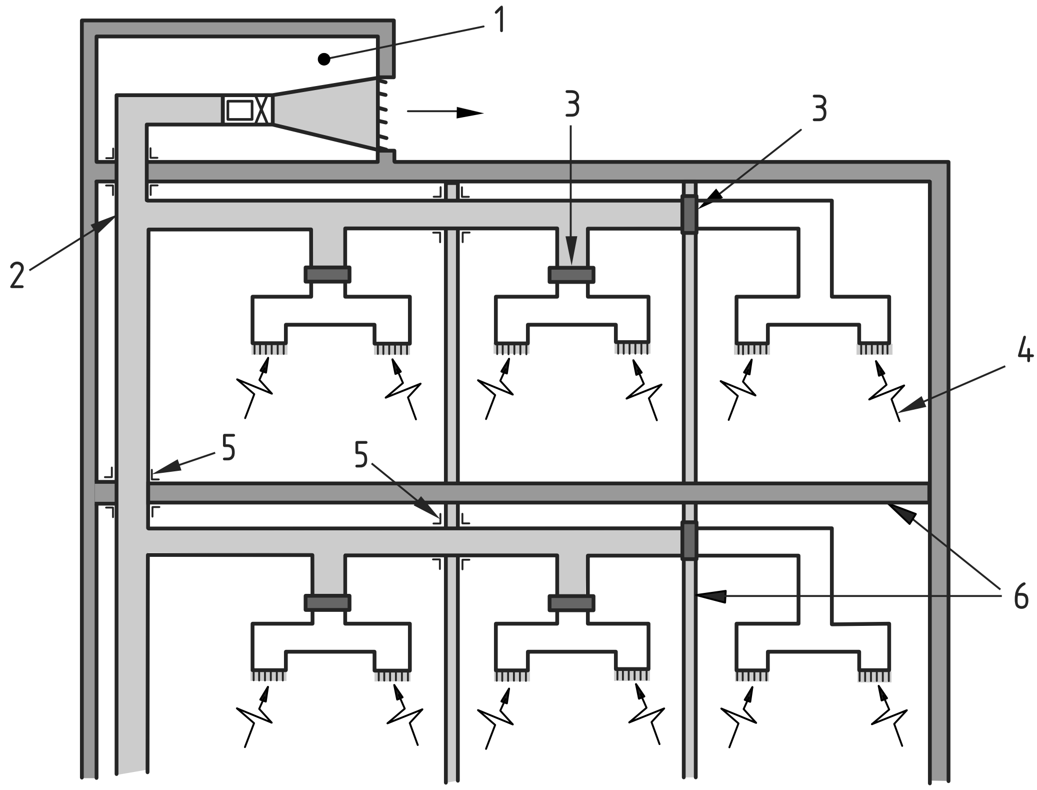
NOTE Detailed guidance is available in the ASFP publication Fire resisting ductwork *[43].*

In method 3, the ductwork itself forms a protected shaft. The fire resistance can be achieved by the ductwork material itself, or through the application of a protective material. See Figure 28.

The fire resistance of the ductwork, when tested from either side, should be not less than the fire resistance required for the elements of construction in the area through which it passes. The supporting hangers should be capable of supporting the ductwork for not less than the period of fire resistance of the ductwork.

Fire-resisting ductwork should meet the appropriate fire resistance period for the specific application when tested in accordance with BS 476-24 or BS EN 1366-1 and classified in accordance with BS EN 13501-3.

Figure 28 **Example of method 3: Protection using fire-resisting ductwork**



Key

1 Plantroom
2 Fire-resisting ductwork
3 Fire damper
4 Air flow
5 Fire-resisting penetration seals tested as part of fire-resisting ductwork system to BS 476-24
6 Fire compartment wall or floor

33.4.3.5 Penetration seals and other limiting factors

NOTE Further guidance is available in the ASFP publication Fire resisting ductwork *[43].*

Where ductwork passes through a compartment wall or floor it should be ensured that the fire separation of the wall or floor is maintained, in one of the following two ways.

a) For fire-resisting ductwork, a penetration seal should be fitted between the duct and the wall or floor. The penetration seal and the ductwork are deemed to be one integral system and for the field of direct application should be the same as that tested or assessed in accordance with BS 476-24.

b) For non-fire-resisting ductwork, a fire damper should be fitted in the plane of the wall or floor. The damper and associated penetration seal should be installed in accordance with a procedure substantiated by test or assessment. The damper should be mounted in the wall or floor and should be supported/restrained independently of the ductwork.

Where fire-resisting ductwork adjoins a damper fitted in a wall or floor, the penetration seal to the wall or floor should be installed as recommended in option b).

The primary reason for providing fire-resisting ductwork systems is to maintain the fire resistance of a compartment wall or floor of a building. It is therefore critical that the correct method of sealing any gaps around the ductwork is used as it passes through any compartment wall or floor. This detail is one of the most common reasons for the failure of the ductwork system in a fire resistance test.

The system performance depends on several factors as follows:

1) thermal expansion or shrinkage of ductwork system;
2) deformation of ductwork;
3) gap size;
4) surrounding construction;
5) specification of seal.

33.4.4 Risks associated with ductwork systems in different types of buildings

NOTE For occupancy characteristics, see Table 2.

33.4.4.1 Occupancy characteristic A (except offices)

Suitably positioned fire dampers are usually sufficient to counter the dangers associated with the spread of fire through ventilation ductwork systems in these occupancies.

33.4.4.2 Occupancy characteristic A (offices) and B

Such buildings usually include large unobstructed areas, and smoke spread throughout a compartment is more likely to occur through such open spaces rather than by means of the ventilation ductwork system.

Fire dampers should not be installed in any ductwork provided to extract or release smoke in basement car parks or in kitchen extract ducts.

Where possible ductwork should not be sited within protected escape routes.

Ductwork systems in premises used for public entertainment should be arranged so that fire and/or smoke cannot transfer through ductwork from any other part of the building into either of the following areas, for a period of time equal to the fire resistance time of the element of the building construction through which the duct passes, or not less than 30 min:

a) areas occupied by members of the public; or
b) protected escape routes;

This should be achieved by fire-protecting the ductwork using method 2 or method 3 (see **33.4.3.3** and **33.4.3.4**).

33.4.4.3 Occupancy characteristic Ci

The particular problem of this type of occupancy lies in ensuring that, where common ductwork is provided, fire in one dwelling will not cause fire gases, etc., to penetrate another dwelling. In multi-storey blocks internal service cores increase the hazard but, more significantly, high buildings can develop large pressure differentials due to wind, temperature differences, etc.

Shunt systems are sometimes employed in blocks of flats to enable branch ductwork to be connected to main ductwork without the use of fire dampers. The design, based on the principle of pressure difference in a stack situation, is intended to retard the passage of fire from one dwelling to another via the ductwork.

33.4.4.4 Occupancy characteristic Cii and Ciii

As with institutional buildings, a large number of small rooms predominate in this type of building and there is a high risk of fire being transmitted by means of the ventilation ductwork system. Whilst the mobility of residents might be unrestricted, their unfamiliarity with the premises and their longer response times, if they are asleep, increase the life risk.

33.4.5 Fire dampers

33.4.5.1 Installation of fire dampers

Fire dampers should be installed within ventilation ductwork in the following situations:

a) method 1 (unprotected ductwork): wherever the ventilation ductwork passes through a fire-resisting wall or floor or any other fire-resisting division;

b) method 2 (ductwork in a fire-resisting enclosure): at all points at which the ventilation ductwork passes through the fire-resisting enclosure;

c) method 3 (fire-resisting ductwork): wherever the ventilation ductwork is penetrated by an unprotected branch, inlet or outlet.

Installation should always be in the plane of the fire resisting division, and not elsewhere in the duct.

See **33.4.3.2**, **33.4.3.3** and **33.4.3.4**.

Smoke detector operated fire/smoke dampers should be installed in all occupancy characteristic Cii and Ciii buildings, unless all occupants of the building can be expected to make an unaided escape and an L1 fire alarm system is installed in accordance with the recommendations given in BS 5839-1:2002+A2:2008, in which case the following exceptions may be made.

a) If the alarm system is arranged so that on the detection of smoke it signals the immediate evacuation of all the occupants of the building, then fire/smoke dampers are not needed.

b) If the building is divided into fire compartments and the alarm system is arranged to signal the immediate evacuation of the occupants of the fire compartment in which the fire has been detected, then smoke detector operated fire/smoke dampers need only be provided where ductwork which forms part of the ventilation system enters or leaves the fire compartment.

Smoke detector operated fire/smoke dampers should be installed in the ductwork. They should be located so as to ensure that smoke is not transferred through ductwork, which penetrates fire-resisting constructions.

33.4.5.2 Fire resistance

It has been found that the failure of a fire damper or its frame under the test conditions described in BS 476-20 or BS EN 1366-2 is most likely to take place within the first hour, and that fire dampers that meet the criterion for integrity after 60 min continue to do so for some considerable time. Though intumescent dampers can meet any heat insulation recommendations, mechanical fire dampers might not, although the provision of two mechanical fire dampers with an air space between them normally improves the thermal performance.

Fire dampers are not generally accepted as fully effective in resisting the penetration of cold smoke due to the leakage that occurs before the activation temperature is achieved. However, some mechanical and intumescent dampers provide very effective hot smoke and fire containment once closed. Mechanical or intumescent fire and smoke dampers that are interfaced with smoke sensors via a fire alarm panel will provide smoke containment as soon as smoke is detected or the activation temperature is achieved.

All fire dampers and their frames, when subjected to the test conditions described in BS 476-20, BS EN 1366-2 or BS ISO 10294-5 should meet the fire integrity criterion for not less than 60 min.

33.4.5.3 Operation

Fire dampers should be simple in their operation, with the minimum number of moving parts. Fire dampers employing channels and grooves to house sliding blades are susceptible to accumulation of dirt and other deposits and are not suitable for some situations, e.g. an extract from a sawmill or a kitchen.

All fire dampers should close automatically under emergency conditions. Mechanical fire dampers should be held open by a thermally activated device set to operate at approximately 74 °C and located in a fully exposed position within the protected opening, although they may also be activated by a smoke detector. Intumescent dampers by their nature are thermally activated and should be demonstrated to close within the time permitted in the time–temperature curve given in ISO 834-1.

Intumescent dampers may also incorporate electrically operated moving components which when activated by a smoke sensor will provide a smoke barrier, prior to the intumescent elements activating.

Closure may be achieved in many ways including gravity operation or with spring assistance. In the latter case springs should be securely fixed and protected from the fire gases so as to exert and maintain the requisite pull both for the working life of the fire damper and, during a fire, for the period prior to the closure of the fire damper.

Thermally actuated devices need to be arranged so that, on operation, any released parts do not impede the movement of the fire damper. The linkage and fixings should be of adequate strength to avoid the need for renewal other than following test or emergency operation. The link will only be effective if arranged in a position fully exposed to the hot gas stream within the protected opening, and not shielded by damper blades or other component parts.

In entertainment premises, where the provision of fire/smoke dampers cannot be avoided in supply ventilation systems and extract systems serving public areas, other than those systems where fire dampers should not be provided (see **33.4.4.2**), the dampers should be activated by smoke detector controlled automatic release mechanisms.

33.4.5.4 Actuation of fire/smoke dampers by smoke detectors

Thermally actuated devices operate only on attaining a certain temperature and might not therefore operate in the presence of smoke alone. A slow burning fire or an admixture of cool air with smoke and fire gases can result in appreciable quantities of smoke passing the fire damper before the thermally actuated device operates.

Where the use of a building presents a high or special life hazard, e.g. if it is used as an hotel or other building involving a sleeping risk (other than blocks of flats), fire/smoke dampers should usually be actuated by smoke detector controlled automatic release mechanisms in addition to being actuated by thermally actuated devices.

Smoke detectors of either the optical or ionization chamber type may be used to actuate the fire/smoke dampers.

NOTE Information on the siting of smoke detectors is given in BS 5839-1:2002+A2:2008, in particular in ***22.3****.*

Care is needed in the selection of the model(s) and number of smoke detectors and their siting, as various factors affect satisfactory operation. In particular, the density of smoke within ventilation ductwork is likely to be considerably reduced by dilution with air (to a greater degree in high velocity systems) with a consequential delaying effect on the operation of the detector. Smoke detectors might, therefore, be better situated in a room or other part of the building rather than within ventilation ductwork, although in recirculating systems a smoke detector should always be installed within the ductwork (see **33.4.8**).

It is important that the controlling authorities are consulted before deciding whether detection of smoke should result in particular fire/smoke dampers being closed, all the fire/smoke dampers in that compartment being closed, or all the fire/smoke dampers in the building being closed.

Detectors of the ionization chamber type can be sensitive to the air flow velocity and consequently when detectors of this type are proposed for use in ductwork, the housing or associated probe should be suitable for the air flow velocity involved.

Smoke detectors and automatic release mechanisms used to actuate fire/smoke dampers should conform to BS EN 54-7 and BS 5839-3 respectively. Smoke detectors should be sited so as to prevent the spread of smoke as early as practicable.

33.4.6 Air handling voids

33.4.6.1 General

Air handling voids, which can be either supply or extract plenums, frequently contain combustible materials, e.g. PVC sheathing of electrical cables. In this situation there is a risk of the ignition of such materials by flames and hot gases being drawn through the air-handling void or by ignition from the cables themselves.

33.4.6.2 Ceiling voids

Ceiling voids in areas of special risk (see **33.4.7**), if used for the supply or extraction of air, need not be provided with a smoke detector, as the air should not be recirculated. For all other areas, if the void above a false ceiling is used for the supply or extraction of air, a smoke detector should be fitted adjacent to each point where supply ductwork enters, or extract ductwork leaves, the storey/compartment in question. Such smoke detectors should:

a) trigger the closing of the fire damper provided to complete the fire separation; or

b) cause the vitiated air containing smoke to be diverted to the outside of the building (see **33.4.8**).

Where a plenum ceiling is not compartmented and exceeds 400 m^2 in area and is not provided with a smoke detection system conforming to BS 5839-1, the electrical wiring within the plenum ceiling should be enclosed in metal conduit or metal trunking or be mineral-insulated metal-sheathed cables.

33.4.6.3 Floor voids

Where the void beneath a platform floor is used for the supply or extraction of air, a sufficient number of smoke detectors should be provided to ensure that upon detection of smoke within any part of the floor void, the supply of air to the void, or extraction of air from the void, would cease.

33.4.7 Segregation of ventilation ductwork serving areas of special risk or carrying polluted air

Certain areas of a building, e.g. non-domestic kitchens, car parks and plant rooms, should have separate and independent extraction systems, and the extracted air should not be recirculated. Separate ventilation should be provided in residential accommodation in mixed use buildings because of the sleeping risk involved.

Certain appliances, such as deep fat fryers, should have their own extract ductwork and it is essential that this ductwork is provided with access for cleaning at intervals not exceeding 3 m. As extract ductwork from kitchens should not be provided with fire dampers, method 2 and method 3 (see **33.4.3.3** and **33.4.3.4**) are the only acceptable means for the protection of such ductwork against fire when immediate discharge to the outside of the building is not possible.

Extract ductwork systems serving the following appliances or parts of a building should be entirely independent of each other and of any ventilation ductwork serving other parts of the building:

- non-domestic kitchens;
- deep fat fryers;
- boiler chambers;
- areas containing oil-immersed electrical plant;
- car parks.

Any ventilation system supplying residential accommodation in a mixed use building (see, for example, **33.4.4.2**) should be independent of any system supplying the other parts of the building.

Ventilation ductwork conveying polluted air, or servicing parts of a building considered to present a special fire hazard, should be independent of any other ventilation ductwork serving other parts of the building.

33.4.8 Recirculating distribution systems

NOTE 1 Advice on the selection and installation of smoke detectors in ductwork is given in BS 5839-1:2002+A2:2008, ***22.10****.*

In any system of air conditioning where vitiated air is recirculated from one part of the building to another, smoke detectors should be installed, linked to the ventilating system controls. This means that when a detection of smoke signal reaches the plant room, either the air will be discharged to the open air or the system will be immediately shut down, thereby preventing the distribution of smoke and hot gases throughout the building.

One or more smoke detectors should be fitted in the extract ductwork before the point of separation of the recirculated air and the air to be discharged to the open air, and before any filters or other air cleaning equipment. Such detector(s) should, if the smoke reaches an optical density per metre of 0.5, be capable of either:

a) causing the system to immediately shut down; or
b) switching the ventilation system from recirculating mode to extraction to open air, so as to divert the vitiated air containing any smoke to the outside of the building.

NOTE 2 Care needs to be taken that this action will not cause excessive negative pressure within the space and require a force in excess of 45 N to be applied to open the doors on the route of escape.

On triggering of the smoke detection system, the supply system should be switched off and the exhaust system should continue to run. This mode of operation allows smoke to be extracted from the space and away from exitways until the system breaks down or a fire damper closes.

If smoke detectors are connected to the general fire alarm system, the method for resetting the ventilation plant after operation of the fire alarm should be completely separate from the method for resetting the fire alarm.

33.4.9 Air transfer grilles

Whilst air transfer grilles in walls, partitions, doors, etc., are not part of ventilation ductwork, they can form essential components of an air distribution system in a building.

Care should be taken in the positioning of air transfer grilles to ensure that they do not allow the passage of fire and smoke. In general, the installation of air transfer grilles should be avoided in any construction required to be fire-resisting, particularly those forming compartment boundaries.

Air transfer grilles should not be installed in:

a) elements of construction enclosing compartments or protected shafts;
b) enclosures to protected stairways, protected lobbies, protected corridors, fire-fighting stairways or fire-fighting lobbies;
c) bedroom walls or doors.

Air transfer grilles fitted in any construction or door that needs to be fire-resisting should be of the intumescent type or fitted with fire dampers. Where these grilles are within the enclosure of protected escape routes, they should incorporate fire and smoke shutters operated by adjacent automatic smoke detectors.

Where it is necessary for air transfer grilles to be fitted with fire dampers, the fire dampers should be in accordance with **33.4.5**.

33.4.10 Fire-fighting control

To ensure the effective use of mechanical ventilation systems, override controls should be provided for fire and rescue service use. It is essential that the provision, location and mode of operation of such facilities are discussed and agreed with the approving authority and the designer of the systems, the user of the premises and the building control authority before any decision is made to provide override facilities for either fire safety or normal air handling systems.

The controls for the ventilation system should be located adjacent to the fire alarm panel. The following should be clearly marked, where applicable:

- "Fire and rescue service ventilation control";
- "Automatic";
- "Off";
- "Extract only".

The signage should be in accordance with BS 5499-1.

33.4.11 External ductwork and exhaust outlets

Exhaust points from ductwork systems should be sited:

a) away from inlet grilles (e.g. inlet grilles for air conditioning systems) to prevent extracted smoke being drawn back into the building; and

b) so as not to further jeopardize the building in the event of fire, i.e. away from final exits, combustible building cladding or roofing materials and openings into the building.

33.4.12 Fire-stopping

Where ductwork using methods 1 and 3 (see **33.4.3.2** and **33.4.3.4**) or ductwork enclosures using method 2 (see **33.4.3.3**) pass through fire-resisting elements of construction, any gap should be adequately fire-stopped for the full thickness of the enclosure, so that the level of fire resistance of the joint is not less than that of the fire-resisting element.

The choice of fire-stopping method and material should take into account longitudinal movement of the ductwork caused by the effects of the fire.

33.4.13 Combustibility of construction products or materials and components

33.4.13.1 Internal linings

All insulation applied as an internal lining to ductwork should have a Class 0 surface (national) or B-s3, d2 (European) (see **35.1**) and be either:

a) a non-combustible material (see **35.1.5**); or

b) a material of limited combustibility (see **35.1.6**).

33.4.13.2 External insulation

All external insulation should be in accordance with one of the following as applicable.

a) External insulation within a fire-resisting ductwork enclosure should have a Class 0 surface (national) or B-s3, d2 (European) (see **35.1**), unless the space between the ductwork and the fire-resisting enclosure is subdivided at each floor level, and wherever the fire-resisting ductwork enclosure penetrates a compartment boundary, by fire-resisting construction with a fire resistance of not less than that of the ductwork enclosure.

b) External insulation not situated within a fire-resisting ductwork enclosure should have a rating for surface spread of flame of not less than that for the surface of the wall or ceiling which the ductwork traverses.

c) External insulation that is not in accordance with a) or b) should not be situated within 500 mm of a fire damper.

33.4.14 Flexible joints and connections

Flexible joints should;

a) not exceed 250 mm in length;

b) consist of or be protected by material which, when tested in accordance with BS 476-20 or BS EN 1366-4, meets the fire integrity criterion for not less than 15 min.

Flexible connections should:

1) not exceed 3.7 m in length;

2) not pass through fire-resisting walls or floors or cavity barriers.

Both flexible joints and connections should be constructed of:

i) non-combustible materials; or

ii) materials conforming to Euroclass A1 as specified in BS EN 13501:2002; or

iii) material which, when tested in accordance with BS 476-6, has a fire propagation index 1 of not more than 12 and a sub-index i_1 of not more than 6, and is situated at least 1 m from any fire damper.

33.4.15 Components

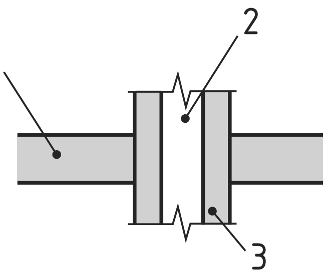
Surfaces of air filters, air attenuators and similar components of ventilation systems exposed to the airflow should be inherently non-flammable or so treated as to make them non-flammable for the duration of their recommended working life.

Viscous fluids in air filters should have a flash point of not less than 177 °C.

33.4.16 Flues

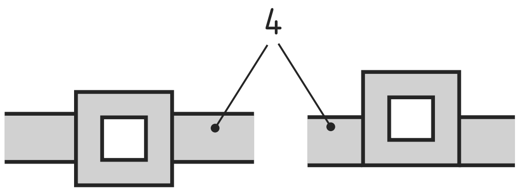
If a flue, or duct containing flues or appliance ventilation duct(s), passes through a compartment wall or compartment floor or is built into a compartment wall, each wall of the flue or duct should have a fire resistance of at least half that of the wall or floor (see Figure 29).

Figure 29 **Flues and compartment walls and floors**



Flue walls should have a resistance of at least one half of that required for the compartment wall or floor, and should be of non-combustible construction.

a) Flue passing through compartment wall or floor



In each case flue walls should have a fire resistance at least one half of that required for the compartment wall, and should be of non-combustible construction.

b) Flue built into compartment wall

Key

1 Compartment wall or floor
2 Flue
3 Flue wall
4 Compartment wall

33.4.17 Protection of pipe openings

Pipework that breaches compartment walls and compartment floors can compromise compartmentation if fire protection is not provided to the pipework. Pipes may be constructed from many different materials and all these materials behave differently in a fire situation. The size of the opening is a major factor in the spread of heat and flame and should therefore be restricted when a pipe breaches a compartment wall or compartment floor. When it is not possible to maintain pipe diameters below the diameter recommended in Table 33, then alternative methods of protection are available.

Table 33 **Maximum nominal interior diameter of pipes passing through a compartment wall/floor**
Dimensions in millimetres

Situation	**Maximum nominal internal diameter**		
	a) Non-combustible material [A)]	**b) Lead, aluminium, aluminium alloy, PVC** [B)]**, fibre-cement**	**c) Any other material**
1) Structure (but not a wall separating buildings) enclosing a protected shaft which is not a stairway or a lift shaft	160	110	40
2) Compartment wall or compartment floor between flats	160	160 (stack pipe) [C)] 110 (branch pipe) [C)]	40
3) Any other situation	160	40	40

A) A non-combustible material (such as cast iron or steel) which if exposed to a temperature of 800 °C, will not soften or fracture to the extent that flame or hot gas will pass through the wall of the pipe.
B) uPVC pipes conforming to BS 4514 and uPVC pipes conforming to BS 5255.
C) These diameters are only in relation to pipes forming part of an above-ground drainage system and enclosed as shown in Figure 30. In other cases the maximum diameters against situation 3) apply.

Pipes that pass through a compartment wall or compartment floor (unless the pipe is in a protected shaft), or through a cavity barrier, should be in accordance with one of the following alternatives.

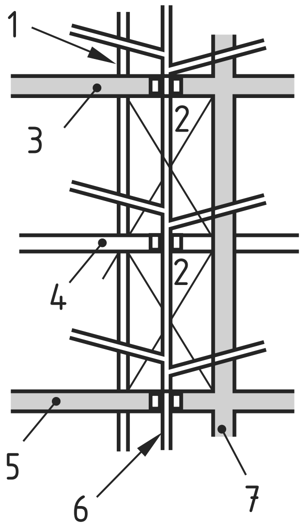
a) For proprietary seals of any pipe diameter, a proprietary sealing system may be provided that has been shown by test to maintain the fire resistance of the wall, floor or cavity barrier.

b) For pipes with a restricted diameter, where a proprietary sealing system is not used, fire-stopping may be used around the pipe (see **33.5**), keeping the opening as small as possible. The nominal interior diameter of the pipe should be not more than the relevant dimensions given in Table 33. The diameters given in Table 33 for pipes of material b) used in situation 2) assume that the pipes are part of an above-ground drainage system and are enclosed as shown in Figure 30. If they are not, the smaller diameter given in situation 3) should be used.

c) A pipe of lead, aluminium, aluminium alloy, fibre-cement or PVC, with a maximum nominal diameter of 160 mm, may be used with a sleeving of non-combustible pipe as shown in Figure 31.

Tests carried out in accordance with BS EN 1366-3 are specific to service penetrations. Ad hoc tests should only be used where directly relevant to the application.

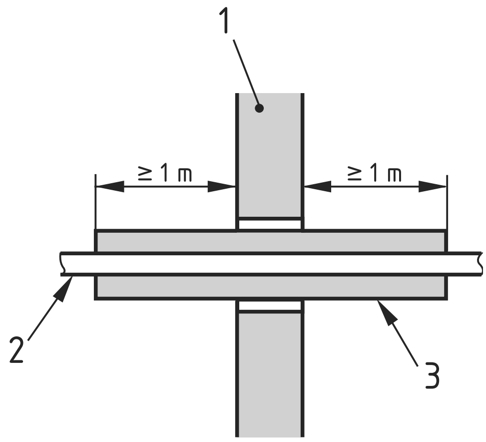
Figure 30 **Enclosure for drainage or water supply pipes**



Key

1 Casing
2 Enclosure
3 Compartment floor carried through to seal enclosure – provide fire-stopping between stack pipe and floor
4 Intermediate floor carried through to seal enclosure – provide fire-stopping between stack pipe and floor
5 Compartment floor
6 Stack pipe
7 Compartment wall

Figure 31 **Pipes penetrating structure**



Key

1 Structure
2 Pipe specification (b) (see Table 33)
3 Sleeve (or pipe) of specification (a) (see Table 33) to be in contact with pipe

33.4.18 Protected service shafts

NOTE Attention is drawn to the Building Regulations 2000 [19], the Building (Scotland) Regulations 2004, as amended [20] and the Building Regulations (Northern Ireland) 2000 [31], in respect of the penetration of compartment walls and compartment floors by services in shafts.

The penetration of fire-resisting floors by services in vertical shafts can prejudice the safety of occupants and create points of weakness in the compartmentation, if any, of the building.

The construction enclosing a protected shaft should:

a) form a complete barrier to smoke and fire between the different compartments which the shaft connects;

b) have the appropriate fire resistance in relation to the element through which it is passing;

c) have the necessary ventilation, i.e. a protected shaft conveying piped flammable gas should be ventilated direct to the outside air by ventilation openings at high and low level in the shaft.

A protected shaft should have at least the same fire resistance as the compartment wall or compartment floor through which it is passing.

33.5 Fire-stopping

33.5.1 General

When a building service passes through a compartment wall or floor there can be an imperfection of fit, which results in gaps in the walls between compartments. This presents a risk of allowing smoke and flame to breach a compartment wall via these gaps. It is therefore necessary to fill these gaps with a material that will restrict the passage of smoke and flame. Various materials can be used, but certain materials are more suited to certain applications.

33.5.2 Applications

Joints between elements that serve as a barrier to the passage of fire should be fire-stopped and all openings for pipes, ducts, conduits or cables to pass through any part of an element that serves as a barrier to the passage of fire should be:

a) kept as few in number as possible;

b) kept as small as practicable; and

c) fire-stopped (which in the case of a flue or duct, should allow thermal movement).

33.5.3 Products and materials for fire-stopping

The selection of products and materials used for fire-stopping should take account of the size and nature of the gap and any anticipated differential movement.

Proprietary fire-stopping and sealing systems (including those designed for service penetrations) are available and may be used provided that they achieve the appropriate level of fire resistance (see Table 24) when tested in accordance with BS 476-22 or BS EN 1634-1.

In the case where minimum differential movement is anticipated and where the gap does not exceed 25 mm, the following fire-stopping materials may be used without specific test evidence:

a) cement mortar;

b) gypsum-based plaster;

c) cement or gypsum-based vermiculite/perlite mixes.

To maintain the physical integrity of fire-stopping, it should be reinforced with (or supported by) non-combustible materials, or materials of limited combustibility, in the following circumstances:

1) in all cases where the gap between elements that need to be fire-stopped is greater than 100 mm; and

2) in any other case where non-rigid or flexible materials are used (unless substantiated by fire test evidence).

34 Concealed spaces

34.1 General

Concealed spaces or cavities in the construction of a building provide a ready route for smoke and flame spread. This is particularly so in the case of voids in, above and below the construction of a building, e.g. walls, floors, ceilings and roof spaces. As any spread of fire or smoke is concealed, it presents a greater danger than would a more obvious weakness in the fabric of the building. Provisions can be made to restrict this by interrupting cavities which could form a pathway around a barrier to fire, subdividing extensive cavities, and closing the edges of openings.

The unseen spread of fire or smoke via voids and cavities can be a threat to occupants if it bypasses compartment boundaries or elements protecting the means of escape.

It can also be a threat to fire-fighters in large spaces if it leads to the obstruction of their line of retreat.

A cavity in an external wall can behave as a chimney, accelerating fire spread up a façade. This can be a threat to occupants or fire-fighters if the cavity is open to the exterior or is more than two storeys high. Sealed cavities are generally not a problem.

Recommendations for cavity barriers are given in this clause for specific locations. The provisions necessary to restrict the spread of smoke and flames through cavities are broadly for the purpose of subdividing:

*NOTE These should not be confused with fire-stopping details; see **33.5** and Figure 32 (see also **34.2**).*

a) cavities, which could otherwise form a pathway around a fire-separating element and closing the edges of cavities, therefore reducing the potential for unseen fire spread; and

b) extensive cavities (see **34.3**).

Consideration should also be given to the construction and fixing of cavity barriers provided for these purposes and the extent to which openings in them should be protected. For guidance on these issues, see **34.4**.

34.2 Provision of cavity barriers

34.2.1 Junctions and compartment walls

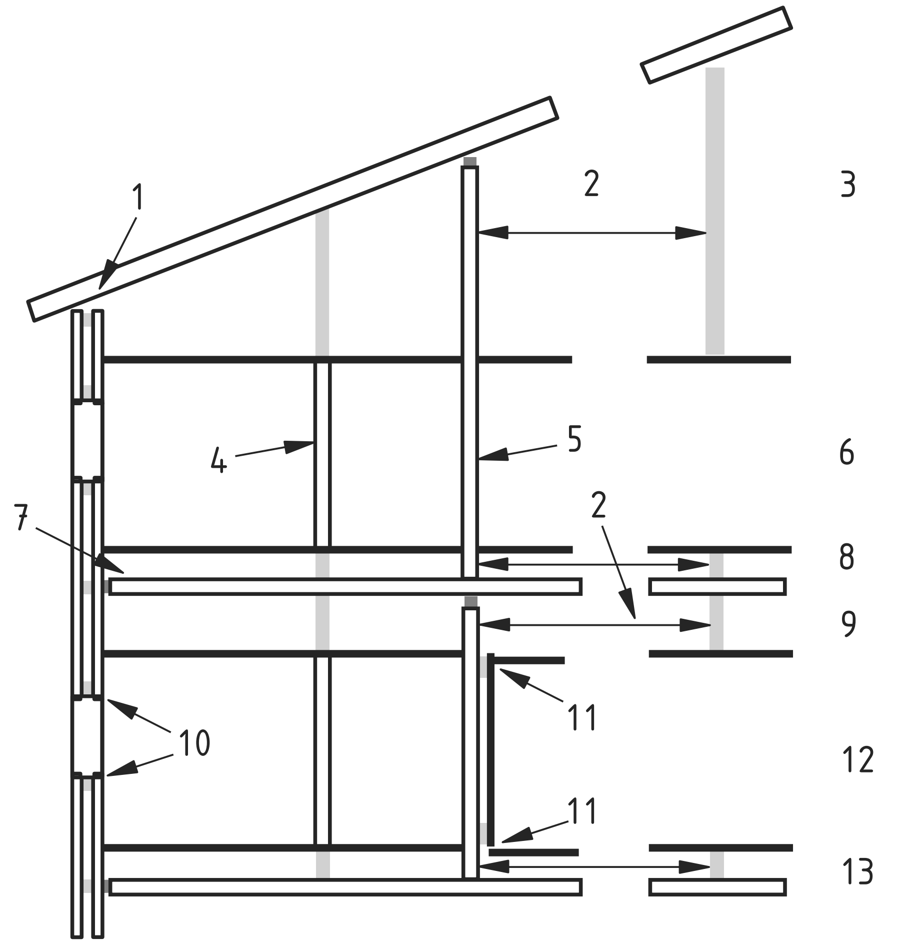
Cavity barriers should be provided to close the edges of cavities, including around openings.

Cavity barriers should also be provided:

a) at the junction between an external cavity wall (except where the cavity wall conforms to Figure 33) and every compartment floor and compartment wall; and

b) at the junction between an internal cavity wall (except where the cavity wall conforms to Figure 33) and every compartment floor, compartment wall, or other wall or door assembly which forms a fire-resisting barrier.

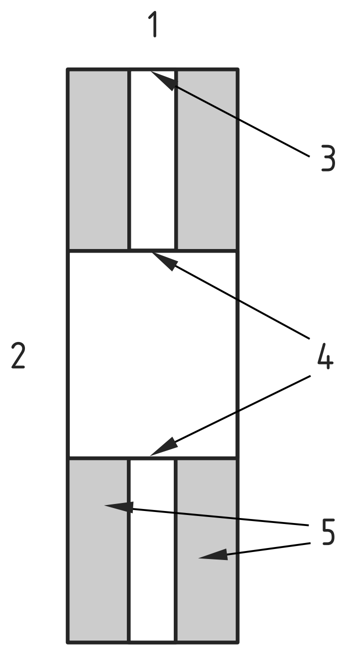
Figure 32 **Provisions for cavity barriers**



Key

1 Close top of cavity
2 Subdivide extensive cavities
3 Roof space
4 Wall forming bedroom or protected escape routes
5 Compartment wall
6 Accommodation
7 Compartment floor
8 Floor space
9 Ceiling space
10 Close around openings
11 Close around edges
12 Accommodation
13 Floor space
Cavity barrier (30 min integrity/15 min insulation as in Table 24)
Fire-stopping (same fire resistance as compartment – not cavity barrier)

Figure 33 **Cavity wall excluded from provisions for cavity barriers**



NOTE 1 Cavities may be closed with a material that might not conform to the various recommendations in Table 24 for cavity barriers. The purpose of closing the cavity is to restrict airflow within the cavity.

NOTE 2 Cupboards for switch boards, service boxes, service panels, etc., may be installed provided that:

- *there are no more than two cupboards per compartment;*
- *the openings in the outer wall leaf are not more than 800 mm × 500 mm for each cupboard; and*
- *the inner leaf is not penetrated except by a sleeve not more than 80 mm × 80 mm, which is fire-stopped.*

NOTE 3 Combustible materials may be placed within the cavity.

Key

1 Section through cavity wall
2 Opening
3 Close cavity at top of wall (unless cavity is totally filled with insulation)
4 Close cavity around opening
5 Two leaves of brick or concrete each at least 75 mm thick

It is important to continue any compartment wall up through a ceiling or roof cavity to maintain the standard of fire resistance, therefore compartment walls should be carried up full storey height to a compartment floor or to the roof as appropriate (see **32.5.2** to **32.5.5**). It is therefore not appropriate to complete a line of compartmentation by fitting cavity barriers above the compartment wall.

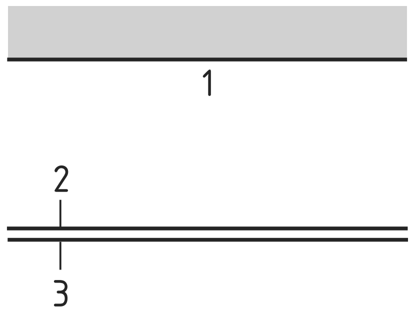
34.2.2 Protected escape routes

For a protected escape route, a cavity that exists above or below any fire-resisting construction because the construction is not carried to full storey height or, in the case of a top storey, to the underside of the roof covering, should either be:

a) fitted with cavity barriers on the line of the enclosure(s) to the protected escape route; or

b) for cavities above the fire-resisting construction, enclosed on the lower side by a fire-resisting ceiling which extends throughout the building, compartment or separated part (see Figure 34).

Figure 34 **Fire-resisting ceiling below concealed space**



NOTE 1 The ceiling should:

- *have at least 30 min fire resistance;*
- *be imperforate, except for an opening described in **34.4**;*
- *extend throughout the building or compartment; and*
- *not be easily demountable.*

NOTE 2 The national classifications do not automatically equate to the equivalent European classifications, therefore products cannot typically assume a European class unless they have been tested accordingly.

NOTE 3 When a classification includes "s3, d2", this means that there is no limit set for smoke production and/or flaming droplets/particles.

Key

1 Floor or roof cavity
2 Ceiling surface/product exposed to cavity – Class 1 (national) or Class C-s3, d2 or better (European)
3 Soffit of ceiling – Class 0 (national) or Class B-s3, d2 or better (European)

34.2.3 Double-skinned corrugated or profiled roof sheeting

*NOTE 1 See also **32.5.5** regarding the junction of a compartment wall with a roof.*

NOTE 2 When a classification includes "s3, d2", this means that there is no limit set for smoke production and/or flaming droplets/particles.

Cavity barriers need not be provided between double-skinned corrugated or profiled insulated roof sheeting, if the sheeting is a material of limited combustibility and both surfaces of the insulating layer have a surface spread of flame of at least Class 0 or 1 (national) or Class Cs3, d2 or better (European) and make contact with the inner and outer skins of cladding (see Figure 35).

Figure 35 **Provisions for cavity barriers in double-skinned insulated roof sheeting**

The insulation should make contact with both skins of sheeting. See also Figure 25 regarding the need for a fire break where such roofs pass over the top of a compartment wall.

a) Acceptable without cavity barriers

b) Cavity barriers necessary

34.2.4 Cavities affecting alternative escape routes

Cavity barriers might be needed where corridors are be subdivided to prevent alternative escape routes being simultaneously affected by fire and/or smoke (see **17.3.11.3** and Figure 8).

34.2.5 Separation of bedrooms

In residential buildings (including institutional buildings), a cavity that exists above or below partitions between bedrooms because the enclosures are not carried to full storey height, or, (in the case of the top storey) to the underside of the roof covering, should either be:

a) fitted with cavity barriers on the line of the partitions; or

b) for cavities above the partitions, enclosed on the lower side by a fire-resisting ceiling which extends throughout the building, compartment or separated part.

34.3 Extensive cavities

Cavity barriers should be used to subdivide any cavity, including any roof space, so that the distance between cavity barriers does not exceed the dimensions given in Table 34.

Table 34 sets out maximum dimensions for undivided concealed spaces. With the exceptions given below the table, extensive concealed spaces should be subdivided to conform to the dimensions in Table 34.

Table 34 **Maximum dimensions of cavities in non-domestic buildings**

Location of cavity	**Class of surface/product exposed in cavity** (excluding the surface of any pipe, cable or conduit, or any insulation to any pipe)		**Maximum dimensions in any direction** m
	National class	**European class**	
Between a roof and a ceiling	Any	Any	20
Any other cavity	Class 0 or Class 1	Class A1; or Class A2-s3, d2; or Class B-s3, d2; or Class C-s3, d2	20
	Not Class 0 or Class 1	Not any of the above classes	10

NOTE 1 The national classifications do not automatically equate to the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly.

NOTE 2 When a classification includes "s3, d2", this means that there is no limit set for smoke production and/or flaming droplets/particles.

The provisions in Table 34 do not apply to any of the following cavities:

a) in a wall which should be fire-resisting only because it is load-bearing;

b) in a masonry or concrete external cavity wall shown in Figure 33;

c) in any floor or roof cavity above a fire-resisting ceiling, as shown in Figure 34 and which extends throughout the building or compartment subject to a 30 m limit on the extent of the cavity; or

d) formed behind the external skin of an external cladding system with a masonry or concrete inner leaf at least 75 mm thick, or by overcladding an existing masonry (or concrete) external wall, or an existing concrete roof, provided that the cavity does not contain combustible insulation and the building is not put to a residential or institutional use; or

e) between double-skinned corrugated or profiled insulated roof sheeting, if the sheeting is a material of limited combustibility and both surfaces of the insulating layer have a surface spread of flame of at least Class 0 or Class 1 (national) or Class C-s3, d2 or better (European) and make contact with the inner and outer skins of cladding (see Figure 35); or

f) below a floor next to the ground or oversite concrete, if the cavity is less than 1 000 mm in height or if the cavity is not normally accessible by persons, unless there are openings in the floor such that it is possible for combustibles to accumulate in the cavity (in which case cavity barriers should be provided and access should be provided to the cavity for cleaning).

Where any single room with a ceiling cavity or underfloor service void exceeds the dimensions given in Table 34, cavity barriers need only be provided on the line of the enclosing walls/partitions of that room, subject to:

1) the cavity barriers being no more than 40 m apart; and

2) the surface of the material/product exposed in the cavity being Class 0 or Class 1 (national) or Class C-s3, d2 or better (European).

Where the concealed space is over an undivided area which exceeds 40 m (this may be in both directions on plan), there is no limit to the size of the cavity if:

i) the room and the cavity together are compartmented from the rest of the building;

ii) an automatic fire detection and alarm system meeting the relevant recommendations of BS 5839-1 is fitted in the building. Detectors are only required in the cavity to satisfy BS 5839-1;

iii) the cavity is used as a plenum and the recommendations for recirculating air distribution systems in **33.4.8** are followed;

iv) the surface of the material/product used in the construction of the cavity which is exposed in the cavity is Class 0 (national) or Class B-s3, d2 or better (European) and the supports and fixings in the cavity are of non-combustible construction;

v) the flame spread rating of any pipe insulation system is Class 1 or Class C-s3, d2 or better (European);

vi) any electrical wiring in the void is laid in metal trays, or in metal conduit; and

vii) any other materials in the cavity are of limited combustibility or Class A2 or better (European).

34.4 Construction and fixings for cavity barriers

NOTE 1 Cavity barriers provided around openings may be formed by the window or door frame if the frame is constructed of steel or timber of the minimum thickness in a) or b) above as appropriate.

Every cavity barrier should be constructed to provide at least 30 min fire resistance. It may be formed by any construction provided for another purpose if it meets the provisions for cavity barriers (see Table 25). Cavity barriers in a stud wall or partition, or provided around openings, may be formed of:

a) steel at least 0.5 mm thick;

b) timber at least 38 mm thick;

c) polythene-sleeved mineral wool, or mineral wool slab, in either case under compression when installed in the cavity; or

d) calcium silicate, cement-based or gypsum-based boards at least 12 mm thick.

A cavity barrier should, wherever possible, be tightly fitted to a rigid construction and mechanically fixed in position. Where this is not possible (for example, in the case of a junction with slates, tiles, corrugated sheeting or similar materials) the junction should be fire-stopped. Recommendations for fire-stopping are given in **33.5**.

NOTE 2 Where cavity barriers are provided in roof spaces, the roof members to which they are fitted are not expected to have any fire resistance for the purpose of supporting the cavity barrier(s).

Cavity barriers should also be fixed so that their performance is unlikely to be made ineffective by:

1) movement of the building due to subsidence, shrinkage or temperature change and movement of the external envelope due to wind; or

2) collapse in a fire of any services penetrating them; or

3) failure in a fire of their fixings (but see note below); or

4) failure in a fire of any material or construction which they abut. (For example, if a suspended ceiling is continued over the top of a fire-resisting wall or partition and direct connection is made between the ceiling and the cavity barrier above the line of the wall or partition, premature failure of the cavity barrier can occur when the ceiling collapses. However, this might not arise if the ceiling is designed to provide fire protection of 30 min or more.)

Any openings in a cavity barrier should be limited to those for:

i) doors which have at least 30 min fire resistance (see **33.1**) and are fitted in accordance with the provisions of **33.1**;

ii) the passage of pipes which meet the provisions in **33.5**;

iii) the passage of cables or conduits containing one or more cables;

iv) openings fitted with a suitably mounted automatic fire damper (see **33.4.5**); and

v) ducts which (unless they are fire-resisting) are fitted with a suitably mounted automatic fire damper where they pass through the cavity barrier.

If a cavity barrier is provided above a partition separating bedrooms in accordance with **34.2.5** which do not need to be fire resisting partitions then i) to v) need not apply. However, openings in the barrier should be kept to a minimum and any penetrations should be sealed to restrict the passage of smoke.

35 Materials and finishes

NOTE ***21.2.6*** *gives guidance on the flooring and floor coverings within the fire-fighting shaft.*

35.1 Classification and use of internal wall and ceiling linings

35.1.1 General

NOTE The test methods currently in use in the UK have been supplemented by European methods which have been introduced under the Construction Products Directive 89/106/EEC [44] as amended by the CE Marking Directive 93/68/EEC [45], and which include additional information for the production of smoke from construction products, as well as the tendency to produce burning droplets or particles.

Reaction to fire properties of a material or product include ease of ignition, rate of heat release, surface flame spread rate, smoke production rate and total potential heat release. The performance of a building element in these respects is heavily influenced by geometric factors like the thickness, orientation and boundary conditions of the object and its component parts. The character of the fire (e.g. the heat flux, mode of heating, air movement, etc.) also affects the element's behaviour.

In most cases the contents of a building have more influence on the size and growth rate of a fire than the fabric. The choice of materials for walls and ceilings does affect the contribution that the building fabric makes to fire severity, but is more important as an influence over the rate at which flames propagate over the surfaces in question than in determining the magnitude of a fully developed fire.

The European classification for products for reaction to fire is defined in BS EN 13501-1. Classes are defined for walls and ceilings by use of one or more tests out from a combination of three defined EN ISO test methods and the EN single burning item test. The best/highest class is A1 and the lowest class is F.

For life safety purposes the surface flame spread and heat release rate characteristics of the lining material should be of a high class in circulation spaces (see Table 35). This is because fire propagation in these spaces could affect the means of escape significantly.

In small rooms the linings play a minor part in safety; and it is only necessary to avoid linings having a high flame spread or heat release rate that might encourage early flash-over in the room (increasing the danger to occupants elsewhere).

In very large rooms there is normally a circulation function, e.g. in open plan offices or shops. However, the highest standard of wall lining performance is not generally necessary because there is a choice of escape routes and the wall area is usually small compared to the plan area.

A higher standard of performance can be necessary for property protection purposes.

The surface linings of the walls and ceilings should generally conform to the classification recommended in Table 35 for the appropriate location. However, parts of walls in rooms may be of a lower class (but not lower than Class 3 or European Class D-s3, d2) provided that the total area of those parts in any one room does not exceed one half of the floor area of the room, subject to a maximum of 20 m^2 in residential accommodation, and 60 m^2 in non-residential accommodation.

Table 35 **Classification of linings** A)

Location	**National class** B)	**European class** C), D)
Small room of area not exceeding 4 m^2 in a residential building and 30 m^2 in a non-residential building and domestic garages not exceeding 40 m^2	3	D-s3, d2
Other rooms (including garages)	1	C-s3, d2
Circulation spaces within dwellings	1	C-s3, d2
Other circulation spaces D) including the common areas of flats	0	B-s3, d2

NOTE Linings which can be effectively tested for "surface spread of flame" are rated for performance by reference to the method specified in BS 476-7:1987, under which materials or products are classified 1, 2, 3 or 4, with Class 1 being the highest.

Class 0 is better than Class 1. It is not identified in any BS test standard. A Class 0 product is either:

a) composed throughout of materials of limited combustibility; or

b) a material having a Class 1 surface spread of flame and which has a fire propagation index (I) of not more than 12 and a sub-index (i_1) of not more than 6.

The fire propagation index is established by reference to the method specified in BS 476-6.

European classifications are described in BS EN 13501-1.

A) Recommendations are given in Clause **34** for linings of concealed voids.
B) The national classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class, unless they have been tested accordingly.
C) When a classification includes "s3, d2" this means that there is no limit set for smoke production and/or flaming droplets/particles.
D) Large rooms such as open plan offices, shops display areas and factories need not be regarded as circulation spaces even though there are circulation routes in them.

For the purposes of classification:

a) a wall is deemed to include:
   - the surface of glazing (except glazing in doors); and
   - any part of a ceiling that slopes at an angle of more than 70° to the horizontal;

b) a wall is not deemed to include:
   - doors and door frames;
   - window frames and frames in which glazing is fitted;
   - architraves, cover moulds, picture rails, skirtings and similar narrow members;
   - fireplace surrounds, mantel shelves and fitted furniture;

c) a ceiling is deemed to include:
   - the surface of the glazing; and
   - any part of a wall that slopes at an angle of 70° or less to the horizontal;

d) a ceiling is not deemed to include:
   - trap doors and their frames;
   - the frames of windows or roof lights and frames in which glazing is fitted;
   - architraves, cover moulds, picture rails, exposed beams and similar narrow members.

35.1.2 Thermoplastic materials

A thermoplastic material is any synthetic polymeric material that has a softening point below 200 °C when tested in accordance with BS EN ISO 306. Specimens for this test may be fabricated from the original polymer where the thickness of material of the end product is less than 2.5 mm.

A thermoplastic material in isolation cannot be assumed to protect a substrate, when used as a lining to a wall or ceiling. The surface rating of both products should therefore meet the recommended classification. If, however, the thermoplastic material is fully bonded to a non-thermoplastic substrate, then only the surface rating of the composite needs to conform.

Thermoplastic materials that cannot meet the classifications given in Table 35 should be classified TP(a) rigid, TP(a) flexible, or TP(b) according to the following methods:

NOTE 1 A TP(a) rigid material may also be a rigid thermoplastic product, a specimen of which (at the thickness of the product as put on the market), when tested in accordance with BS 2782-0:2004, Annex B[1], performs so that the test flame extinguishes before the first mark, and the duration of flaming or afterglow does not exceed 5 s following removal of the burner.

a) TP(a) rigid:
   1) rigid solid PVC sheet;
   2) solid (as distinct from double- or multiple-skin) polycarbonate sheet at least 3 mm thick;
   3) multi-skinned rigid sheet made from unplasticized PVC or polycarbonate which has a Class 1 rating when tested in accordance with BS 476-7 or European Class C-s3, d2;
b) TP(a) flexible:
   1) flexible products not more than 1 mm thick that conform to the Type C requirements of BS 5867-2:2008 when tested in accordance with BS 5438:1989+A2:1994, Test 2, with the flame applied to the surface of the specimens for 5 s, 15 s, 20 s and 30 s respectively, but excluding the cleansing procedure;

NOTE 2 A TP(b) material may also be a product which, when a specimen of the material between 1.5 mm and 3 mm thick is tested in accordance with BS 2782-0:2004, Annex B [1], has a rate of burning which does not exceed 50 mm/min.

NOTE 3 If it is not possible to cut or machine a 3 mm thick specimen from the product, then for the purposes of BS 2782, a 3 mm test specimen may be moulded from the same material as that used for the manufacture of the product.

c) TP(b):
   1) rigid solid polycarbonate sheet products less than 3 mm thick, or multiple-skin polycarbonate sheet products that do not qualify as TP(a) by test.

NOTE 4 A guide to the various test methods in BS 476 and BS 2782 is given in PD 6520. A guide to the development and presentation of fire tests and their use in hazard assessment is given in BS 6336.

Thermoplastic materials may be used in windows, roof lights and lighting diffusers in suspended ceilings provided that they meet the recommendations given in Table 36 and Figure 36 for the appropriate classification.

[1] This annex reproduces BS 2782:1970 (1974), Method 508A. BS 2782:1970 was declared obsolete in 1992 but Method 508A was retained as an informative annex in BS 2782:2004 because it is referred to in legislation.

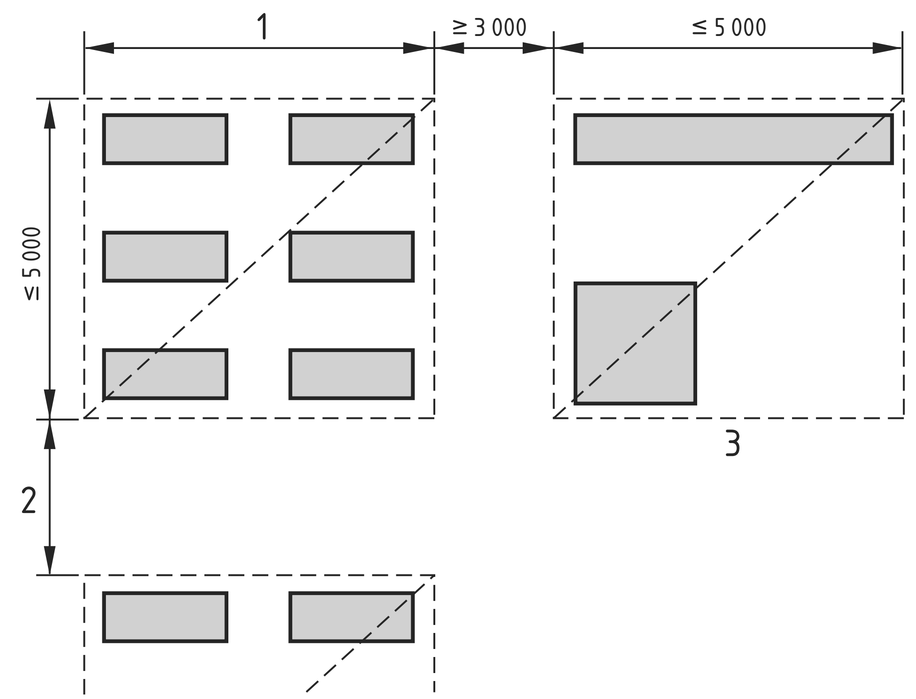
Table 36 **Limitations on Class 3 plastics roof lights and lighting diffusers in suspended ceilings**

Min. classification of lower surface	Use of space below diffusers of roof light	Max. area of each diffuser panel or roof light [A)] m^2	Max. total area of diffuser panels and roof lights % [B)]	Min. separation distance between diffuser panels or roof lights [A)] m
TP(a)	Any except protected stairway	No limit	No limit	No limit
Class 3 [C)]	Rooms	5	50 [D)]	3
Class 3 [C)]	Circulation spaces	5	15 [D)]	3

A) Smaller panels may be grouped together provided that the overall size of the group and the space between one group and any others meets the dimensions shown in Figure 36.
B) Percentage of floor area of the space in which the ceiling is located.
C) There are no limits on Class 3 material in small rooms (see **36.5.3**).
D) The minimum 3 m separation recommended in Figure 36 between each 5 m^2 should be maintained. Therefore, in some cases it might not also be possible to use the maximum percentage quoted.

Figure 36 **Limitations on spacing and size of plastic roof lights having a Class 3 lower surface (as part of the room lining)**

Dimensions in millimetres



Key

1 5 000 max. dimension of group of panels
2 3 000 min. dimension between groups of panels
3 5 000 is maximum area of diffuser or roof light in any one 5 000 × 5 000 group

Panel of diffuser or roof light

Separated groups of panels or roof lights

35.1.3 Lighting diffusers

Lighting diffusers should meet the relevant classification in Table 36 or be classified as TP(a) or TP(b) in accordance with **35.1.2**.

Thermoplastic lighting diffusers meeting classification TP(a) may be used without restriction.

Thermoplastic lighting diffusers meeting classification TB(b) may be used in ceilings to rooms and circulation spaces (but not protected stairways) only if they meet the recommendations given in Table 36 and Figure 36.

Wall and ceiling surfaces exposed within the space above a suspended ceiling (other than the upper surfaces of the thermoplastic panels) should meet the relevant classification in Table 35, according to the type of space below the suspended ceiling.

35.1.4 Suspended or stretched-skin ceilings

The ceiling of a room may be constructed either as a suspended or stretched skin membrane from panels of a thermoplastic material of the TP(a) flexible classification, provided that it is not part of a fire-resisting ceiling. Each panel should not exceed 5 m^2 in area and should be supported on all its sides.

35.1.5 Non-combustible materials

Non-combustible materials should be used in the following situations:

a) ladders forming part of an escape route in ancillary accommodation identified as higher fire risk;

b) refuse chutes;

c) suspended ceilings and their supports where the undivided cavity exceeds 40 m in extent (see also **34.3**);

d) as a sleeving where a pipe penetrates a compartment wall or floor [see **33.4.17**c)];

e) walls of a flue that penetrates a compartment floor or wall (see Figure 29);

f) construction of an open-sided car park.

35.1.6 Materials of limited combustibility

Materials of limited combustibility should be used in the following situations:

a) means of escape stairs in certain single stair buildings where this is recommended in **18.2**;

b) reinforcement or support for fire-stopping referred to in **33.4.1**;

c) insulated double-skin roof sheeting that is without internal cavity barriers (see **34.2** and Figure 32);

d) areas of roof covering separating small areas of certain types of plastics roof light (see **35.1.2**) and roofs (see **36.5.3**) according to the distance to the relevant boundary;

e) ceiling tiles of panels of any fire-protecting suspended ceiling (see Table 28);

f) roof deck referred to in **32.5.5** and Figure 25 where a compartment wall meets a roof;

g) any material in a ceiling void where the undivided cavity exceeds 40 m in extent (see also **34.3**);

h) insulation material in external wall construction referred to in **36.6**;

i) insulation above any fire-protecting suspended ceiling Type Z (see Table 28).

35.2 Special roof coverings

Special roofing types include:

- air-supported structures;
- flexible membrane roofs;
- PTFE-coated roof membranes.

Any flexible membrane covering a structure other than an air-supported structure, should conform to BS 7157:1989, Annex A.

Guidance on the use of PTFE-coated materials for tension membrane and similar roofs and structures is given in BR 274 [46].

35.3 Insulating core panels

35.3.1 General

NOTE Examples of possible solutions and general guidance on insulating core panels construction are given in the IACSC publication Design, construction, specification and fire management of insulated envelopes for temperature controlled environments *[47]. Of particular relevance is Chapter 8, which gives guidance on the design, construction and management of insulated structures.*

Insulating core panel systems are used for external cladding as well as for internal structures. Both types of panel system have unique fire behaviour characteristics. Those used for internal structures can present particular problems with regard to fire spread.

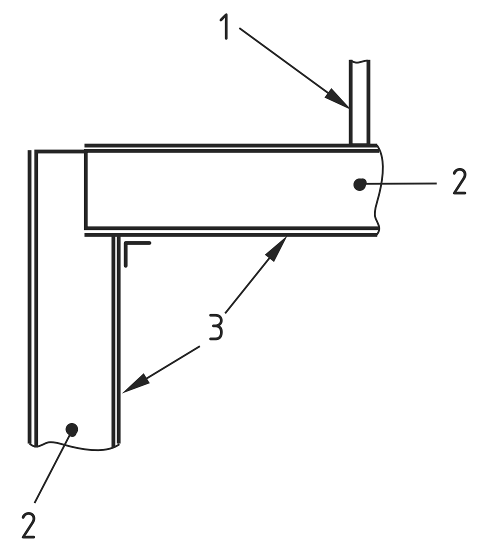
Insulating core panels typically consist of an inner insulating core sandwiched between, and bonded to, a membrane such as facing sheets of galvanized steel, often bonded with a PVC facing for hygiene or decorative purposes. The panels are used in many different ways:

- as free-standing enclosures, internally to the building;
- as discreet partitions or ceilings;
- fixed internally to external steelwork;
- fixed externally to internal steelwork;
- as additional linings to the existing building fabric.

The most common use of insulating core panels, when used for internal structures, is to provide an enclosure in which a chilled or sub-zero environment can be generated for the production, preservation, storage and distribution of perishable foodstuffs. However, this type of construction is used in many other applications, particularly where the maintenance of a hygienic environment is essential, e.g. microelectronics manufacture. They are also used for schools and a wide variety of buildings with public access.

The panels are characterized by novel jointing systems (see Figure 37), usually designed to provide an insulating and hygienic performance. When used for the external building envelope they usually feature through-fixings to the structure, and sometimes cover-plates over the joints for increased fire performance. Where hygiene requirements are paramount, special consideration needs to be given to the fixing method, as bacteria can move from the ambient side of the panel to the temperature-controlled area along a fixing.

Figure 37 **Thermoplastic cored internal wall and ceiling panels, typical junction**



Key

1 Ceiling panels partially supported by structure above
2 Insulating core material
3 Metal or similar washable facing bonded to insulating core material

Panels or panel systems should not be used to support machinery or other permanent loads. Any cavity created by the arrangement of panels, their supporting structure or other building elements should be provided with suitable cavity barriers.

35.3.2 Fire behaviour of core materials and fixing systems

The potential for problems involving mineral fibre cores is less than those for polymeric core materials. The degradation of polymeric core materials can be expected when exposed to radiated/conducted heat from a fire.

Regardless of the type of core, when exposed to the high temperatures of a developed fire, an insulating panel will tend to delaminate between the facing and core material, due to a combination of expansion of the membrane and softening of the bond line. Panels are available with higher fire resistance properties, which often feature enhanced jointing design.

Once a panel is involved in a fire, either directly or indirectly, it will have lost most of its structural integrity. The stability of the system then depends on the residual structural strength of the non-exposed facing, the joint between panels and the fixing system.

Many jointing or fixing systems for insulating core panels have an extremely limited structural integrity performance in fire conditions. If the fire starts to heat up the support fixings or structure to which they are attached, then there is a chance of total collapse of the panel system.

When compared with other types of construction techniques, insulating core panel systems provide a unique combination of problems for fire-fighters, which can include:

- hidden fire spread within the panels;
- production of large quantities of black toxic smoke;
- rapid fire spread leading to flashover.

These three characteristics are common to both polyurethane and polystyrene cored panels. The rate of fire spread in polyisocyanurate cores is significantly less than that of standard polyurethane or polystyrene cores, especially when any external heat source is removed.

In addition, irrespective of the type of panel core, all polymeric systems are susceptible to:

- delamination of the steel facing;
- collapse of the system;
- hidden fire spread behind the system.

35.3.3 Risk assessment

Where insulating core panels are to be used, a risk assessment should be carried out to identify the potential fire risk within the enclosures formed by the panel systems, and one or more of the following solutions should then be adopted at the design stage:

a) removing the risk;

b) separating the risk from the panels by an appropriate distance;

c) providing a fire suppression system for the risk (see Clause **39**);

d) providing a fire suppression system for the enclosure (see Clause **39**);

e) providing fire-resisting panels, including appropriate materials/fixing and jointing systems.

35.3.4 Use of core materials

The core material used in an insulating core panel should where possible be appropriate for the panel's intended application.

a) Core materials of limited combustibility should be used in areas such as:
   - cooking areas;
   - hot areas;
   - bakeries;
   - general fire protection;

b) Most core materials can be used in areas such as:
   - chill stores;
   - cold stores;
   - blast freezers;
   - food factories, with definitive measures to reduce fire risk;
   - clean rooms.

NOTE Core materials may be used in other circumstances where a risk assessment has been made and other appropriate fire precautions have been put in place.

35.3.5 Use of materials/fixing and jointing systems

The following measures should be adopted where appropriate.

a) Insulating envelopes, support systems and supporting structure should be designed to allow the envelope to remain structurally stable by alternative means such as catenary action following failure of the bond line between insulant core and facing materials. This typically involves positive attachment of the lower faces of the insulant panels to supports.

b) The building superstructure, together with any elements providing support to the insulating envelope, should be protected to prevent early collapse of the structure or the envelope.

NOTE Irrespective of the type of panel provided, it is necessary to ensure that the supplementary support method supporting the panels remains stable for an appropriate time period under fire conditions. It is not practical to fire-protect light gauge steel members such as purlins and sheeting rails which provide stability to building superstructures and these can be compromised at an early stage of a fire. Supplementary fire-protected heavier gauge steelwork members could be provided at wider intervals than purlins to provide restraint in the event of a fire.

c) In designated high-risk areas, non-combustible insulant cored panels can be incorporated into walls and ceiling construction at intervals, or strips of non-combustible material can be incorporated into specified wall and ceiling panels, in order to provide a barrier to fire propagation through the insulant.

d) The insulating envelope should be detailed to ensure that the combustible insulant is fully encapsulated by non-combustible facing materials that remain in place during a fire.

e) The panels should incorporate pre-finished and sealed areas for service penetrations.

36 External fire spread between neighbouring buildings

NOTE 1 A roof is not subject to the provisions in this clause unless it is pitched at an angle greater than 70° to the horizontal. Similarly, vertical parts of a pitched roof such as dormer windows (which taken in isolation may be regarded as a wall), would not need to meet these provisions unless the slope of the roof exceeds 70°. It is a matter of judgement whether a continuous run of dormer windows occupying most of a steeply pitched roof should be treated as a wall rather than a roof.

NOTE 2 Guidance on the construction of walls common to two or more buildings is given in ***32.4.1.2****.*

NOTE 3 The measures recommended in this clause will not necessarily protect a building from a fire in an existing building on an adjoining site. The property loss prevention aspects of the situation need to be assessed in each case.

36.1 General

The guidance given in this clause is concerned with the measures available to restrict potential to spread fire from the building of origin to a neighbouring structure. Two basic methods of fire spread between buildings are considered:

a) direct impingement of flames from one building on another; and

b) radiation (possibly supplemented by burning debris).

For buildings within 1 m of the relevant boundary (see **36.2.1**), flame spread is the main mechanism for fire spread. Beyond this distance, the mechanism for fire spread is assumed to be radiation.

Fire spread from building to building by radiation is dependent on:

1) the distance between and orientation of the building of origin and the neighbouring structure (radiator to receiver) [this is based on the principles of configuration (or view) factor];

2) the extent of the building surface capable of transmitting heat (external construction that has fire resistance is considered to have sufficient insulating properties, such that heat transfer can be ignored); and

3) the intensity (emissive power) of the source radiation.

The radiative energy emitted by the building of fire origin is dependent on the size and severity of the fire.

For the purposes of the guidance given in this clause, it is assumed that:

i) fire does not spread beyond the compartment of origin;

ii) the compartment of origin has reached flashover;

iii) all unprotected areas of one compartment will be radiating with equal intensity;

iv) radiation intensity at each unprotected area is:
   - 84 kW/m^2 for occupancy characteristic A (office and open-sided car parks only), B (assembly only) and C;
   - 168 kW/m^2 for all other occupancy characteristic;

v) radiation is halved by the action of an automatic sprinkler system; and

vi) any glazing, and/or the supporting structure, in the façade of the building of fire origin has failed in terms of integrity, unless the glazing system is classified for fire resistance according to either BS 476 or BS EN 13501 to the same standard as the wall as recommended in Table 25, because the radiation levels will vary between insulating and non-insulating glass.

No account is taken of the attenuation of the level of radiation.

36.2 Boundaries

36.2.1 Relevant boundary

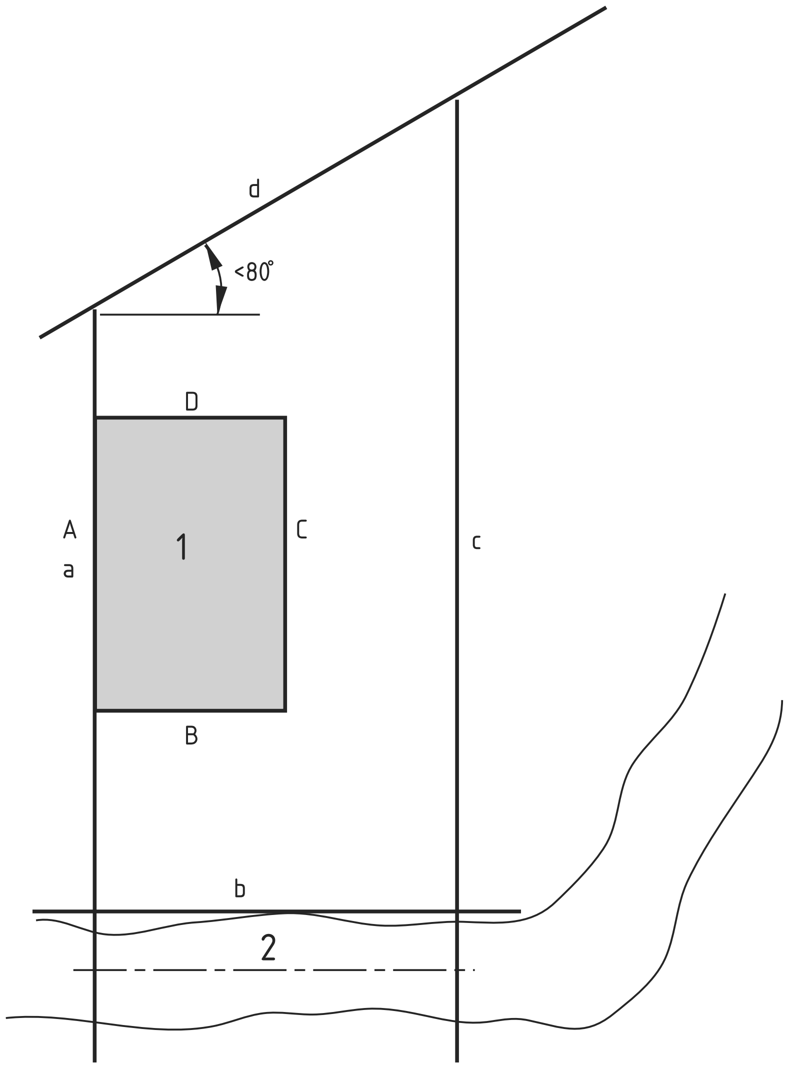
NOTE A notional boundary can be a relevant boundary.

The relevant boundary is the boundary to which separation distance is measured.

The relevant boundary is usually the site boundary. However, where a wall faces onto a space that is unlikely to be developed, such as a road, canal or river, then the boundary can be assumed to be an imaginary line half way across this feature.

A wall is treated as facing a boundary if it makes an angle of 80° or less (see Figure 38).

Figure 38 **Relevant boundaries**



Key

1 Building

2 Relevant boundary may be the centre line of a road, railway, canal or river

Boundary a is coincident with and therefore relevant to side A.

Boundary b is the site boundary.

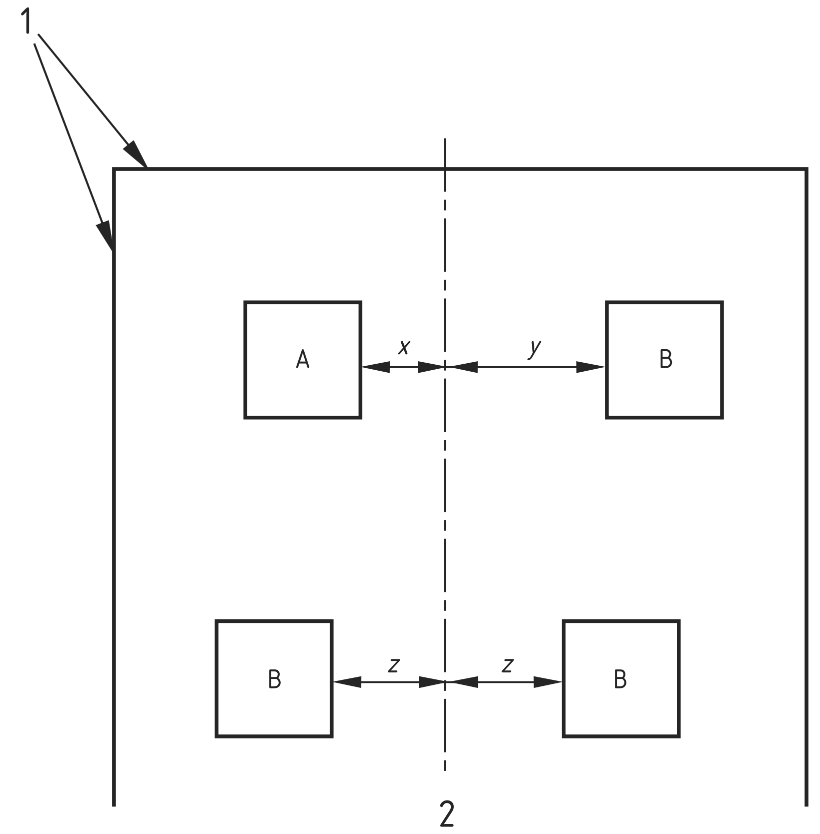
As the building overlooks a river, canal, road or similar feature, boundary b is taken as relevant to side B.

Boundaries c and d are parallel with, or less than 80° to, sides C and D and are therefore relevant to them.

36.2.2 Notional boundary

A notional boundary is an imaginary line assumed to exist between two buildings. (See Figure 39.)

Figure 39 **Notional boundaries**



Key

1 Site boundary
2 Notional boundary line between buildings
A Existing building
B New/proposed building
x Notional boundary set by existing building
y New building positioned according to notional boundary
z Notional boundary half-way between two new buildings

Separation between buildings on the same site that are operated/managed by the same organization can usually be ignored for life safety purposes. But because they represent a greater life risk than other uses, where either, or both, of the buildings are in occupancy characteristic B (assembly and recreation only) and C, a notional boundary should be established. However, where both buildings are protected by a sprinkler system, this might not always be necessary.

It is assumed that building A is existing and building B is new/proposed. When the need for a notional boundary is determined, its location is established according to Figure 39. Where both buildings are new, one should be designated as existing and the recommendation for notional boundary assessed accordingly.

When considering the location of a new building, the position of the notional boundary should be set according to the amount of unprotected area (see **36.3**) in the façade of the existing building. A proposed new building should be subject to the restrictions on proximity and extent of unprotected area relevant to this notional boundary. (See **36.4.4**.)

Where both buildings are new, the notional boundary can be assumed to exist half way between the two buildings and the location of each is set accordingly.

36.2.3 Property protection between buildings on the same site

The principle of a notional boundary can be applied to any building for property protection purposes.

36.3 Unprotected area

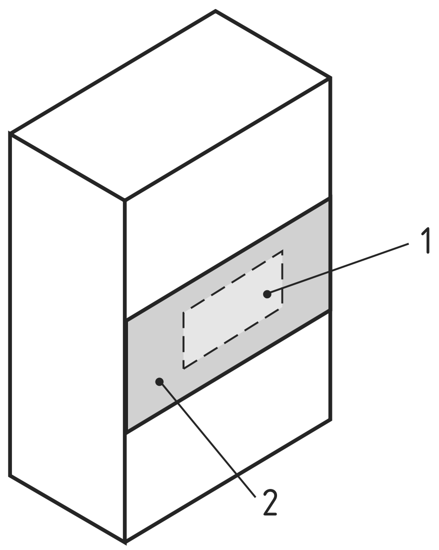
36.3.1 General

For life safety, any part of an external façade that has a period of fire resistance less than the appropriate level recommended in Table 24 is counted as unprotected area.

Included in the unprotected area calculation is any section of external wall which has the appropriate standard of fire resistance, but has a combustible material more than 1 mm thick as its external surface. However, this section of wall is counted as having an unprotected area amounting to half the actual area of the combustible surface (see Figure 40).

The amount of unprotected area in the façades of buildings needs to be restricted according to the distance between these façades and the relevant (or notional) boundaries (see **36.4**).

Figure 40 **Combustible surface material as unprotected area**



Key

1 Area of surface counted as unprotected (50% of area of actual surface)

2 Area of combustible surface material (>1 mm thick)

The following are not considered to contribute to the extent of unprotected area:

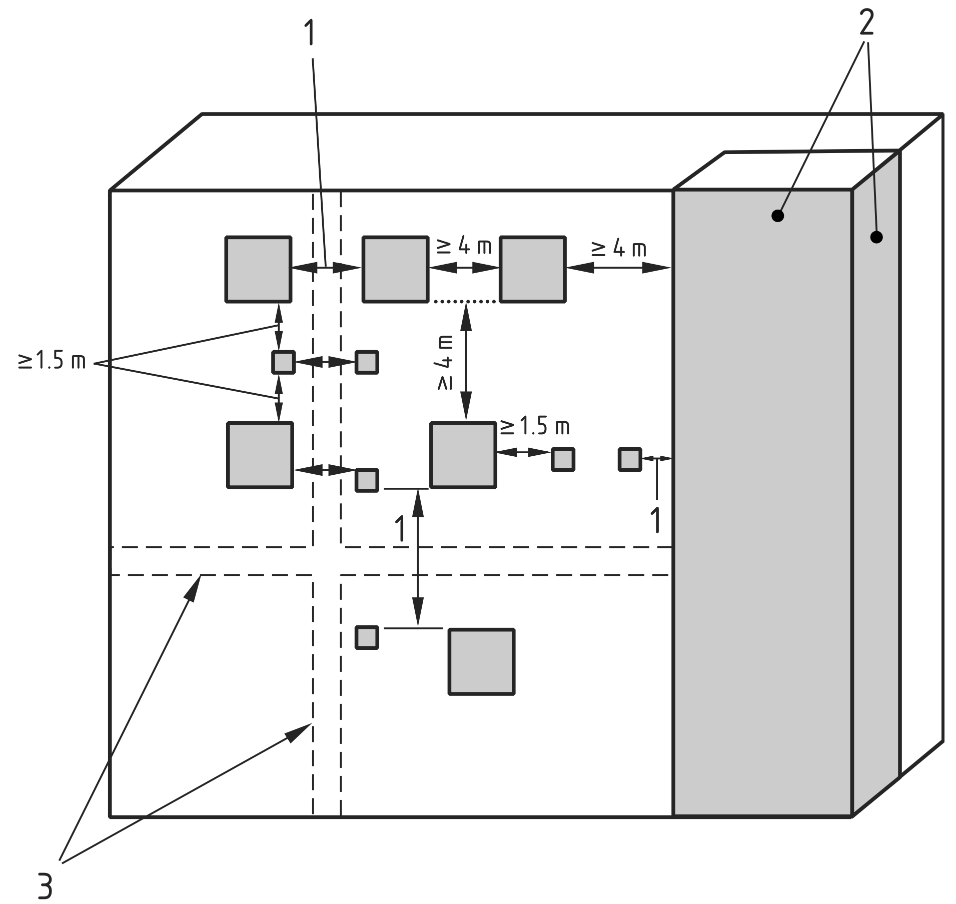
a) any part of an external wall of a stairway in a protected shaft;

b) parts of the external wall of an uncompartmented building that are more than 30 m above mean ground level. This is relevant for large hall type structures, where the floor area at heights above 30 m is likely to be limited and the fire load is confined to the lower level. Where high rack storage is present in a building or part of a building, the areas containing the high rack storage would not qualify for this exclusion;

c) small unprotected areas in an otherwise protected façade according to the constraints shown in Figure 41.

Small unprotected areas pose a negligible risk of fire spread.

Figure 41 **Exclusions from unprotected area calculations**



Key

1 Unrestricted

2 External wall of shaft that is enclosed by a minimum of 60 min fire resistance from the accommodation side

3 Compartment boundaries

36.3.2 Automatic sprinklers

Where a building is provided with automatic sprinklers, the amount of unprotected area may be doubled or the distance to the boundary for a given amount of unprotected area may be halved.

36.3.3 Canopies and open-sided car parks

In view of the high degree of ventilation and heat dissipation achieved by open-sided construction (i.e. canopies), provided the edges of the canopy are at least 2 m from the relevant boundary, the separation distance may be determined from the wall, rather than the edges of the canopy.

This principle is also valid for open-sided car parks. Where property protection is an issue, boundary separation can still be necessary, but, for life safety, provided that the car park is at least 1 m from the relevant boundary it can be treated as having the equivalent fire size (and therefore radiation intensity) as a sprinklered building.

36.3.4 External wall of portal frame buildings

NOTE A design method is set out in the SCI publication Single storey steel framed buildings in fire boundary conditions *[48]. This publication offers guidance on many aspects of portal frames, including multi-storey types. If a portal framed building is fitted with a sprinkler system in accordance with the relevant requirements in BS EN 12845 or BS 5306-2, then the recommendations of this publication for designing the foundations to resist overturning need not be applied.*

Portal frames used in single-storey buildings might need no fire resistance, as the structure only supports a roof (see **31.1.4**). However, where a portal framed building is near a relevant boundary, the external wall might need fire resistance to restrict the spread of fire between buildings.

It is generally accepted that a portal frame acts as a single structural element, because of the moment-resisting connections used, especially at the column/rafter joints. If the stability of an external wall is linked to that of the portals, the column and rafter members should have fire resistance to avoid premature failure of the relevant external wall.

However, the foundations and their connection to the portal frame can be designed to transmit the overturning moment caused by the fire-induced collapse of unprotected rafters, purlins and some roof cladding, while allowing the external wall to retain its stability/integrity.

Portal frames of reinforced concrete can normally support fire-resisting external walls without specific provision at the column bases to resist overturning.

36.4 Degree of separation

36.4.1 General

*NOTE The guidance in **36.5** also relates to the separation distance between a roof and a relevant boundary.*

A building should be separated from the relevant boundaries by at least half the distance at which the total thermal radiation intensity, received from all unprotected areas in the external façade, would be 12.6 kW/m^2.

The intensity of radiation to cause ignition of wood in still air conditions is 12.6 kW/m^2. Ignition inside a receiver building is dependent on the amount of unprotected area in its façade.

The use of distance to a relevant boundary, rather than to another building, allows development on the neighbouring site without prejudice.

36.4.2 External walls within 1 m of the relevant boundary

NOTE 1 These recommendations are aimed at protecting neighbouring buildings from direct flame impingement as well as radiation.

NOTE 2 ***36.6*** *gives guidance on external wall materials and construction.*

Where an external wall is coincident with (see Figure 38) or within 1 m distance of a relevant boundary it should:

a) achieve the appropriate level of fire resistance in terms of integrity and insulation (see Table 24) from both sides when tested in accordance with BS 476-22 or BS EN 1634-1;

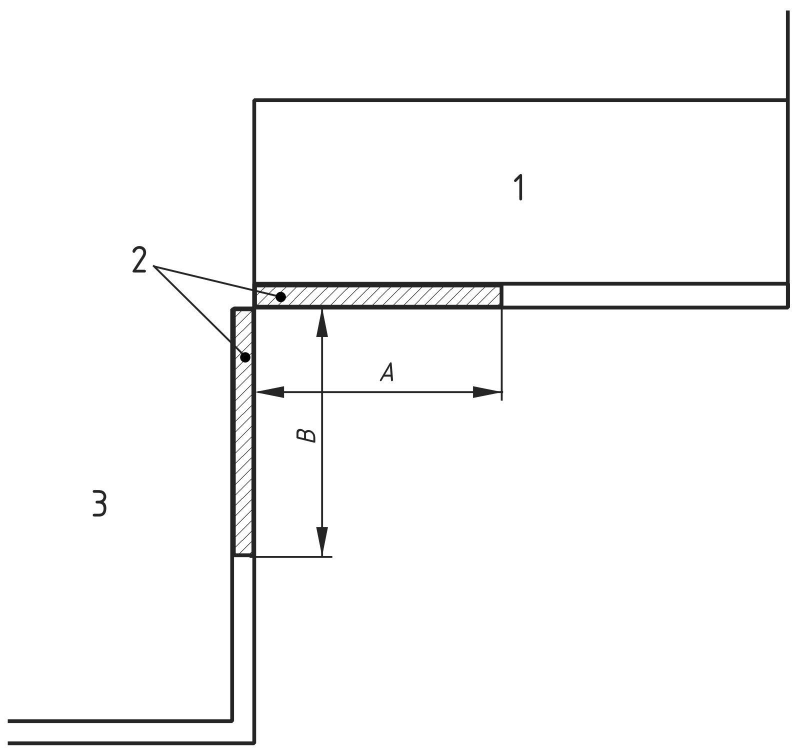
b) have only small, unprotected areas conforming to the limits shown in Figure 42;

c) resist direct flame impingement and high levels of radiation from the adjoining site;

d) have non-combustible surfaces;

e) be an effective barrier to a fire either inside or outside the building.

Figure 42 **Extent of unprotected area forming an internal angle**



Key

1 Protected route

2 Fire-resisting construction including insulation performance

3 Accommodation

Either A or B should be 1 800 mm where the protected route is for means of escape and 5 000 mm where the protected route is for fire-fighting access.

36.4.3 External walls 1 m or more from the relevant boundary

Where a wall is situated at least 1 m from all points on the relevant boundary:

a) the extent of unprotected area should not exceed that given by one of the appropriate methods in **36.4.4**;

b) the rest of the wall (if any) should have the fire resistance stated in Table 25 or Table 26 (with 15 min in terms of insulation).

If a building has an automatic sprinkler system, the incidence of radiation to adjoining buildings will be much reduced.

However if a building is not sprinklered, or if property protection is a consideration, the proportion of external wall that is not fire-resisting should be limited. These limitations are based on the distance to the relevant boundary and the likely intensity of the fire.

36.4.4 Calculation methods

There are four methods for determining the maximum permissible amount of unprotected area between a building and a relevant boundary.

a) *Small residential (occupancy characteristic C).* Table 37 should be used to determine the appropriate boundary separation distance when the building is intended for residential use and is:

   1) no greater than 3 storeys in height; and

   2) no more than 24 m in length.

b) *Enclosing rectangles*. For details of this method refer to part 1 of BR 187 [36].

c) *Aggregate notional area*. For details of this method refer to part 1 of BR 187 [36].

d) *Fire engineering calculation* (see BS 7974).

Table 37 **Small residential unprotected area limits and boundary distances**

Minimum distance between façade and relevant boundary m	**Maximum total unprotected area per compartment** m^2
1	5.6
2	12
3	18
4	24
5	30
6	No limit

36.5 Roofs

36.5.1 General

The recommendations in this subclause are principally concerned with the performance of roofs when exposed to fire from the outside. They limit the use, near a boundary, of roof coverings that are unlikely to give adequate protection against the spread of fire over them.

NOTE 1 The term "roof covering" is used to describe a construction that can consist of one or more layers of material, but does not refer to the roof structure as a whole.

*NOTE 2 The circumstances when a roof is subject to the provisions for space separation are explained in Clause **36**, Note 1.*

NOTE 3 Recommendations and guidance concerning the fire properties of roofs are given in:

*a) **31.1.4** for roofs that are part of a means of escape and for roofs that are used as a floor;*

*b) **35.1** and **36.5.3** for the internal surfaces of roof lights as part of the internal lining of a room or circulation space;*

*c) Clause **32** for roofs that pass over the top of a compartment wall;*

*d) **35.1.6** for the construction of roof coverings in roofs incorporating roof lights.*

*NOTE 4 Guidance on roofing materials is given in **35.2**.*

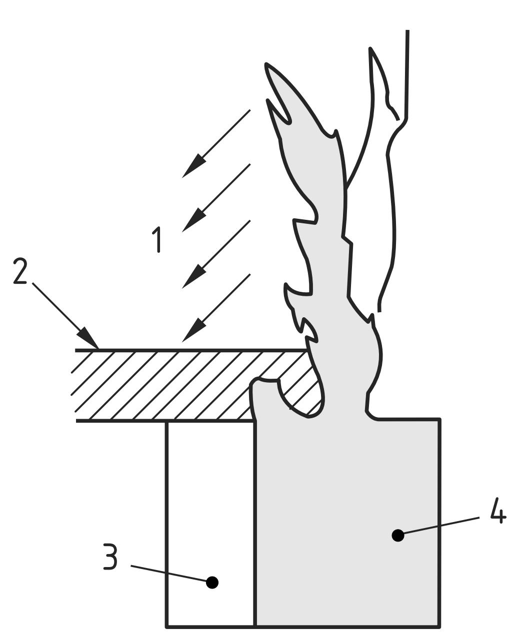
The relevant test methods for the external fire performance of roof systems are BS 476-3 and DD ENV 1187:2002, Test 4.

For restriction of fire spread over roofs the properties of a roof covering are only of relevance:

a) if the roof is close enough to a boundary to be at risk of ignition from a fire in other buildings; and

b) in the vicinity of a compartment wall, to avoid fire spread between compartments via a roof covering (see Figure 43).

Figure 43 **Roof covering adjoining line of compartmentation**



Key

1 Radiation and flame impingement

2 Roof

3 Compartment wall

4 Fire in adjoining compartment

36.5.2 Separation distances

The separation distance is the minimum distance from the roof (or part of the roof) to the relevant boundary, which may be a notional boundary. Separation distances should be as recommended in Table 38 for the appropriate type of roof covering and building use.

NOTE Advice on fire protection of thatched buildings is available from the Dorset Building Control Technical Committee at http://www.dorset-technical-committee.org.uk/reports/report1.asp.

Table 38 **Separation distances for roof coverings**

Designation of covering of roof or part of roof [A)]	**Distance of roof from any point on relevant boundary**			
	Less than 6 m	**At least 6 m**	**At least 12 m**	**At least 20 m**
AA, AB or AC	Acceptable	Acceptable	Acceptable	Acceptable
BA, BB or BC	Not acceptable	Acceptable	Acceptable	Acceptable
CA, CB or CC	Not acceptable	Acceptable [B), C)]	Acceptable [B)]	Acceptable
AD, BD (or CD [B)])	Not acceptable	Acceptable [C)]	Acceptable	Acceptable
DA, DB, DC (or DD [B)])	Not acceptable	Not acceptable	Not acceptable	Acceptable [C)]

NOTE 1 Unwired glass at least 4 mm in thickness has an AA designation.

NOTE 2 See Table 39 for limitations on plastics roof lights.

A) The performance of roof coverings is designated by reference to the test methods given in BS 476-3 (or DD ENV 1187).

B) Not acceptable on any of the following buildings:

- occupancy characteristic A;
- buildings with a volume of more than 1 500 m^3.

C) Acceptable on buildings not listed in footnote B, if part of the roof is no more than 3 m^2 in area and is at least 1.5 m from any similar part, with the roof between the parts covered with a material of limited combustibility.

36.5.3 Roof lights

The separation distance for plastics roof lights should be as recommended in Table 39 for the appropriate classification. Roof lights should be at least 1.5 m from a compartment wall.

Plastics roof lights should not be used in protected stairs.

NOTE 1 When used in roof lights, a rigid thermoplastic sheet product made from polycarbonate or from unplasticized PVC, which achieves a Class 1 rating for surface spread of flame when tested in accordance with BS 476-7 or the European equivalent, is deemed to have an AA designation.

The roof covering material surrounding a plastics roof light should be of limited combustibility for at least 3 m distance.

The designation of external roof surfaces is defined in BS 476-3.

Products may have upper and lower surfaces with different properties if they have double skins or are laminates of different materials, in which case the more onerous distance applies.

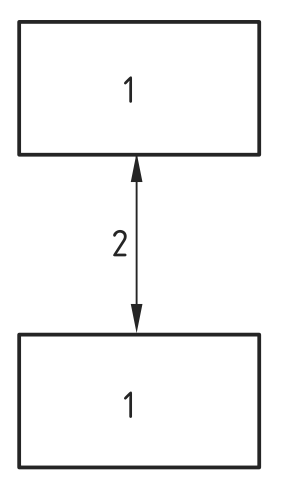
NOTE 2 The method of classifying thermoplastic materials is given in ***35.1.2****.*

Table 39 **Separation distance for plastics roof lights**
Dimensions in metres

Space that roof light can serve	Min. classification on lower surface A)	Min. distance from any point on relevant boundary to roof light			
		Class 3 plastics roof lights		TP(a) and TP(b) plastics roof lights	
		AD, BD, CA, CB, CC, CD	DA, DB, DC, DD	TP(a)	TP(b)
Balcony, veranda, carport, covered way or loading bay, which has at least one longer side wholly or permanently open	Class 3	6	20	—	—
	TP(b)	—	—	N/A	6
Detached swimming pool	Class 3	6	20	—	—
	TP(b)	—	—	N/A	6
Conservatory, garage or outbuilding, wholly or permanently open with a maximum floor area of 40 m^2	Class 3	6	20	—	—
	TP(b)	—	—	N/A	6
Circulation space B) (except a protected stairway)	Class 3	6	20	—	—
	TP(b)	—	—	N/A	6
Room B)	Class 3	6 C)	20 C)	—	—
	TP(b)	—	—	N/A	6 C)
Any space except a protected stairway	TP(a) rigid	—	—	6	N/A

A) See also the limits in Table 38.
B) Single skin roof light only, in the case of non-thermoplastic material.
C) The roof light should also meet the provisions of Figure 44.

Figure 44 **Limitations on spacing and size of plastics roof lights having a Class 3 or TP(b) lower surface**



Key
1 Roof light, max. area 5 m^2, or group of roof lights amounting to no more than 5 m^2
2 Not less than 3 m between any two roof lights in any direction

36.6 External fire spread over the external faces of buildings

The guidance in this subclause is concerned with the reaction to fire properties of the wall.

External walls should be constructed such that they will not support fire spread at a speed that is likely to threaten people in or around the building.

Flame spread over or within an external wall construction should be sufficiently controlled to avoid creating a route for rapid fire spread bypassing compartment floors or walls.

External wall surfaces near other buildings should not be readily ignitable, to avoid fire spread between buildings.

NOTE The total amount of combustible material might also be limited in practice by the provisions for space separation.

External walls should either meet the performance criteria given in BRE Report BR 135 for cladding systems using full scale test data from BS 8414-1 or BS 8414-2, or meet the following recommendations.

a) The external surfaces of walls should meet the provisions in Figure 45.

b) In a building with a storey 18 m or more above ground level, any insulation product, filler material (not including gaskets, sealants and similar), etc., used in the external wall construction should be of limited combustibility. This restriction does not apply to masonry cavity wall construction that conforms to Figure 33.

c) Cavity barriers should be provided in accordance with **34.2**.

d) In the case of a an external wall construction, of a building which, by virtue of the recommendations in **34.3**d), is not subject to the provisions of Table 34, the surfaces which face into cavities should also meet the provisions of Figure 45.

37 Accommodation ancillary to the main use of the building

37.1 Engineering services installation rooms

37.1.1 General

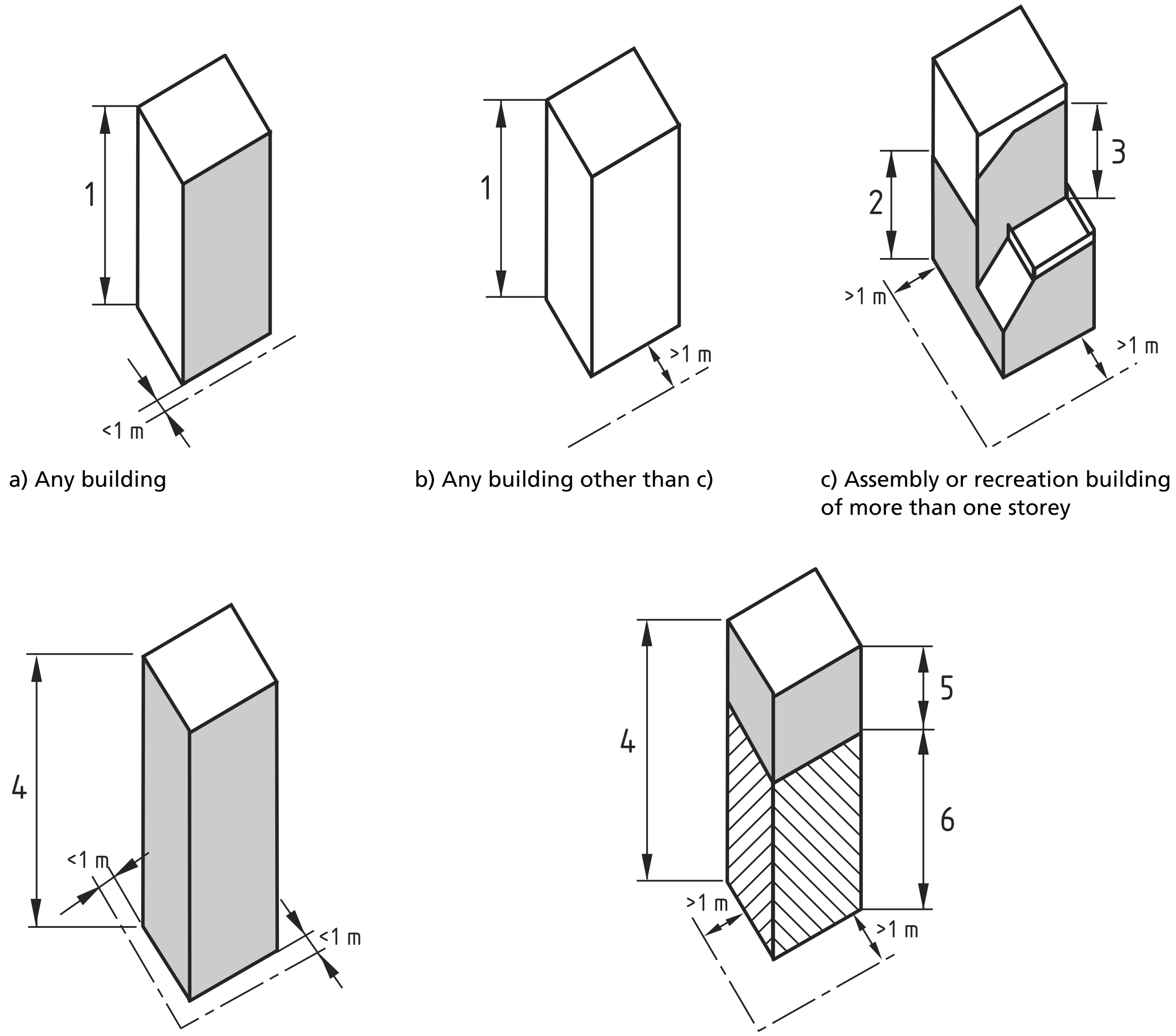
NOTE If there is cause to store or use dangerous substances or preparations, i.e. substances or preparations that are explosive, oxidizing, extremely flammable, highly flammable or flammable, or such substances are liable to be produced, the attention of building designers and management is drawn to the Dangerous Substances (Explosive Atmospheres) Regulations 2002 [27] and specifically in the case of petroleum spirit, i.e. petrol, to the Petroleum (Consolidation) Act 1928 [28].

Engineering services installation rooms include electrical switchgear rooms, boiler rooms, fuel storage spaces, mechanical ventilation and air conditioning plant rooms, rooms housing fixed internal combustion engines, rooms housing refrigeration plant that utilizes a flammable or toxic refrigerant (other than equipment of a domestic nature) and battery charging rooms. Special design considerations are necessary where these are determined to be high fire risk areas (see **13.6**).

Service installation rooms should be sited so that escape from other exits is not prejudiced by the risk of an outbreak of fire in such a room.

Service installation rooms in which flammable liquids or gases are used or stored should have imperforate sills to doorways and any necessary drainage should be provided with interceptors.

Figure 45 **Provisions for external surfaces of walls**



a) Any building

b) Any building other than c)

c) Assembly or recreation building of more than one storey

d) Any building

e) Any building

Key

1	Building height <18 m
2	Up to 10 m above ground level
3	Up to 10 m above a roof or any part of the building to which the public have access
4	Building height 18 m or more
5	Portion of building more than 18 m above ground level
6	Portion of building up to 18 m above ground level
	Relevant boundary
	No provision in respect of the boundaries indicated
	Class 0 (national class) or class B-S3, d2 or better (European class). Profiled or flat steel sheet at least 0.5 mm thick with an organic coating of no more than 0.2 mm thickness is also acceptable.
	Index (I) not more than 20 (national class) or class C-s3, d2 or better (European class). Timber cladding at least 9 mm thick is also acceptable. (The index I relates to tests specified in BS 476-6.)

NOTE 1 The national classifications do not automatically equate to the equivalent European classifications, therefore products cannot typically assume a European class unless they have been tested accordingly.

NOTE 2 When a classification includes "s3, d2", this means that there is no limit set for smoke production and/or flaming droplets/particles.

Service installation rooms should, where necessary for the safe operation of the equipment and to avoid undue build-up of heat, be ventilated (either directly or indirectly) to the outside air. The provision of ventilation for the safe operation of equipment and to avoid undue build-up of heat should not impair any fire resistance provisions for service installation rooms.

37.1.2 Walk-in refrigerated cold rooms and associated systems

Refrigerated cold rooms, cold stores and other refrigerated enclosures of the walk-in type (all referred to as cold rooms) are within or part of another building; a cold warehouse is the building itself. These are commonly constructed using insulating core panel systems (see **35.3**).

Refrigeration systems associated with cold rooms should conform to BS EN 378.

NOTE 1 Information on refrigeration systems associated with cold rooms is given in the current codes of practice issued by the Institute of Refrigeration, i.e.

- *Cold store code of practice – Part 1: Enclosure construction [49];*
- *Cold store code of practice – Part 2: Design and construction of refrigeration systems [50];*
- *Safety code for refrigerating systems utilizing carbon dioxide [51];*
- *Safety code for compression refrigerating systems utilizing ammonia [52];*
- *Safety code for compression refrigerating systems utilizing Groups A1 and A2 refrigerants [53];*
- *Safety code for compression refrigerating systems utilizing Group A3 refrigerants [54].*

NOTE 2 Information on the design of cold rooms and stand-alone cold stores is given in the IACSC publication Design, construction, specification and fire management of insulated envelopes for temperature controlled environments *[47].*

NOTE 3 Information on the fire behaviour of insulating core panels used for internal structures is given in the Building Regulations 2000, Approved Document B [33], Appendix F (Fire safety).

37.1.3 Boiler rooms, fuel storage areas, transformer, battery and switchgear rooms, and rooms housing internal combustion engines

37.1.3.1 Boiler rooms

NOTE In the design of a boiler room and ancillary spaces, the possibility of a future change to other fuels might need to be taken into account.

Boiler rooms (other than those covered by BS 5410-2) should have provision for smoke venting.

Oil-fired installations should be in accordance with BS 5410-1 and BS 5410-2.

Town, natural and liquefied gas boiler installations should be in accordance with BS 6798 or BS 6644.

37.1.3.2 Fuel storage spaces

Oil should be stored and supplied in accordance with BS 5410-1, BS 5410-2 and BS 799-5.

Solid fuel should be stored in bunkers protected by non-combustible walls of sufficient thickness to prevent heating of the fuel by boilers or steam pipes.

Fuel storage areas (other than those covered by BS 5410-2) should have provision for smoke venting.

NOTE Guidance on fuel storage areas used for the bulk storage of liquefied petroleum gas are given in the following publications:

- *LP Gas Association Code of Practice No.1, Part 1 [55], Part 2 [56] and Part 4 [57];*
- *LP Gas Association Code of Practice No.7 [58];*
- *LP Gas Association Code of Practice No.24, Part 1 [59] and Part 2 [60].*

37.1.3.3 Medium and high voltage transformer and switchgear rooms, and battery rooms

A medium or high voltage transformer, or switchgear room, or battery room, unless situated on the roof or in a separate enclosure, should be sited adjacent to an external wall and entered only from the open air.

A medium or high voltage transformer, or switchgear room, or battery room, should be ventilated. BS 6133 gives advice on this for battery rooms using lead-acid stationary batteries.

37.1.3.4 Rooms housing fixed internal combustion engines

Rooms housing fixed internal combustion engines should be treated as enclosing places of special fire hazard and should be separated from other parts of the building by partitions of fire-resisting construction and from any protected stairway by a protected lobby or corridor (see **31.2**).

37.2 Waste storage and treatment

Waste retained in premises constitutes a fire risk, particularly if it is bulky. BS 5906 gives advice on the collection, storage and disposal of waste, together with information about on-site treatment systems such as compactors, balers and incinerators, which reduce the volume of waste and its fire risk.

NOTE 1 Solid waste storage is controlled by the Building Regulations 2000 [19], the Building (Scotland) Regulations 2004, as amended [20], and the Building Regulations (Northern Ireland) 2000 [31].

Waste storage chambers, on-site treatment of solid waste and chute systems should be designed and constructed in accordance with BS 5906.

NOTE 2 Attention is drawn to the Dangerous Substances (Explosive Atmospheres) Regulations 2002 [27] where the waste is a dangerous substance or preparation, i.e. substances or preparations that are explosive, oxidizing, extremely flammable, highly flammable or flammable, or where such substances are liable to be produced in the treatment of the waste.

37.3 Main storage areas (including receiving and dispatch areas)

NOTE If there is cause to store or use dangerous substances or preparations, i.e. substances or preparations that are explosive, oxidizing, extremely flammable, highly flammable or flammable, or such substances are liable to be produced, the attention of building designers and management is drawn to the Dangerous Substances (Explosive Atmospheres) Regulations 2002 [27] and specifically in the case of petroleum spirit; i.e. petrol, to the Petroleum (Consolidation) Act 1928 [28].

Main storage areas include areas to be used for the storage of goods for sale/dispatch, furniture, stationery, waste paper/packaging and similar combustible material, receiving and dispatch rooms and packing and sorting rooms.

Smoke-venting of large storage areas is important, especially those below ground level where windows cannot normally be provided. If possible, storage areas need to be sited adjacent to an external wall to facilitate the provision of clean air inlets and smoke extracts, which should discharge at or above ground level and be so situated that smoke from them cannot jeopardize the means of escape from the building. It is preferable, moreover, that storage areas are not sited adjacent to escape routes to which the public have access.

Office and sales areas generally, and areas used by the public in particular, should be kept substantially free of dangerous substances, such as highly flammable materials to avoid their being considered high fire risk areas (see **13.6**). Such substances should be kept in stock rooms (see **15.2**) to which the public is not admitted. Main storage areas, if either situated below ground level or exceeding 450 m^2 in area, should have provision for smoke venting in accordance with Clause **28**.

38 Engineering services

38.1 Gas services

38.1.1 General

NOTE 1 Attention is drawn to the following regulations:

- *Gas Safety (Installation and Use) Regulations 1998 [61] in respect of the installation pipework and meters for natural gas in commercial and domestic premises;*
- *Gas Safety (Installation and Use) Regulations 1998 [61] in respect of service and installation pipework and meters for LPG gas in commercial and domestic premises;*
- *Pipelines Safety Regulations 1996 [62] in respect of the service pipes for natural gas.*

NOTE 2 Further guidance on service and installation pipework for natural gas is given in IGE/TD/4 [63] and IGE/UP/2 [64].

NOTE 3 Further guidance on meter installations is given in IGE/GM/1 [65].

NOTE 4 Further guidance on LPG pipework is given in LP Gas Association Code of Practice No. 22 [66].

All gas service and installation pipes for both natural gas and liquefied petroleum gas (LPG) should be installed such that the fire resistance of the building is unimpaired.

In large buildings emergency control valves should be located external to the building.

38.1.2 Gas services in escape routes

In new buildings, installation and service pipes should not be run in a protected stairway or lobby, where this provides the only means of escape in case of fire. Similarly, in respect of gas supplies to extensions and alterations to existing buildings unless it is impractical to avoid, this includes new installation and service pipes. Similarly, where installation and service pipes in such a stairway or lobby are to be replaced, consideration should be given to the possibility of their re-siting outside the stairway or lobby.

38.2 Electrical services

NOTE This subclause does not cover automatic fire detection and alarm systems or emergency lighting systems.

38.2.1 General

All electrical services should be installed, and periodically inspected and tested (with any necessary maintenance carried out), by suitably qualified engineers in accordance with BS 7671. Special attention might need to be given to the mechanical protection of wiring in certain premises such as places of entertainment and workshops.

38.2.2 Electrical risers

The size of the electrical risers should be large enough only to accommodate the electrical services, and/or any working space needed to install/maintain the equipment.

Electrical risers within any protected stairway should be separated therefrom by 30 min fire-resisting construction and access doors, which should be kept locked shut and be openable only by the management responsible for the building.

Electrical risers where installed elsewhere than in a stairway should be enclosed with fire-resisting construction of a standard equivalent to the elements of structure of the building and the doors thereto should be capable of being locked shut (see **42.2.4**). However, where each floor is continued into the riser shaft so that each floor is separated from the other, the riser need not be enclosed with fire-resisting construction.

Meters installed within any protected stairway should be enclosed within a secure cupboard, which should be of 30 min fire-resisting construction.

38.2.3 Electrical services for life safety and fire equipment

38.2.3.1 Electrical power supplies to life safety and fire protection equipment

Since it is not possible to determine where a fire might start, all power supplies (primary, secondary and emergency) to life safety and fire protection equipment, and their associated control equipment back to the origin of the supply within the building should be regarded as being within the hazard/risk area. Therefore great care needs to be taken in the design to ensure that power is available at all times.

Consideration also needs to be given, not only to routeing of cables, but to positions of terminations, circuit protection facilities and control panels, to ensure that these are also provided with protection from the effects of fire.

The electrical power supply to life safety and fire protection equipment should be separate from all other circuits in the building so that the failure of other equipment does not render the installation inoperative.

Each connection to the power supply should be via an isolating protective device reserved solely for the life safety and fire protection equipment and independent of any other main or submain circuit. Such isolating protective devices (with high-rupturing safety devices) should be clearly labelled and identified as to their purpose. They should be secured against unauthorized operation and should, except for maintenance, be kept locked-on. Additional warning labels should be provided, with their location and wording depending on whether the isolating protective device is fed from the live side or the dead side of the main isolating device. If fed from the live side:

a) the label on each isolating protective device should read: "Warning: this supply remains live when the main switch is turned off"; and

b) a label should be placed on the main isolating device reading: "Warning: the…(state circuit)… supply remains live when this switch is turned off".

If fed from the dead side, a label should be fixed to the main isolating device reading: "Warning: this switch also controls the supply to the …(state circuit)…".

Where a central control room is provided, monitoring facilities should be provided at the central control room to show, as far as is reasonably practicable, that power is available up to the final control point, e.g. motor contactor, to all fire safety systems.

38.2.3.2 Protected circuits for the operation of equipment in the event of fire

Wiring systems for both the primary and secondary power supply to electrical equipment required to operate in the event of fire need to be of a type or installed in a manner such that, in the event of fire anywhere in the building, the circuits will continue to operate and the cables will maintain circuit integrity.

Wiring systems should conform to the following specific recommendations.

NOTE Where appropriate, conformity is for integrity and insulation from the side of the construction remote from the cable.

a) The wiring systems should either:

   1) consist of mineral-insulated, copper-sheathed cables conforming to BS EN 60702-1 and meeting the relevant life safety and/or fire safety performance objectives given in BS 7346-6; or

   2) consist of other cables meeting the relevant life safety and/or fire safety performance objectives given in BS 8491; or

   3) be protected against exposure to the fire by separation from any significant fire risk by a wall, partition or floor with a fire resistance of not less than that required for the building.

   The mechanical protection of cables by conduit, ducting or trunking should not be considered to give protection against fire.

b) The wiring systems should be separate from any circuit provided for any other purpose.

c) Jointing and termination methods should be chosen to minimize any reduction in reliability and resistance to fire below that of unjointed cable. Jointing and termination methods for cables conforming to BS EN 60702-1 should in addition conform to BS EN 60702-2.

d) Wiring systems in accordance with items a), b) and c) should be provided for fire extinguishing systems, sprinkler systems, smoke control systems, fire-fighting shaft systems, motorized fire shutters, CCTV systems installed for monitoring means of escape, and data communications systems that link fire safety systems.

e) The wiring systems should be protected from mechanical damage.

38.2.3.3 Primary and secondary power supplies

NOTE 1 In some cases, where the power demand from a system is low (such as control systems for natural vent actuators), a secondary supply can be achieved by the use of back-up batteries.

NOTE 2 For legal and technical reasons, power supply companies have reservations about offering a power supply from a second substation to provide protection against the occurrence of a fault (unconnected with the fire) on the high-voltage distribution system. Accordingly, a generator or an independent power supply needs to be provided if protection against faults is required by the occupier.

To reduce the risk of the loss of electrical supply to fire protection systems that are required to operate continuously during a fire [such as those listed in i) below], a secondary power supply is essential. This supply needs to be of sufficient capacity to maintain supplies to all life safety and fire equipment installations. The secondary power system needs to be designed to operate safely in fire conditions. Consideration of the means for the provision of a secondary supply should include the overall electrical distribution system within the building, and also the power needs for other equipment requiring a secondary power supply.

The changeover from the primary to the secondary power supply needs to be automatic so that the life safety installations continue operation. Both the primary and secondary supplies to the life safety installations need to be sufficiently protected against fire and water damage, and also separated from each other, so that the failure of cables or equipment, either by mechanical breakdown or damage by fire, in any one system, does not affect the other supply. Protection against fire may be achieved by choice of cable, choice of route (for example, through protected areas, or external to the building) or by the provision of additional fire protection.

It is essential that the fire procedures of the building do not include the isolation of circuits supplying power to the above mentioned equipment.

Power supplies should conform to the following specific recommendations.

a) A secondary power supply independent of the primary power supply to the building, e.g. an automatically started generator or a supply from another substation, should be provided which, independently of the primary supply, will be of sufficient capacity to maintain in operation for at least 3 h the following:

   1) any powered smoke control systems (including systems using pressure differentials);

   2) any fire and rescue service communication systems; and

   3) any other fire protection or fire-fighting equipment; except automatic fire detection and alarm systems.

b) The secondary power supply should be capable of providing the power supply for items a1), a2) and a3) within 15 s of the failure of the primary electrical supply. Where the alternative power source is a generator, it should be capable of providing the power necessary for at least 3 h without replenishment of fuel.

c) Where the secondary electrical supply is to be taken from a separate substation to that supplying the primary electrical supply, the following criteria should be met.

   1) The electrical supplies to the two independent substations should be taken from two separate high-voltage supplies, and not originate from the same substation.

   2) The failure of one substation should not lead to the failure of the other.

   3) The two independent substations should be adequately separated. Where the substations are located within the building they serve, the following criteria should be met:

      i) each substation should be enclosed within a fire-resisting structure having a minimum of 2 h fire resistance;

      ii) the two substations should be located in two separate parts of the building.

   4) Supply cables from the high-voltage substations should enter directly the high-voltage/low-voltage switchrooms and not pass through the building.

   5) The two sets of supply cables should be adequately separated from each other to avoid a single fault affecting both supplies.

d) Whichever secondary power source is provided, the distribution should be organized such that the secondary supply remains live when the remainder of the supplies in the building are isolated in an emergency.

NOTE 3 Further guidance on the selection of cables is given in BS 7346-6.

e) Cables supplying current to the life safety installations should be installed in accordance with BS 7671 and the manufacturer's instructions. The cables should have an inherently high resistance to fire and be protected where necessary against mechanical damage. Cables, switchgear and other equipment transmitting the secondary power supply should be separate from those of the primary supply, or be physically protected so that a breakdown, or any cause of breakdown, on one supply would not lead to a simultaneous failure of the other supply.

NOTE 4 This is not to be confused with the lift shaft.

f) The primary and secondary power supply cables should be terminated in a change-over device located within the plant room(s) housing the life safety and fire protection equipment, or in the case of a fire-fighting lift, within the fire-fighting shaft.

g) The change-over device should automatically effect the transition from the primary to the secondary power supply if the primary supply to the particular plant fails.

h) Any electrical substation or enclosures containing any distribution board, generator, powered smoke control plant, pressurization plant, communication equipment, and any other equipment associated with life safety and fire protection systems, should be separated from the building by construction with a duration of fire resistance of not less than 2 h.

i) Secondary power supplies should be provided for the following:
   1) sprinkler pumps;
   2) wet riser pumps;
   3) fire-fighting lifts;
   4) fire-fighting shafts (associated equipment and normal lighting);
   5) fire-fighting intercommunications installations;
   6) pressurization fans (air supply and pressure relief);
   7) depressurization fans (air supply and pressure relief);
   8) smoke control system;
   9) evacuation lifts.

38.3 Enclosure of engineering services

Some engineering services are potential sources of fire, and it is essential that the equipment associated with them is properly installed and maintained.

The importance of correct installation in the first place is emphasized, because electrical, lighting, heating and ventilation systems can be concealed above suspended ceilings and/or within service ducts. Electrical control gear is also often located behind ceiling and wall panels. Installation faults that might lead to fire are particularly dangerous because the fire is likely to remain undiscovered for a time.

Platform floors are provided in some buildings for the installation of services to equipment and work stations. Two types of platform floors are in common use:

a) those with limited access, having runs of removable panels, individual access traps, or both;
b) those with full access, having a load-bearing deck comprising removable panels supported on adjustable pedestals.

With either type, a fire might develop in the void formed between the underside of the platform floor and the upper surface of the structural floor beneath. The platform floor needs to retain its load-bearing function and contain the fire for a period of time sufficient for the occupants to escape. In this context, a reference to a "structural floor" includes the oversite or sealing floor slab of the lowest floor in the building.

Ducts for engineering and building services should be in accordance with BS 8313; ductwork for ventilation and air conditioning should be in accordance with **33.4.2**.

All access hatches or traps in fire-separating elements should be secured in a closed position and suitably protected and protected to maintain the fire resistance of the element.

38.4 Lighting

*NOTE 1 Guidance on lighting diffusers is given in **35.1.3**.*

NOTE 2 The installation of lighting systems is controlled by the Building Regulations 2000 [19], the Building (Scotland) Regulations 2004, as amended [20], and the Building Regulations (Northern Ireland) 2000 [31].

38.4.1 Types of luminaire

Luminaires range from tubular fluorescent to filament and high-pressure lamps. Fluorescent luminaires operate at relatively low temperatures and the tubes themselves are not likely to be a source of fire. Electrical breakdown of associated gear and wiring in the luminaire, however, can lead to ignition of adjacent combustible materials. Correct installation is therefore essential.

All incandescent filament lamps and high-pressure discharge lamps operate at elevated temperatures, and where such lamps are used they should not be close to or fixed to materials that are readily ignited. Care should be taken in the selection of plastics materials or finishes, some of which can be highly flammable.

Methods of lighting can be subdivided broadly into three groups:

a) recessed luminaires;

b) illuminated ceilings;

c) luminaires at or below ceiling level.

Luminaires should conform to the relevant part and section of BS 4533.

38.4.2 Recessed luminaires

When recessed luminaires are within suspended ceilings they can overheat, resulting in failure of the insulation of electric wiring and apparatus. The control gear of fluorescent luminaires is particularly likely to cause overheating, as is the use of incandescent lamps of a wattage in excess of the design standard.

Such overheating can result in fire within a concealed space, with consequential problems of detection and extinguishment. A ceiling having recessed luminaires might be intended to contribute to the fire resistance of beams or a floor above. In such a case, any perforations for fittings or access are a potential source of failure of the ceiling.

Where luminaires are recessed into a fire-resisting/fire-protecting suspended ceiling, the protection afforded by the ceiling should be maintained by the provision of a fire-resisting barrier behind the fitting and any accessway to the fitting.

38.4.3 Illuminated ceilings

By the nature of their function and the construction and materials used, these ceilings contribute nothing to the fire resistance of the structure. The materials might be combustible and care in their selection is important in order to minimize their contribution to any fire that might occur.

38.4.4 Luminaires at or below ceiling level

Luminaires at or below ceiling level, if properly fitted and maintained, usually present a negligible fire risk, but care is necessary in siting to avoid interference with the water distribution pattern of sprinkler heads (if fitted). Care is also necessary to prevent accidental operation of sprinklers and fire detectors by heat from luminaires. Where spot and other low-level luminaires are used, care needs to be taken to avoid close proximity to combustible goods and materials and to ensure that there is no heat built up within a confined area. In service corridors, loading bays and engineering services rooms the use of pendant-type luminaires should be avoided; bulkhead type luminaires are preferable.

38.5 Heating systems

NOTE The installation of space heating systems is controlled by the Building Regulations 2000 [19], the Building (Scotland) Regulations 2004, as amended [20], and the Building Regulations (Northern Ireland) 2000 [31], and by regulations applicable to the fuel(s) used.

Experience has shown that, in buildings of all sizes, few fires are caused by central-heating systems. Most fires from heating appliances are produced by local heating units, particularly those that are not fixed.

All heating appliances and systems should be in accordance with, and should be installed in accordance with, the relevant specifications and codes of practice.

38.6 Lifts, escalators, moving walks and goods conveyors

38.6.1 Lifts, escalators and moving walks

*NOTE 1 The enclosure of lift shafts is covered in **32.5.6.4**. Fire-fighting lifts are covered in **21.3**.*

NOTE 2 Guidance on undertaking modifications to existing lift installations is given in BS 5655-11 and BS 5655-12.

Lifts for passengers, passengers and goods, and goods alone should be selected, located and installed in accordance with BS 5655-6, and tested in accordance with BS 8486-1 for electric lifts or BS 8486-2 for hydraulic lifts when first installed.

Escalators and moving walks should be selected and located in accordance with BS 5656-2, constructed and installed in accordance with BS EN 115, and tested in accordance with BS 5656-1 when first installed.

Lift machine rooms/machinery spaces should conform to the appropriate part of BS EN 81.

Where escalators connect different compartments:

a) the shutter(s) protecting the opening(s) should not be connected to a fire alarm system or to a central control point;

b) on the fusing of the link operating the shutter(s), the escalator should be stopped in accordance with BS EN 115.

38.6.2 Goods conveyors

NOTE Fire resistance tests for conveyor systems and their closures are specified in BS EN 1366-7.

Where goods conveyors connect different compartments:

a) the closure(s) protecting the openings should either be connected to the fire detection and alarm system, or operated automatically by local heat or smoke detectors;

b) closures on goods conveyors should be controlled in such a way that they seek or make a suitable space between payloads to allow full closing.

38.7 Incinerators

NOTE All types of incinerators, except those fired by electricity, are controlled (as fittings) by the Building Regulations 2000 [19], the Building (Scotland) Regulations 2004, as amended [20], and the Building Regulations (Northern Ireland) 2000 [31]. The means of flueing incinerators, including those fired by electricity, are also controlled by these regulations with regard to the discharge of products of combustion and the risk of fire spread.

There are two main types of incinerators:

a) incinerators for the disposal of bulk waste;

b) sanitary incinerators for toilets.

Incinerators can be fired by gas or electricity, but, irrespective of the source of heating, the fire risk arises from the nature and bulk of the waste to be consumed.

Incinerators, other than sanitary incinerators, require special consideration, and preferably should be isolated in a separate building.

Section 8: Special risk protection

39 Special risk protection

Apart from the general coverage by a sprinkler system, there might be localized areas of fire risk that justify the installation of a dedicated automatic suppression or extinguishing system. The installation of such systems can also provide significant contribution to reduce the risk profile (see **6.4**). Examples already mentioned elsewhere in this British Standard are engineering services installation rooms, e.g. transformers and switchgear rooms, data processing equipment and air filters and oil baths in ventilation systems. They can also include areas where dangerous substances, such as extremely and highly flammable materials, are handled and processed.

Automatic fixed gas, foam, powder, water spray deluge systems or other purpose-designed extinguishing systems might be stand-alone, or might be provided as an adjunct to sprinkler systems to protect specific equipment or processes; e.g. bakers' ovens and deep fat fryers.

In general, systems for the protection of special risks should be designed to suit the specific circumstances, and specialized designers and manufacturers should be consulted. Guidance on the selection of automatic fire extinguishing systems is given in BS 5306-0. Carbon dioxide systems are covered in BS 5306-4, gaseous fire-extinguishing systems in BS ISO 14520 (all parts), foam systems in BS 5306-6, powder systems in BS EN 12416-2 and high-velocity waterspray systems in BS EN 12845 (new systems) and BS 5306-2 (existing systems).

Specific guidance on the protection of data processing equipment is covered in BS 6266.

Section 9: Managing occupied buildings

*COMMENTARY ON SECTION **9***
*This section is concerned with the management of fire safety, and provides guidance for building designers and fire safety managers (in smaller premises, the fire safety manager is likely to be the owner of the building), addressing the issues that will apply whilst the building is in use or which need to be taken into account when alterations to the building or the use of it are being considered. Clause **40** deals with the period prior to occupation of a building and is mostly of relevance to building designers, although it is also of some relevance to fire safety managers. Clauses **41** to **48** deal with management issues following occupation of a building and are mostly of relevance to fire safety managers. Guidance on management issues to be considered during the design process is given in Section **4**.*

*This British Standard covers premises of all sizes and complexity and in consequence some material is only applicable to certain sizes or types of premises. Users of this British Standard should use only those clauses applicable to the premises to which they are dealing, e.g. in respect of existing small business premises, provisions in Clause **43** to Clause **46** inclusive need to be tailored to the actual risks and situation present.*

40 Commissioning and hand-over

40.1 Management issues

Before accepting a building for occupation it is essential that the safety of the staff and public (as well as that of construction personnel if the building is being completed in phases) is assured by ensuring that all safety systems are properly installed and operational.

The design and construction of the building and the systems installed in it should be recorded in the fire safety manual (see Clause **9** and Annex H).

On completion of the fire safety system, the complete installation should be checked for conformity to the approved drawings and system design. Instructions on its use, planned maintenance and testing should be supplied to the owner of the premises and included in the fire safety manual (see Clause **9** and Annex H).

The hand-over procedure should include operation of the system by actuating smoke detectors if appropriate. All elements of the system and control interfaces should then operate automatically. Checks should be made to ensure that any heating, ventilation and air conditioning system (HVAC) does not affect the operation of any smoke detectors.

All fire safety systems should be individually tested to establish whether the final installation conforms to the agreed design specification, is functioning correctly and is ready for acceptance testing. It should be documented in writing that the installation of each system component is complete and the component is functional. The fire safety systems should then be tested as a whole to ensure that they are fully integrated and that the final integrated system conforms to the agreed design specification and is functioning correctly.

The extent and form of any acceptance tests should be agreed with the enforcing authority at the design stage, but they should include demonstrations that determine whether the correct outputs are produced for given inputs for each control sequence specified. Any non-conformities or malfunctions should be corrected before the system is activated. Upon activation, operation of all active elements (e.g. fans, dampers, doors and related equipment) should be recorded and verified. If standby generators are installed to provide emergency electrical power, these should be checked for effective operation. If a standby generator is common to a number of emergency systems, then this check should be carried out with all the systems powered by the generator simultaneously to ensure that the maximum potential load is tested.

All installed safety systems should be operational before:

a) the building (or part of the building) is accepted;

b) units are handed over to tenants in mixed use developments and premises.

The appropriate members of the management team should be available during the hand-over period to ensure that an understanding of every aspect of the building is passed on.

The use of all installed safety systems should be demonstrated, if necessary by full commissioning tests involving fire and/or smoke, with the appropriate members of the management team and fire and rescue service present. Such tests have a number of purposes, including:

1) demonstrating the soundness of the safety system design;

2) identifying any problems of detail not considered in the design;

3) demonstrating that the design has been properly implemented;

4) identifying any problems with interactions, or failures to interact;

5) providing management with the opportunity to operate the systems;

6) giving confidence to the users of the building;

7) giving confidence, and training, to the fire and rescue service.

The management team should be provided with the fire safety manual (see Clause **9** and Annex H).

Where various functions interface, e.g. smoke detection and smoke control, these systems should be commissioned together to ensure that the prescribed fire safety procedure is implemented.

All components of any installed safety system for which a tenant is responsible should be operational and compatible with the systems common to the complex before the tenant occupies their unit (e.g. the public address system of the complex needs to be able to override any background music or public address system in a unit).

Guidance on commissioning and hand-over of fire safety installations other than smoke control systems is given in the appropriate systems standards. The commissioning and hand-over of smoke control systems should be carried out in accordance with Annex N.

40.2 Approvals and certification

All documentation relating to approvals and certification should be made available to the fire safety manager and should be included in the fire safety manual (see Clause **9** and Annex H).

Any outstanding issues, conditions or other implications should be stated on the approvals documentation.

41 Managing occupied buildings

41.1 Appointment of fire safety manager and other personnel

A competent person should be appointed as fire safety manager. This person should be given sufficient stated authority, powers of sanction and resources to take responsibility for the day-to-day safety management of the building and to ensure that essential repairs or maintenance are carried out. The powers of sanction might include closing the building to the public, restricting its use, or shutting down normal operations.

The role of fire safety manager may be combined with other health, safety or security functions. In small occupancies the role of fire safety manager may be assigned to the owner or general manager.

The fire safety manager should appoint a duty safety officer on every shift to be the key decision maker in responding to a fire incident. A duty safety officer should be present at all times whenever the building is occupied. The most appropriate person could be the senior operator in any central control room who is likely to receive the most information about a fire incident. In the case of a fire incident, the duty safety officer should hand over control to the fire and rescue service on their arrival but should be available to provide advice to the fire and rescue service on request.

Other fire and security personnel should be fully briefed as to the extent of their duties concerning precautions against fire during and outside working or opening hours. Fire safety training should be given in accordance with Annex O.

In some buildings fire marshals/fire wardens should be appointed to assist in an emergency, in particular with evacuation. This might include the stationing of fire marshals/fire wardens at hazard points to direct people requiring assistance.

41.2 Management organization and structure

The tasks of the fire safety manager (see **41.1**) are likely to interact with other management functions such as facilities management, safety management and security. Such management functions should be integrated in such a way as to avoid conflicts as a result of overlapping responsibilities, or discontinuities in coverage. In an occupancy where a single person has responsibility for all aspects of safety, this is likely to be straightforward, but where two or more persons are responsible for different aspects of safety, e.g. fire safety and security, it is important to define clear areas of responsibility.

In a complex, a fire safety manager should be appointed at senior level to take responsibility for day-to-day safety management, but a committee of senior staff should also be appointed, to be responsible for the major facilities or operational units in the complex. This committee should be headed by the fire safety manager and should include such persons as:

- managers of larger units, e.g. fronting shopping precincts;
- managers of cinemas, theatres or other entertainment venues;
- operators of other discrete parts of a complex, e.g. offices, hotels or transport termini.

The committee should review safety matters and exchange information on special events, changes in operations or proposals for physical alterations that could affect safety management.

The safety management structure should reflect the expectations of the public. For example, in a shopping complex the public might look to individual shop staff for help, rather than the complex management staff, or in a theatre, the public might look to any of the staff including programme sellers and bar staff.

The safety management structure should provide for:

- clear lines of responsibility, authority, accountability and resources, particularly in relation to common areas;
- replacements during the absence of persons with specific responsibilities;
- an emergency services liaison officer to call, and provide information to, the fire and rescue service.

The safety management structure should reflect changing work patterns or changing operational management structures, but frequent changes in responsibilities or procedures should be avoided.

41.3 Overview of the fire safety manager's responsibilities

NOTE 1 Attention is drawn to legal duties relating to fire risk assessment and to the terms, conditions and restrictions imposed by any licence.

The fire safety manager should:

a) be aware of all of the fire safety features provided and their purpose;

b) be aware of any particular risks on the premises [e.g. issues relating to hot work (see **42.6** and **48.2**) or unusual construction materials such as sandwich panels];

c) be aware of their responsibilities towards disabled people (see Clause **46**);

d) be in attendance on the premises whenever members of the public are present or when the building is occupied;

NOTE 2 It is acceptable for a competent person other than the fire safety manager to be in attendance at such times, provided that this person has been delegated in writing and that cover is not interrupted.

e) liaise with, and where necessary seek the advice of, the fire authority, the licensing authority and other relevant enforcing authorities;

f) have authority to deal with individuals who sabotage or tamper with safety systems, who ignore any smoking policy, or who block exits;

g) liaise with other fire safety managers in a multi-occupancy building (see **41.4**);

h) ensure that public areas are suitably controlled (see **41.5** and Annex P);

i) ensure that tenants, concessionaires and caretakers are appropriately briefed (see **41.6** and **41.7**);

j) ensure that audits are carried out as necessary (see **41.8**);

k) ensure that all necessary and appropriate communication systems are in place to deal with any fire incident (see **41.9**).

The management of fire safety encompasses the entire life cycle of the building and includes:

- day-to-day operation of the building;
- changes to the building (extensions, alterations, refurbishment);
- changes of use;
- units in disuse;
- demolition;
- the fire, if a fire occurs.

The responsibilities of the fire safety manager therefore include:

1) identifying and reducing the likelihood of fire occurring;
2) developing and implementing a fire strategy appropriate for the particular risk;
3) training of staff and maintaining training records;
4) inspection, maintenance and testing of potential hazards (e.g. heat-dissipating equipment);
5) monitoring and maintenance of means of escape, evacuation procedures, monitoring the behaviour of occupants and adjusting plans accordingly;
6) maintaining access and egress and other special provisions for disabled people;
7) routine maintenance and testing of fire safety equipment, systems and procedures;
8) inspection, maintenance and testing of emergency communication systems;
9) monitoring general maintenance and building works that might affect the fire safety provisions;
10) supervision, monitoring and instruction to contractors and subcontractors on the premises;
11) agreeing the safe system of work for non-routine activities where these increase the risk from fire, including issuing hot work permits;
12) ensuring compliance with the appropriate standards;
13) notifying the authorities of any changes that might affect the fire precautions in the building, e.g. structural alterations, extensions, alterations to internal arrangements or commencement of keeping explosives or highly flammable materials.

Additional responsibilities of the fire safety manager, primarily in larger buildings, include:

i) the appointment of fire marshals/fire wardens;

ii) the appointment or delegated appointment of members of any site fire team;

iii) development of the training policy for the building;

iv) ensuring that staff have the necessary competencies;

v) organizing periodic audits to review:

- current fire safety management procedures;
- the effect of changes in personnel or in usage of the building;

vi) ensuring the effectiveness of automatic fire safety systems, i.e. that they are suitable even after a change in building usage;

vii) continuous safety system reviews and risk assessment (especially after refurbishment);

viii) monitoring and control of refurbishments and other building works;

ix) carrying out checks prior to entry by members of the public;

x) maintaining emergency plans (including evacuation plans, victim help and emergency accommodation plans) and fire control centre functions;

xi) regular trials of the fire safety system (including major incident simulations);

xii) monitoring and reviewing the fire safety manual (see Clause **9** and Annex H);

xiii) maintaining documentation for the fire safety manual, including training records, test evacuation records and details of "near miss" events;

xiv) recording changes to the building;

xv) contingency planning for abnormal occupancy levels;

xvi) contingency planning for equipment failure or repair;

xvii) responding to any rare or unexpected events that could increase the risk of fire or affect the evacuation procedures, e.g. by limiting the number of people permitted on the premises;

xviii) consideration, and if appropriate preparation in collaboration with appropriate local authorities, of disaster plans, where a fire incident could affect the local community (e.g. from smoke or water pollution);

xix) assessment and mitigation of potential environmental impact of fire (e.g. water run-off) in collaboration with appropriate local authorities;

xx) planning for bad weather.

41.4 Buildings occupied by more than one organization

Where a building is occupied by more than one organization, fire safety precautions and facilities should be in place for all common or public areas as well as for the individual areas occupied by each organization.

NOTE The responsibilities of fire safety managers of individual units and occupancies are in no way diminished by the existence of a further tier of management with a wider span of control.

The fire safety managers of each individual organization should liaise to ensure that:

- the emergency procedures are clearly understood by all relevant parties;
- every aspect of the fire safety precautions and facilities is clearly allocated to be the responsibility of at least one party;
- no element of the procedures is unreasonably duplicated;
- evacuation strategies for disabled people are co-ordinated between the different occupancies (see Clause **46**).

Where fire safety management is outsourced, e.g. as part of facilities management, then final responsibility should reside within the main organization.

41.5 Public areas

Fire safety management is particularly important in buildings that contain large public spaces (e.g. atria), as such spaces can contribute to the rapid spread of fire and smoke, putting a large proportion of the occupants at risk simultaneously.

The fire protection systems in such areas are generally operated automatically, e.g. sprinkler and smoke control systems.

The control of conditions in public areas should be carried out in accordance with Annex P.

41.6 Tenants, concessionaires and residents

Where a building is occupied, or partially occupied, by tenants or concessionaires it is important that any tenants or concessionaires are integrated into the fire safety arrangements for the building and do not, and are not permitted to, negate the fire safety arrangements for the building. The fire safety manager should advise such persons formally of the fire safety arrangements for the building, what to do to prevent fires occurring and what to do in the event of a fire. This information should be contained within a tenant's handbook which should also address the potential for particular problems arising where tenants employ sub-contractors, e.g. for fit-out work.

Owners of multi-occupancy residential buildings (primarily flats) should follow the recommendations given in Annex Q.

NOTE Annex R contains information that can be given to owners and occupiers of dwellings in residential buildings (including flats). Examples of fire instruction notices for residential buildings are given in Annex S.

41.7 Caretakers

Where a caretaker or other person is employed to maintain common areas within a building, the fire safety manager should advise such persons formally of the fire safety arrangements for the building.

The owner may delegate management responsibilities to a caretaker. In such cases, the caretaker may be given the role of fire safety manager, provided that the owner gives the caretaker the authority and resources needed to carry out the role in accordance with the recommendations given in this British Standard.

41.8 Continuing control and audit procedures

Assessed capability. *Users of this British Standard are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.*

An audit to review:

a) current fire safety management procedures, including maintenance procedures; and

b) the effectiveness of automatic fire safety systems, i.e. to ensure that they are suitable even after a change in compartment usage;

should be carried out as a matter of routine and especially when there are significant changes to personnel, or the usage of the building.

The findings of the audit should be included in the fire safety manual (see Clause **9** and Annex H), with any resultant remedial changes. The audit may be part of the testing and review of the fire safety manual (see **H.5**). Criteria to aid in the audit of the management system are given in **0.1**.

41.9 Communications

The potential for loss of life in fire is greater in large and/or crowded and/or complex buildings. Effective communication is therefore an essential part of successful fire management.

The fire safety manager should ensure that all necessary and appropriate systems of communication are in place to deal with any incident, including both equipment and chains of command. Issues that should be addressed include:

- the communications structure, in particular where there is a cascade decision process involving a number of levels of management, or when it is intended to investigate first alarms before sounding warnings, or if control room staff are taking decisions based on many channels of information;
- the need for testing and auditing the communication systems as part of the testing and auditing of the overall fire safety procedures;
- the need for routine maintenance and testing of communication systems, including "emergency conditions" testing;
- selection of languages to use in voice messages;
- alternative formats and systems to provide for blind and partially sighted people, and people who are deaf and hard of hearing;
- provision of simple instructions for people with language or learning difficulties;
- use of communication systems in the early stages of a fire to inform disabled people of the situation and any appropriate routes to use;
- contingency planning, e.g. for abnormally high numbers of persons present in the premises, for absent staff or for equipment failure;
- planning for business continuity.

42 Fire prevention

42.1 General

The main "everyday" task of the fire safety manager is to attempt to avoid fires occurring; to work to create an environment in which fires are prevented from starting or, if they do, from developing beyond a very minor event. Preventing fire from occurring is as important as having properly working safety systems to deal with a fire incident. For the safety of occupants, the maintenance of furniture, furnishings, decor and equipment is as important as the maintenance of fire safety equipment.

The tasks of the fire safety manager to seek to prevent a fire occurring include:

a) monitoring the behaviour of occupants;

b) monitoring any policy on smoking;

c) housekeeping (see **42.2**);

d) routines for the disposal of waste;

e) minimizing hazards of combustible contents, furnishings and surface finishes;

f) minimizing hazards of materials, components and elements of construction;

g) establishing purchasing standards for furniture, furnishings and fittings;

h) seeking to avoid conditions leading to gas and dust explosion hazards;

i) maintenance of furniture, furnishings, decor and equipment;

j) reviewing and appraising the means by which a fire might start and spread, and the potential consequences;

k) maintaining integration with other systems (e.g. ventilation, communications);

l) assessing the risks from new equipment, new business processes or changing or new technologies;

m) issue and control of work permits and associated procedures;

n) training and education (see Annex O);

o) establishing and maintaining out-of-hours inspection and security procedures, including means of preventing arson (see **42.2.4**, **42.4** and **42.5**);

p) supervising and instructing contractors and subcontractors (see **42.6**);

q) routine checks, inspections, tests and monitoring the maintenance of equipment that could cause fires (especially heat generating equipment), chafing of cables, self-heating and fuel supplies (see **42.7**).

If necessary, separate teams should be set up to monitor all of the possible areas of hazard. Regular inspections should be carried out and should be logged in the fire safety manual (see Clause **9** and Annex H).

Smoking presents one of the greatest risks and in many countries, including the UK, it is now prohibited in public buildings by law. However, where there is no legal prohibition, smoking should where practicable be prohibited other than in designated smoking areas, and fire-safe ashtrays and bins should be provided.

42.2 Housekeeping

42.2.1 General

Good housekeeping is an essential ingredient in fire safety management. It can reduce the chance of a fire starting, can reduce the potential rate at which a fire can grow and the size it can reach, and can ensure that the fire protection features in a building function as intended in the event of a fire. There are two primary aspects to housekeeping: reducing the chances of a fire developing or starting, and protecting escape routes (see **43.2**).

All employees should be made aware of the particular risks associated with hazardous substances and practices that can be encountered.

Where additional risks are introduced anywhere in the building, such as motor vehicles for display purposes, advice as to their storage and protection should be obtained from the appropriate authority. Grottoes in shops can present particular problems and advice should be sought from the fire authority.

42.2.2 Reducing ignition sources

Potential ignition sources should be identified and controlled, for example:

- smoking. Where smoking is permitted, suitable ashtrays should be provided. Illicit smoking should be controlled by appropriate management and building design;
- the use of naked flames such as candles, or heaters using naked flames;
- processes involving hot works;
- cooking;
- misused or faulty electrical equipment;
- overheated or worn cables;
- lighting displays, such as halogen lights placed near flammable material.

Efforts should be made to reduce the risks from arson, e.g. by checking "dark" areas (e.g. cinemas or darkrooms) and by carrying out checks out of hours or after closing.

It is essential that all equipment is installed, maintained, used and managed in appropriate manner and by competent persons. Staff training should support this. Particular care should be taken with electrical equipment. The build-up of dust and grease in equipment can cause equipment to overload by blocking ventilation and overloading machinery, and misuse can lead to ignition, e.g. by disabling electrical cut-outs.

42.2.3 Reducing fuel load

The risk from fire can be reduced if the amount of combustible material is reduced or stored more safely. The following are examples of actions that can be taken.

- Reduce the fire load, e.g. by replacing bottled gas heating with electric heating sources or reducing the amount of stock stored in a building.
- Alter the way goods are stored. A fire will grow significantly more quickly in goods stored vertically, such as pallets stacked on top of each other or in high bay storage, than goods stored over a greater horizontal area, such as on the floor of a warehouse.
- Only store goods and furnishings in an appropriate manner, e.g. in dedicated store rooms.
- Ensure that all highly flammable substances are used and stored safely, and if necessary, in appropriate storage containers.
- Control the amount and storage of rubbish, storing it in a safe location away from buildings, preferably in a designated area.
- Remove redundant services, such as communication cables, particularly in voids, as these can constitute a significant fire load.
- Construct display fittings, linings, special displays and grottoes using materials that are not readily ignitable. Site them in such a way that exits are kept clear and unobstructed, and exit signs are visible from the relevant part of the premises.

42.2.4 Maintenance of fire protection measures

It is essential that the fire protection measures in a building are able to carry out their function in a fire. These should be checked periodically. Daily inspections should be carried out to ensure that the fire protection measures are available at all times. Such inspections should include, but will not necessarily be limited to, the following.

- Escape routes should be kept clear at all times. Storage of goods and equipment could block exits and provide an unwanted fire load and potential source of ignition.
- Door locks, panic bars and automatic door release mechanisms should be maintained so that they are easily openable in an emergency.
- Fire alarm call points and other fire safety equipment such as fire extinguishing and fire main inlet and outlet values should not be obstructed by stored goods, machinery or parked vehicles.
- All fire safety equipment, e.g. fire alarms, emergency lighting, automatic fire suppression systems and fire extinguishers, should be maintained and tested in accordance with the relevant standard by competent persons.
- Certain parts of the building fabric can contain flammable elements which can significantly contribute to fire spread, such as many insulated core panels. Checks should be made to see that any damaged panels are repaired.
- In store rooms, goods should not be stacked close to windows, and if there is a sprinkler system, goods should be stacked not higher than the height recommended in BS EN 12845 (new systems) and BS 5306-2 (existing systems).

42.3 Audience/crowd control

The fire prevention routine for buildings admitting the public should be an everyday process. This is particularly important for buildings handling large crowds, such as places of entertainment or sports stadia.

Audience and crowd control, including pre-admittance checks, should be carried out in accordance with Annex T.

In addition, regular checks should be carried out during opening hours, and after the complex is closed at night.

42.4 Arson

Arson in buildings has increased greatly in recent years. The motives for arson are varied, but include spite, revenge, jealousy, pyromania, profit-making including insurance fraud following bankruptcy, the desire to damage competitors, fraud related to slum clearance, gaining possession of a building, and the desire of criminals to conceal their crime.

Arson can present a serious threat to life, especially if the fire is started with a rapid-burning material such as petrol or if the arsonist starts fires in several places simultaneously so that the alternative escape routes normally provided in a building are blocked. In commercial and industrial buildings, arson can also cause large direct losses and serious interruptions in business operations.

Good security arrangements can reduce the risk of arson (see **10.3.4**), but care should be taken to ensure that they do not prejudice the means of escape (see **42.5**).

The fire safety manager should ensure that any measures intended to prevent unauthorized access do not hinder the entry of the fire and rescue service to fight the fire or effect the rescue of trapped persons.

42.5 Conflicts between security and means of escape

There can be a conflict between security arrangements and means of escape, and the fire safety manager should ensure that security arrangements do not prevent occupants from reaching a place of relative or ultimate safety. Security of the building can be in both directions: ingress and egress. In certain premises, e.g. places of lawful detention, the need to restrict the occupants from leaving the premises should be taken into account when determining emergency procedures.

Security arrangements should also take into account the needs of the fire and rescue service who might have to enter the building to effect rescue or assist with evacuation.

42.6 Contractors and subcontractors on the premises and hot work

*NOTE See also **48.2** and Annex U.*

Contractors and subcontractors can present an additional fire risk, as they are likely to be unfamiliar with the premises and with the associated fire risks and fire precautions. The risk is increased when contractors and subcontractors are carrying out hazardous activities such as hot work (e.g. cutting or welding), or when they are using substances that give off flammable vapours (e.g. some adhesives).

To minimize this risk, all activities of outside contractors should be strictly supervised and controlled. The supervision should include checks of any area where hot work is to be undertaken or where contractors have been engaged. The fire safety manager, or a delegated representative, should ensure that all necessary precautions against fire are taken, and should instruct contractors in fire safety procedures (see Annex O).

Arrangements should also be made for the safety of the contractors themselves in the event of fire.

42.7 Maintenance of building plant and equipment

Fire can start in machinery and equipment which is not adequately maintained or cleaned.

The fire safety manager should be aware of the equipment and processes within the building and ensure that this equipment and plant is being maintained in accordance with established good practice.

Electrical and gas installations are required to be regularly examined by a competent person who, if not qualified, should have authority to engage a qualified person to carry out any repairs deemed necessary for safety reasons.

43 Ensuring that systems respond properly in an emergency

43.1 General

It is essential that in the event of a fire, all fire safety provisions function as intended and all fire emergency procedures are implemented in order to facilitate appropriate action. Since it can never be foreseen when a fire might occur, it is part of the role of the fire safety manager to ensure that all of the built-in passive and active safety systems operate (or are effective) on demand.

43.2 Escape routes

In order to ensure that escape routes are available for use at all times when the building is occupied:

a) all escape routes, including refuges, should be maintained free from obstruction;

b) goods, materials, unwanted furniture, etc., should not be stored within escape routes. Any obstruction should be removed immediately;

c) adequate provision for enclosed storage areas should be made within the building;

d) all escape routes should be inspected frequently and, in respect of buildings open to the public, on each occasion prior to the admittance of the public. A log detailing the frequency and results of inspection should be included in the fire safety manual (see Clause **9** and Annex H) and corrective measures should be taken where necessary. Door wedges should be removed;

e) fire doors that are intended to be kept closed should be closed and not obstructed;

f) fire doors on hold-open devices should be operable and should not be obstructed;

g) the exterior of the building should be inspected to ensure that final exits and routes to assembly points are not blocked by materials, vehicles or (in the winter) snow;

h) entrance halls, lobbies or corridors should not contain furniture or fittings that would reduce, at any point, the required exit width;

i) circulatory routes within sales, production and storage areas should be clearly defined, e.g. by the use of floor coverings of contrasting colour;

j) in a building or part of a building served by a single stair, and in fire-fighting stairs, furniture should not be placed within the stair enclosures and exits therefrom. In multi-stair premises, subject to risk assessment, furniture may be placed within the entrance hall forming part of one protected stairway only, provided that upholstered furniture is kept to a minimum and is of a type not easily ignited;

k) fire safety signs and notices, fire extinguishers, manual call points, escape lighting, fire doors and shutters should not be obscured, even temporarily, by stock, or by advertising banners, posters, etc.;

l) seating areas should not be provided within escape corridors;

m) maintenance and redecoration of surface finishes and floor coverings should not use materials that might propagate surface spread of flame and/or fire, or adversely affect the means of preventing such propagation;

n) the floor surfaces, including stairs, stair nosings and ramps, within escape routes should be maintainable, even and non-slip. Resilient floor surfaces should be maintained in accordance with BS 6263-2 and using only emulsion polish (i.e. not wax polish);

o) where staff might have to rescue occupants from locked rooms, e.g. hotel bedrooms, master keys to all lockable rooms should be available for designated staff.

43.3 Maintenance of fire safety equipment and provisions

NOTE 1 Guidance on passive fire protection provisions is given in the Partners in Innovation publication Ensuring best practice for passive fire protection in buildings *[67].*

Planned inspection, maintenance and testing procedures should be established and used to ensure that all fire protection systems can operate effectively when required. Arrangements should be made for all fire safety equipment, installations and systems (including fire detection systems, automatic suppression systems, door control mechanisms, smoke control systems, evacuation and fire-fighting lifts, emergency lighting, standby power systems, escalators, and all passive fire protection provisions) to be inspected and tested on a regular basis by a competent person. Alterations, additions, repairs or modifications to services and equipment should be carried out only by competent persons.

Routine inspections and maintenance of fire safety installations should be carried out in accordance with Annex V. Routine inspections and maintenance of ventilation and air conditioning ducts should be carried out in accordance with Annex W. Operational tests, routine inspections and maintenance of fire-fighting lifts should be carried out in accordance with BS EN 81-72 and the lift owner's manual. See also **21.2**.

Management procedures should ensure that control is exercised over the parking of commercial vehicles on service roadways also used for fire and rescue service access, so that fire appliances are not obstructed in an emergency and are able to proceed to within the required distance of fire main, foam or other inlets. In the interests of security, it might be deemed necessary, in agreement with the fire authority, to restrict unauthorized entry along such roadways.

Routine maintenance, inspection and testing for particular systems should be carried out in accordance with the relevant British Standards, for example:

a) BS 5839-1 for fire detection and fire alarm systems;

b) BS 5266-1 for emergency and escape lighting systems;

c) BS EN 12845 (new systems) or BS 5306-2 (existing systems) for automatic sprinkler systems in commercial or industrial buildings;

d) BS 9251 for automatic sprinkler systems in residential and domestic buildings;

e) BS 8214 for fire doors;

f) BS 7273-4 for fire door automatic release mechanisms;

g) BS 7346-3 or the relevant part of BS EN 12101 for smoke control systems;

h) BS 5306-1 or BS EN 671 and BS 5306-3 for portable fire extinguishers and hose reels;

i) BS 5306-4, BS ISO 14520, BS 5306-5, BS 5306-6 and BS EN 12416-2 for gaseous, foam and powder extinguishing systems;

j) BS 5306-1 or BS EN 671 for fire hydrants and fire mains;

k) the appropriate part of BS 7036 for automatic opening doors.

*NOTE 2 Clause **23** gives additional recommendations for fire hydrants and fire mains.*

A record of all tests and checks, and any defects remedied, should be maintained in the fire safety manual (see Clause **9** and Annex H).

44 Planning the response to a fire

44.1 General

The task of the fire safety manager in planning the response to a fire is to seek to ensure, in the event of a fire, that all occupants escape to a place of ultimate safety quickly and without injury or distress. This requires that occupants first react promptly to any alarm, and secondly exit the building by the most efficient route.

In a complex building this will usually require that trained staff assist other occupants who are not necessarily familiar with the building or its safety systems.

The tasks for the fire safety manager in planning for a fire include:

- staff training and test evacuations, including full evacuations;
- reviewing all plant and equipment interface controls, to ensure that they properly mesh with agreed procedures;
- continuous inspection and testing of system and emergency procedures (including major incident simulations);
- testing under simulated emergency conditions;
- carrying out safety audits and inspections;
- responding to false alarms;
- learning from and recording test evacuations, false alarms, "near miss" events and minor incidents;
- reviewing staff duties and training procedures;
- checking the record as-built drawings and specifications for all fire protection measures;
- feedback from, and to, participants, from staff, other occupants, etc., from test evacuations;
- managing the site fire team;
- liaising with the external fire and rescue service, and provision of an emergency pack (see **45.7**);
- monitoring and recording, in the fire safety manual (see Clause **9** and Annex H), revisions to safety plans.

Specific plans may include:

- developing and maintaining emergency plan(s) [including evacuation plans, PEEPs (see **46.7**), victim help and emergency accommodation plans];
- planning for bad weather (including evacuation into hostile weather conditions);
- plans for the mitigation of potential environmental impacts of fire (e.g. water run-off);
- risk management, contingency planning, restart planning;
- contingency plans for salvage and damage control.

44.2 The fire routine

NOTE 1 Nearly all big fires start off as small fires. Many minor fires do not appear to be (and are not) life-threatening, and can be successfully extinguished with portable first-aid fire-fighting equipment. However, if this initial judgement is faulty then disaster can follow and this is a key issue for the fire routine and for training (see Annex O).

The fire routine sets out the actions to be taken by staff on discovery of a fire or on the raising of the alarm. Advice should be sought from the fire and licensing authorities when drawing up the fire routine.

The emergency actions (see Clause **45**) should form the core of the fire routine, but it should also take account of:

- the uses to which the premises are put;
- the means of giving warning and the means of communication that are available within the premises;
- the relationship between trained staff and other occupants;
- the familiarity of occupants with the building;
- the availability of fire marshals/fire wardens or a site fire team;
- the needs of all occupants, in particular those of people who might need additional assistance in the event of a fire (see **44.3** and Clause **46**).

The fire routine should be tailored to the building, kept simple and should minimize the decisions that have to be taken to cope with an incident, but it should cover every situation from a false alarm to a major incident.

NOTE 2 Examples of fire instruction notices for residential buildings, shops, offices, industrial and storage buildings are given in Annex S.

Fire instruction notices should be exhibited at conspicuous positions in all parts of a building, including residential buildings, stating in concise terms the essentials of the action to be taken upon discovering a fire and on hearing the fire alarm. Notices should be available in an accessible format, e.g. of a suitable size text which is easily read. Use of an easy-read format and/or pictorial format should be considered.

Specific roles should be delegated to specific members of staff.

Master keys should be given to members of staff who have been designated to assist in an evacuation. Such persons should be instructed to carry the keys at all times.

44.3 Provision for people at particular risk

*NOTE In the event of a large group of disabled people attending an event in an assembly building, it is advisable for the organizers of the group to discuss emergency evacuation arrangements with the management of the building (see also Clause **46**).*

Fire safety procedures should, where appropriate, make provision for occupants who might need assistance to make their way to a place of ultimate safety in a fire (see Clause **46**). If there is a need to make specific arrangements, especially in existing buildings, then consultation with the individual(s) or representative organizations should take place at the earliest opportunity.

Such occupants might include:

- mobility-impaired people;
- blind and partially sighted people;
- people who are deaf and hard of hearing;
- people with mental health problems;
- people with learning disabilities;
- people with unseen disabilities (e.g. heart problems);
- the very elderly and the very young;
- heavily pregnant women;
- people who are intoxicated.

44.4 Fire control centre functions

Where a control centre is provided, it should be equipped in such a way as to give the control room staff the means of monitoring a situation and initiating appropriate action, and to enable them to provide appropriate verbal guidance, as necessary, to the occupants of the building in the event of a fire.

Public announcements should be compatible with, and take advantage of, the siting of fire exits and fire exit directional signs. The information should be succinct, unambiguous and believable, and should avoid presenting occupants with too many choices.

*NOTE Clause **25** gives recommendations for the equipping of fire control centres.*

Recommendations for the management of fire control centres are given in Annex I (see also **10.4.2.1**).

44.5 Evacuation management

*NOTE 1 Further recommendations on specific issues relating to evacuation management are given in Clause **46** and Annex I.*

Research indicates that a feature of fire disasters is the delay in people starting to move to safety. This "time to start" often exceeds the time needed to move to safety. There is also evidence that people do not respond quickly to simple alarm sounders. It is essential that there is an effective means of initiating and controlling the evacuation of premises such as a shopping complex where large numbers of people could be at risk.

Fire alarms in most smaller buildings are best operated in a "single stage" mode in which the actuation of a call point or detector gives an instantaneous warning from all fire alarm sounders for an immediate evacuation.

NOTE 2 A staged evacuation alarm system enables two or more stages of alarm to be given within a given area, i.e. "alert" or "evacuate" signals, or "staff alarm" and "evacuate" signals.

NOTE 3 Phasing vertical movement can be necessary for a number of reasons, e.g. where people need to rest during the evacuation.

In large or complex buildings a staged evacuation procedure (see **12.3.1**) may be adopted, in which the operation of a call point or detector gives an evacuation signal on the storey or zone affected, and an "alert" warning signal sounds in all other parts of the premises. The decision to evacuate the remainder of the occupants then rests with the management and/or the fire and rescue service. It is essential that adequate means of communication between storeys or zones is provided. A public address system or voice alarm system is the most suitable way to control the evacuation process instead of fire alarm sounders.

If phased evacuation is to be used, it should be carried out in accordance with Annex X. Phased evacuation should be used only if the escape stairs have been designed for that use. Such evacuation is normally coordinated from a fire control centre, having directive public address announcements aided by colour closed-circuit television (CCTV).

Members of the public might need to be guided to a suitable exit. People tend to follow the same route they used to enter the complex, or they might be disorientated or unaware of the location of exits, and if they arrived by car they are likely to try to return to it. If parents and children are separated they will tend to seek each other so as to leave together.

In premises open to the public the staff should be easily identifiable, preferably uniformed, and should have the training necessary to give instruction and assistance with authority so as to ensure prompt compliance with any public address announcements.

Staff whose duties include assisting members of the public should receive information in facilitating evacuation, which might also require specific training in helping persons who need assistance to evacuate to a safe part of the building or exit the building to a place of ultimate safety. All staff should be informed of the location of evacuation lifts and barrier-free routes (where provided) for people who might need assistance from the building.

Where escalators are provided in shops, the staff drill should include provision for nominated members of the staff to move to the foot or head (as appropriate) of each escalator on the sounding of the fire alarm or escalator alarm to control the use of the escalator.

Where the premises include separate areas, such as residential accommodation or private apartments, these should be included in these duties.

44.6 Test evacuations (fire drills)

*NOTE 1 Recommendations for evacuation procedures are given in Clause **45**.*

*NOTE 2 Recommendations for test evacuations for people requiring assistance are given in **46.11**.*

NOTE 3 Test evacuations can also be required by certifying authorities as part of their assessment.

Implementation of procedures should be tested at least once, but preferably twice, in each twelve month period and there should be a test evacuation of the entire building at least once per year. Staff employed in particular zones of a complex should take part in a test evacuation exercise at least twice per year. Any observed deficiencies in the fire safety management should be remedied, and any improvements found necessary to the management of evacuation should be reflected in formal amendments to the written instructions.

The purpose of any test evacuation should be clearly identified by the fire safety manager, and explained to the staff, so that it can be assessed afterwards. Objectives include:

a) testing management procedures;

b) providing staff with practical training;

c) establishing the effectiveness of training;

d) identifying weaknesses in emergency communications procedures and systems;

e) identifying positive and negative reactions of staff with designated responsibilities;

f) assessing the reliability of equipment;

g) rehearsing joint action with the fire and rescue service.

While a test evacuation with members of the public is generally regarded as disruptive to trade, it is extremely important as staff members will gain invaluable practice in communicating with the public during evacuations. While the disruption caused might be reduced by holding exercises at less busy times, the greatest experience is gained by holding and monitoring a periodic exercise when the largest numbers are present. Useful experience and tests of communications between staff in units, and between units and the central control room, can be gained during more regular staff training exercises in which members of the public are not involved.

Monitored evacuation tests should be carried out shortly before and after the first full occupation of a new building. If the interval between the first and last phases of the building coming into occupation is more than about twelve months, it can be advisable to conduct a monitored evacuation in the interim period (see also Clause **47**).

Test evacuations should not be held at regular times to avoid staff or regular visitors becoming prepared for them. Each test evacuation should presume a different scenario, so that there is flexibility to cope with differing situations. In some test evacuations it can be appropriate to remove a stairway from service, to simulate smoke penetration. Test evacuations should be notified only to those people who have designated responsibilities, to make the evacuations as realistic as possible. Designated responsibilities should include witnessing the exercise and reporting back on its positive and negative aspects. People undertaking this task should not be otherwise involved in the evacuation (e.g. should not be given fire marshal duties).

When test evacuations are held, continuous monitoring of the exercise is essential, preferably by video recording, to allow a detailed comparison to be made afterwards between planned and actual activity, and to assist with training. For example, to assess the effectiveness of a public announcement, information is needed on its timing and audibility, as well as a record of the movement of people in the areas concerned. This same monitoring information should also be obtained from false alarms, "near miss" events and minor real incidents.

It is often difficult to avoid occupants being aware that the event is not a real fire. This is likely to influence their behaviour, in particular their sense of urgency. Results from test evacuations should be supplemented with findings from false alarms, where occupants might not be aware that there is no emergency.

On occasions it can be appropriate to undertake a test evacuation in collaboration with the fire and rescue service and, if large numbers of persons are involved, with the police.

NOTE 4 Particular care is needed when carrying out manual handling operations.

Test evacuations should where possible include the procedures for evacuating disabled people (see **44.3** and Clause **46**).

Employing fire safety systems as part of a test evacuation provides an opportunity to check whether such systems are creating unforeseen difficulties (e.g. pressures across doors) and whether software-controlled procedures [e.g. sequences involving closing down the heating, ventilation and air conditioning (HVAC), switching on fans and lights, opening vents, releasing doors and sounding alarms] are operating as intended.

If an evacuation has to be carried out in response to a bomb threat, the normal evacuation procedure should be used as far as practicable.

A full de-briefing of the exercise should be carried out so that any lessons can be learned and evacuation procedures amended if necessary.

The effectiveness and validity of incident planning should be recorded on both technical and procedural levels. The results of any test evacuation should be recorded in the fire safety manual (see Clause **9** and Annex H).

44.7 False alarms

NOTE See BS 5839-1 for guidance on reducing false alarms.

False alarms can be disruptive and costly and can lessen the urgency with which both staff and public respond to an alarm. They can have a disproportionate effect on disabled people. Steps should be taken to reduce the incidence of false alarms, by repair, modification or replacement of detectors, but without reducing sensitivity.

44.8 Contingency planning for business interruption

The fire safety manager might wish to make contingency plans to cope with or avoid the interruption of business in the event of a fire. Such plans could include:

- preparing a list of contacts;
- arranging alternative premises;
- keeping duplicates of business records off-site.

Planning for business re-start can form part of the overall risk management.

See also **4.3** and Annex A.

44.9 Protection of building structure, contents, and the environment

NOTE 1 Building fabric and property protection are a particular issue for historic buildings.

The fire safety measures taken to protect occupants of a building often protect its contents and structure as well, but the fire safety manager might wish to make additional plans for the protection of building structure, contents, and the environment.

NOTE 2 Advice is given in the LPC design guide for the fire protection of buildings *[39].*

If there is any conflict between the need to protect occupants and the wish to protect building structure, contents, and the environment, the safety of the occupants should always take precedence.

44.10 Salvage and damage control

Salvage and damage control are concerned with limiting loss and damage to the building fabric, contents and business operation. Plans might be made for action both during and after an incident. Pre-planning might include the identification of:

- the priority risks (permanent or movable objects);
- the best ways and means of removing and protecting priority risks;
- people involved and designation of roles;
- access to and facilities for people involved;
- aftercare of the risk.

To assist in the salvage and damage operation, information packs should be compiled and kept up to date. They should contain:

- a list of people to contact in an emergency;
- details of the roles of the people involved;
- building and room plans;
- description of risks;
- details of the mode and method of salvage;
- advance identification of, and arrangements with, salvage companies and building contractors;
- aftercare details.

Salvage operations should be carried out only after all the occupants of a building have been accounted for. Once the occupants have been safely evacuated, salvage operations may be coordinated with fire-fighting activities.

45 Emergency actions

45.1 General

The emergency actions that should be included in the fire routine (see **44.2**) include:

a) action on discovery of a fire;

b) warning and evacuation signals:
  - interpreting and responding to signals;
  - two-stage alarm systems;
  - cascade alarm/decision systems;
  - other communications;

c) calling the external fire and rescue service, providing information and advising them;

d) evacuation procedures:
  - general evacuation procedures;
  - fire evacuation procedures;
  - evacuation control (i.e. from a control room);
  - organizing evacuation;
  - phased evacuation;
  - search activities;
  - dealing with the public (e.g. people with personal belongings or shopping);
  - dealing with sleeping residents;
  - dealing with occupants who require assistance, including disabled people (see **44.3** and Clause **46**);
  - motivating people to move;
  - dealing with reverse flows (e.g. parents searching for children);
  - mustering occupants;
  - the use of refuges;
  - audience/crowd control;

e) fighting the fire and other staff activity:
  - action to be taken by senior fire marshal and deputy senior fire marshal;
  - action to be taken by other fire marshals/fire wardens;
  - selection of fire-fighting equipment, first-aid fire-fighting, other fire-fighting;
  - managing the site fire team;
  - managing control room operations;
  - ensuring that active systems have activated;
  - shutting down or ensuring that non-essential equipment is off;
  - interaction with other personnel (in particular security) or other agencies;

f) meeting the external fire and rescue service, providing information and advising them:
   - completion of evacuation:
   - accounting for occupants;
   - care for displaced occupants;
   - care and assistance of (uninjured) victims;
   - provision of emergency accommodation;

g) re-entry to the building;

h) actions to be taken after the incident.

Other issues to consider include:

- preventing/minimizing business interruption;
- environmental protection;
- security/salvage and damage control;
- protecting the building contents;
- protecting the building fabric;
- recording lessons learned.

45.2 Action on discovery

A fire might be discovered by a person, or the occupants of a building might be alerted to a fire by the operation of an automatic fire detection system or an extinguishing system.

Building occupants should be instructed that on discovering a fire they should immediately raise the alarm locally, operate the fire alarm system and alert the appropriate persons, e.g. the control room if there is one, or a designated member of staff. In the event of a fire, the control room or designated member of staff should establish the location and apparent extent of the fire and assess the situation.

45.3 Warning and evacuation signals

The fire alarm evacuation signal normally consists of a continuous signal by means of bells, sirens, hooters, flashing beacons, etc., which indicates that all persons are required to evacuate the premises immediately.

In premises where a staged evacuation/alarm system is used, the staff should be instructed, on being alerted, to take up their pre-arranged emergency positions before the general alert is given.

Where a phased evacuation is being implemented, staff with specific responsibilities, e.g. fire marshals/fire wardens, should proceed to their allotted duties to supervise the evacuation procedure.

Where voice alarms or other forms of communication such as visual display screens are available, more informative messages may be provided. In some buildings consideration needs to be given to the selection of additional languages that might be appropriate.

Whatever system is used it should be clear and unambiguous.

45.4 Calling the fire and rescue service

The fire and rescue service should always be called immediately to a fire by dialling 999 (or 112 from a mobile phone), however small the incident might appear (see also **44.2**), even if there is an automatic device for calling them. Notices giving the correct calling procedure should be posted conspicuously in appropriate positions.

If an automatic device for calling the fire and rescue service is provided, e.g. a connection from an automatic alarm or extinguishing system, it is vitally important that prior notification is given to the fire and rescue service of a proposal to carry out a practice or test and, if necessary, a code word should be agreed.

In premises which rely on a nominated person dialling 999 (or 112 from a mobile phone) during normal working hours to summon the fire and rescue service, additional persons should be nominated to ensure that provision is made for people who regularly work outside these hours, or to cope with unexpected absences of key staff.

45.5 Evacuation procedures

*NOTE 1 Examples of evacuation strategies are given in Annex Y. Examples of messages for use during a phased evacuation are given in Annex Z. For further guidance on phased evacuation, see **44.5** and Annex X.*

The evacuation procedures should define the evacuation sequence and should include provision for:

- buildings where there is overnight occupancy;
- buildings without evacuation lifts;
- buildings with evacuation lifts, including the management of such lifts;
- evacuation procedures for disabled people (see **44.3** and Clause **46**);
- refuges and intermediate places of safety;
- the role of the structural protection;
- communications during the evacuation.

The evacuation procedures should ensure that:

a) everyone assembles at a place of ultimate safety and is accounted for, so that if anyone is missing the fire and rescue service can be informed on their arrival;

b) designated members of staff check that no one is left behind;

c) appropriate assistance is provided for any persons who are unable to self-evacuate;

d) persons are deterred from re-entering the building until it is safe to do so.

The evacuation procedures should also take into account the way in which people tend to respond to a fire alarm, particularly in buildings that are open to the general public or have a lot of untrained staff. Particular problems can include:

- persons being unwilling to evacuate the building if they have to leave personal belongings behind, including meals and unpaid-for shopping;
- persons wishing to take with them a coat or other outdoor clothing, particularly in the winter;

- persons who have entered the building with friends or family wishing to locate them, even if this necessitates moving away from the exits against the flow of evacuees (this is especially likely in buildings where crèches are provided);
- people whose practical needs have not been taken into account (see Clause **46**).

NOTE 2 Special procedures are needed to cope with crowds, especially in occupancies where crowds occur only occasionally, such as for special events (see also Annex T).

Staff should be trained to deal with such situations and to assist people to evacuate as speedily as possible, including providing reassurance that belongings will remain safe in the building.

In the event of a general alarm to evacuate the building being given, all persons who have not been allocated specific fire duties should be instructed to leave in an orderly manner, without stopping to collect their personal belongings. Specific fire duties that should be allocated to trained individuals include:

1) supervising the evacuation from each storey, ensuring that all people have left each area and reporting to that effect to the senior fire marshal;
2) ensuring that people with PEEPs (see **46.7**) are enabled to put their personal evacuation plan into operation;
3) ensuring that doors are closed as each storey or section is cleared;
4) bringing passenger lifts immediately to the final exit level, unless this is the fire floor, and keeping them there during the fire emergency;
5) meeting the fire and rescue service on its arrival and giving all relevant information (see also **45.7**);
6) ensuring that everyone assembles at a place of ultimate safety and is accounted for, so that if anyone is missing the fire and rescue service can be informed on their arrival;
7) ensuring that people do not re-enter the building until authorized to do so;
8) instructing people not to move cars which are parked within or near the building, because of the risk of impeding access to the fire and rescue service.

45.6 Fighting the fire

In the event of a fire being discovered, the agreed fire procedure should always take priority. After raising the alarm and calling the fire and rescue service, attempts may be made to fight the fire with the equipment provided, if:

a) trained staff are available for the purpose;
b) it is deemed safe to do so;
c) such action would contain or extinguish the fire;
d) it is likely to have a direct and immediate effect in protecting life.

If it is necessary to abandon fire-fighting, the staff involved should be instructed to withdraw, closing doors behind them, and leave the premises.

The task of fighting the fire may be undertaken by the site fire team, if such a group has been appointed. The fire safety manager, or a delegated representative, may oversee these activities, and the evacuation, from any control room in the complex.

45.7 Receiving the fire and rescue service

It is essential that a person is on duty at the point of arrival of the fire and rescue service who is able to direct the fire-fighters to the affected area and is ready with any necessary keys, information about the building and other relevant help.

On the arrival of the fire and rescue service, it should be ensured that every assistance is given to enable them to attack the fire effectively, and in particular that they are informed of the situation as regards the safety and whereabouts of the occupants of the building.

To assist operational fire crews, an emergency pack containing essential information for fire-fighting, and indicating escape routes, special hazards and special procedures, should be prepared in advance in consultation with the fire and rescue service. This information should be extracted from the fire safety manual and kept in a readily accessible and secure location (e.g. a plans box) at the premises and/or with the agreement of the fire and rescue service, made available to the fire and rescue service in advance in hard copy, digital or other format. The emergency pack and its contents should conform to the recommendations given in Annex M.

45.8 Completion of evacuation

On completion of evacuation, all staff should instructed to report to a previously determined assembly point or points, which should be sufficiently far from the premises to avoid interference with the fire and rescue service or danger from falling debris. People should be instructed not to re-enter the building without the permission of the fire and rescue service officer in charge.

Where practicable, staff so appointed should attempt to account for all occupants of the building, e.g. by means of a previously established list of occupants or successful completion of a PEEP (see **46.7**). Where there are a number of exits from a building it can be advisable to gather evacuees for a roll-call.

Any pre-planned procedures (see **44.1**) with respect to issues such as the following should be implemented:

- care for evacuees (including provisions for accommodation, blankets and similar for night time or bad weather evacuations);
- provision for additional needs of disabled people following an evacuation (e.g. if people have been separated from mobility aids, medication, etc.);
- reuniting family groups;
- notifying relatives and providing transport home;
- salvage;
- environmental protection.

45.9 Re-entry to the building

Following an evacuation of a building, re-entry to the building should not be permitted unless express permission is given to the fire safety manager by the senior responsible officer (e.g. senior fire safety officer, senior police officer or structural engineer) at the scene.

Full re-entry should not take place until the fire safety manager confirms that:

- the building is structurally safe;
- the building is free of contaminants;
- the necessary plant and building services are fully operational;
- the safety systems are fully operational, e.g. recharging of battery-powered emergency lights, resetting of fire alarm systems, etc.

45.10 After the incident

Once an incident is over, the lessons learned from the incident should be recorded in the fire safety manual (see Clause **9** and Annex H) and improvements in systems and procedures implemented as necessary.

Information should be obtained from as many sources as possible to maximize the lessons learned. Sources of information can include:

- interviews with persons involved in the incident;
- logging systems used to record building information;
- fire detector actuation;
- security cameras.

False alarms, minor incidents and "near miss" events can also provide useful lessons. However, whenever an evacuation occurs as a result of a false alarm, as with an actual event, the opportunity should be taken to record the lessons learned and to assess, and improve, the whole fire safety system.

46 Evacuation of disabled people

46.1 General

Providing an accessible means of escape solution should be an integral part of the fire safety management process. Fire safety management should take into account the full range of people who might use the premises, paying particular attention to the needs of disabled people.

It is important to note that it is the responsibility of the premises management to ensure that all people can make a safe evacuation. The evacuation plan should not rely on the assistance of the fire and rescue service. This is an important factor that needs to be taken into account in building design.

It cannot be assumed that facilities provided in a building to make it accessible will be usable in a fire evacuation. For example, lifts that are not appropriately designed for emergency evacuation might not be usable for evacuation. This needs to be considered at the design stage when it is relatively easy to incorporate accessible escape features which will make evacuation planning more effective, an evacuation easier to manage and help to preserve the dignity of disabled people in an evacuation.

46.2 Mobility-impaired people

Many people other than wheelchair users are considered to have mobility impairments. This category includes people who can use stairs but might not be able to reach a place of ultimate safety in the normal movement times used to calculate evacuation times. Awareness of this is particularly relevant if a time-to-safety calculation is used to assess the evacuation strategy in the premises. It might, therefore, be necessary to include any of the following features in the design of an escape route:

- making use of horizontal evacuation to a different fire compartment;
- the use of lifts;
- making all escape routes accessible, e.g. adding ramps if necessary;
- fitting extra hand rails and step edge markings.

46.3 Wheelchair users

Assumptions should not be made about the abilities of wheelchair users and their ability to leave a building safely. Whenever possible a PEEP (see **46.7**) should be produced.

Where this is not possible and general arrangements need to be made, horizontal escape is the most suitable evacuation method, possibly to another fire compartment, if direct escape to a place of ultimate safety is not possible. The provision of lifts to make buildings accessible is now generally accepted, and it is recommended that the use of lifts for evacuation purposes is encouraged. This might require the use of dedicated evacuation lifts, or the building being so designed that a non-evacuation lift can be used in a fire evacuation.

Where carry-down procedures are necessary this can be done in a variety of ways including using the person's own wheelchair, using a dedicated evacuation chair, or using powered stair climbers. It is imperative that an appropriate number of staff trained in both disability awareness and the use of carry-down procedures are on duty. The number of staff on duty needs to reflect the usage of the premises at any given time. It should be noted that it can take as many as four people to use a evacuation chair safely and effectively.

46.4 People who are deaf and hard of hearing

The needs of people who are deaf and hard of hearing should be taken into account in the design of fire alarm systems and evacuation management plans. The use of flashing beacons, vibrating pagers or pillows, and similar alert devices should be considered, appropriately located and backed up by an integrated fire management plan. Where an individual PEEP (see **46.7**) can be produced, the use of a buddy system should be considered.

Account should be taken of the possibility of a deaf or hard of hearing person being separated from their assistance dog.

46.5 Blind and partially sighted people

Most blind and partially sighted people have some sight and will be able to use this during an escape to make their own way out of a building as part of the crowd. Escape routes can, however, be improved by the use of good signage and features such as orientation clues, tactile information, audio signals, good colour contrast and step edge marking; tactile information will also be of use to those people who have no sight at all. All such provisions should be backed up by appropriate staff training for assisting in an evacuation, together with individual PEEPs (see **46.7**) as appropriate.

Account should be taken of the possibility of a blind or partially sighted person being separated from their assistance dog.

46.6 People with cognitive disabilities

This includes people with dyslexia, autism and dysphasia, as well as people with learning difficulties. People with cognitive disabilities might have problems comprehending what is happening and might not have a good perception of the risk from fire. They might also have difficulties in orientation and be reluctant to take an unknown route to leave a building. Good escape route design, orientation information and training of staff to understand how to assist people with cognitive disabilities are thus necessary, together with the use of PEEPs (see **46.7**) where possible.

46.7 Use of personal emergency evacuation plans

Personal emergency evacuation plans (PEEPs) are recommended for all people requiring assistance to leave the building. Through the recording of PEEPs, the management team should be made aware of the amount of staff support required for each evacuation. There are three types of PEEP that might need to be developed.

a) **Individual PEEP for disabled people who are regularly in the premises, for example staff and regular visitors**
Following discussions with an individual, a plan can be developed for their specific needs which should contain details of how they will evacuate the premises. By taking into account the individual needs of a person when preparing a PEEP, management will be able to make any reasonable adjustments to the premises or procedures that are necessary. They will also be able to make provision for actions to be taken in the event of a false alarm, or if the person cannot return to the building after a fire.

b) **PEEPs for visitors to the premises who will make themselves known to staff, such as hotel guests**
Visitors who are likely to require assistance in the event of an evacuation should be encouraged to make themselves known to staff on arrival.

   Management should be encouraged to have available, especially at reception, staff who are trained in disability awareness. This will make this process more comfortable for disabled people and more effective for management. The generic PEEPs should provide a wide range of guidance for differing disabilities and be adapted for the individual premises. They need to include what the visitor should do in a evacuation, and what the management response will be. They should also reflect what specific fire safety provisions are provided for disabled persons on the premises, e.g. fire alarms adapted for people who are deaf and hard of hearing. It is important that the generic PEEP is discussed with each visitor and their particular needs taken into account where possible.

c) **PEEPs for visitors not previously identified to staff, such as in a shopping centre**
The standard evacuation plan should include measures to make evacuations suitable for all persons on the premises. Information for disabled people should be noted in fire action notices and in the fire management plan. It is vitally important that staff are trained so that they are aware of the facilities and their responsibility to evacuate disabled people and know how to use features such as evacuation lifts or refuges. Enough staff should be available at all times to make sure that evacuation plans are viable. This is particularly important where features such as carry-down procedures are to be adopted to evacuate mobility-impaired people.

46.8 Use of refuges

Refuges are places of relative safety where people whose abilities or impairments might result in delayed evacuation can await assistance from building management with the next part of their movement to a place of ultimate safety. Refuges should be provided and constructed in accordance with Annex G.

It is essential that communication issues between those organizing the evacuation of the building and all refuges are properly addressed. The persons controlling the overall evacuation need to ascertain in respect of each and every refuge:

a) how many people there are who require evacuation assistance;

b) the nature of any impairment that might affect their ability to escape (see **44.3**);

c) the refuge or refuges in which they are located.

In addition:

1) the people in each refuge should be assured that their presence there is known to the building management;

2) in order to avoid anxiety and confusion, the people in each refuge should be kept informed of the situation and told about the actions that building management are taking in order to effect their safe evacuation.

To address these issues there needs to be a system of two-way communication between those waiting in each refuge and the team who are organizing the evacuation of the building. These two-way communication systems need to be such that they are readily operated by, and comprehensible to, all persons likely to need to use them. See also **41.9**.

46.9 Evacuation using lifts

A lift to be used for the evacuation of disabled people should be either an evacuation lift or a fire-fighting lift and should be operated under the direction and control of the fire safety manager or a delegated representative. Evacuation lifts should be provided, constructed and operated in accordance with Annex G. In some circumstances a lift not designed for evacuation may be usable for evacuation in certain situations. If this is to be considered then a suitable fire risk assessment should be undertaken to evaluate whether the lift meets the functional recommendations of an evacuation lift (see **3.70.2** and Annex G).

In the risk assessment all the features of fire protection in a building should be taken into account. For example, in a building with automatic sprinklers and significant compartmentation or smoke control, a risk assessment might conclude that a non-evacuation lift would be usable in the initial stages of a fire. Likewise, in a very large building, a non-evacuation lift which is remote from a fire in the initial stage might also be usable.

Issues that should be included in the risk assessment should include thorough checks to ensure that:

- the interface between the lift control system and the fire alarm system will support the evacuation management strategy;
- controlled operation of the lift will be possible during an evacuation;
- the power supply to the lift is likely to remain usable throughout the time required for evacuation;
- the lift enclosure and associated escape routes will remain free from the effects of fire, heat and smoke during the evacuation;
- there is a suitable communications system available to ensure that staff can use the lifts safely to evacuate mobility-impaired people;
- there is an alternative escape route available for situations when the use of the lift is not viable.

46.10 Evacuation using stairways

Whilst many disabled people are able to descend (or ascend) a stairway, possibly with assistance, others might need to be carried (see **46.3**). In all cases, the method of evacuation should be discussed with the individuals concerned and, where possible, incorporated into their PEEP (see **46.7**).

Blind and partially sighted people can best be guided on level surfaces by allowing them to take a helper's arm and follow the helper. On stairways the helper should descend first and the blind or partially sighted person follow with a hand on the helper's shoulder. If a blind or partially sighted person is accompanied by a guide dog, the person should be asked how best the animal can be helped. Some guide dogs follow on their owner's command but generally, if a helper is leading a blind or partially sighted person, the guide dog should be held by the leash, rather than the harness.

Building management should ensure that staff designated to help disabled people in the event of fire are fully trained in the techniques of helping to evacuate them.

46.11 Test evacuations for people requiring assistance

*NOTE Recommendations for regular test evacuations are given in **44.6**.*

A test evacuation, in which people who require help are assisted to a place of ultimate safety, should be carried out at least once a year and should be both horizontal and vertical.

It should be noted that repeated evacuations (whether as tests or as a result of a false alarm) can pose significant risks to disabled people which are not encountered by others, e.g. in the use of carry-down chairs. Management should endeavour to reduce these risks by the prevention of unnecessary evacuations and provision of appropriate training for staff that might not necessarily include evacuation of the disabled person (see also **44.6** and Annex O).

If members of the public are to be on the premises during a test evacuation, the fire and rescue service should be informed of the intention to carry out the evacuation and asked to cooperate in the exercise. A report recording the findings of each test evacuation should be prepared and circulated to members of staff. Conclusions reached from the experience that would improve easy and clear understanding of escape instructions and signage or the process of evacuation should be incorporated in a revision to the written instructions.

46.12 Fire instructions and training

It is vitally important that fire instructions are accessible and easily understood, both for staff and visitors. Written instructions should be available in alternative formats such as large print, Braille, or on audio devices. Videos, DVDs or photographic instructions may be used which can help people with cognitive disabilities. Videos and DVDs should make use of subtitles and British Sign Language interpreters to help convey the information. If computer-based staff training packages are used, these should be readily accessible to all who need them.

NOTE Where equipment is provided to assist in the evacuation of disabled people (e.g. evacuation chairs, stair traversing devices, etc.), it is important to ensure that its operational capability is maintained.

It is imperative that staff designated to help disabled people in the event of fire are fully trained in the techniques of evacuating disabled people, that such training is delivered appropriately, and that it is developed with the involvement of disabled people. Disability equality and awareness training will also improve the confidence and effectiveness of staff in both developing and delivering accessible escape solutions.

47 Management of fire safety prior to full occupation of a building

NOTE Attention is drawn to the Construction (Design and Management) Regulations 2007 [18] in respect of fire safety in buildings under construction. Additional guidance is given in:

- *Health and Safety Executive publication L 144 [68];*
- *Health and Safety Executive publication HSG 168 [69];*
- *Fire Protection Association publication* Fire prevention on construction sites – The joint code of practice on the protection from fire of construction sites and buildings undergoing renovation *[70].*

Where there is partial or phased occupation of a building or complex, and during fitting out, then the guidance in this British Standard should be followed as far as is practicable. Added vigilance is often needed in these situations, particularly as fire safety systems might still not be in place or operational.

The following very general guidance applies.

- During construction work, and particularly when work is being carried out in buildings which are partially occupied, appropriate arrangements should be made to ensure the safety of escape routes and operation of all fire protection facilities.
- Where work is being carried out before fire protection facilities are in place, suitable alternative arrangements should be made for the safety of the building and its occupants.
- Management should ensure that arrangements are made for the instruction and supervision of contractors/workers in maintaining fire safety.
- Special attention is required to ensure that escape routes do not become blocked or obstructed by building materials, etc., and that where work involves a escape route, sufficient alternative routes are provided and properly identified.
- Particular care is needed before any hot work is carried out (see **42.6** and **48.2**).
- If flammable substances, e.g. some adhesives and solvents, are to be used, the contractors should be specifically instructed to follow good safety practices, e.g. there should be no likely sources of ignition, including pilot lights on appliances, and the area should be well ventilated.
- Effective arrangements should be made to ensure that contractors are briefed on the actions to be taken in case of fire and are made familiar with the appropriate escape routes.
- A log of the contractors' attendance should be maintained so that at any time the number and location of all personnel can be ascertained.

The recommendations above are important in any circumstances, but are of even greater importance if work is being carried out in any part of the premises whilst the building is occupied, or if the premises are to be open to the public shortly after work has ceased.

Some buildings are speculative and have no known occupier at the time of construction. Either such buildings should be well equipped with fire safety provisions and anticipate the minimum of fire safety management from the eventual occupiers, or the management assumptions or implications should be stated in the fire safety manual (see Clause **9** and Annex H) as a limitation on the eventual use of the building.

48 Building works, alterations, decommissioning and demolition

48.1 General

NOTE 1 Attention is drawn to the Construction (Design and Management) Regulations 2007 [18] in respect of building works. Additional guidance is given in:

- *Health and Safety Executive publication L 144 [68];*
- *Health and Safety Executive publication HSG 168 [69];*
- *Fire Protection Association publication* Fire prevention on construction sites – The joint code of practice on the protection from fire of construction sites and buildings undergoing renovation *[70];*
- *Institution of Structural Engineers publication Appraisal of existing structures [71].*

NOTE 2 Attention is drawn to the Building Regulations 2000 [19], the Building (Scotland) Regulations 2004, as amended [20] and the Building Regulations (Northern Ireland) 2000 [31] in respect of approval for building works.

Experience has demonstrated that fires are more likely to occur when general maintenance work or alterations are being carried out to a building, most notably when work is being carried out by external contractors or subcontracting specialists. General recommendations for working with contractors and subcontractors are given in **42.6**.

Guidance should be given to both general maintenance staff and external contractors on:

a) the fire safety arrangements within the building, to ensure that they are not adversely affected by maintenance work or alterations;

b) procedures to avoid fire occurring, particularly in relation to hot work such as welding or cutting (see **48.2**).

Minor alterations to building design can have a significant influence on the effectiveness of arrangements for the detection and control of smoke. The smallest increase in the degree of roof covering, or even the removal of some roof coverings, could result in a change of predicted smoke flow. The substitution of materials used in decorative features, shop fascias or the walls of common areas, could change the rate at which fire might spread if it penetrated to those areas. The characteristics of materials used in roofs and ceilings are particularly important, as are their contours, and the decorative treatment of ceilings might have a significant effect on sprinkler discharge. It is also essential that no painting is carried out, or hanging decoration permitted, which would affect the operation or distribution of water from a particular sprinkler head.

There is a need for documentation in many cases, and a permit system for contractors carrying out any kind of structural work. Any form of heat process to be used should be the subject of specific permit approval and insistence on appropriate safeguards (see **48.2**).

Hazards can arise when buildings are in the course of extension or alteration but still partly in use. These hazards can arise as a consequence of one or more of the following:

- loss or diversion of escape routes;
- disruption of fire protection facilities, including the temporary loss of structural elements, such as walls, that might have a fire protection role;
- the presence of building materials that are flammable.

To address these hazards, the general guidance in Clause **47** should be followed.

48.2 Hot work

Hot work should only be undertaken if no satisfactory alternative method is feasible.

Hot work is any procedure that might involve or have the potential to generate sufficient heat, sparks or flame to cause a fire. Hot work includes welding, flame cutting, soldering, brazing, grinding and the use of other equipment incorporating a flame, e.g. tar boilers, etc.

A hot work permit procedure, which may be part of an overarching safe system of work/permit to work procedure, should be followed before any hot work is allowed in or near a building. This is to ensure that correct actions are taken before hot work commences, during the operation and afterwards.

Where hot work is necessary, it should be carried out in accordance with Annex U.

48.3 Change of use of buildings

*NOTE 1 The proposed use of a building is taken into account at the design stage (see Clause **10**) and is used as a basis for the fire safety documentation (see Clause **9** and Annex H). Sometimes a building will be designed to allow for later changes of use [see Note to **10.1**c)], but generally the fire safety documentation needs to be reassessed if the use of the building is changed.*

NOTE 2 Attention is drawn to the fact that changes in the use of buildings can be subject to review by various regulatory bodies.

Where there is a proposed change of use of a building, or where the scale of the operation within the building is likely to change, then the fire safety documentation should be re-examined and assessed for the new use. The management assumptions and the level of management specified should either remain appropriate for the new use or be changed to suit (see Clause **8**).

Changes for which a reassessment of the fire safety documentation is needed include alterations to the management structure, additional facilities or equipment retro-fitted to the building.

48.4 Units in disuse and areas decommissioned

48.4.1 General

Despite the supportive value of automatic detection and fire extinguishing systems, surveillance by human presence and immediate action taken in the very first stages of fire represent the most effective way of limiting its effects. When the human element is not present, as in the case of an unoccupied unit or a decommissioned part of a building, the occupants of the remainder of a building or complex are deprived of a first line of defence against fire.

Even if a temporary discontinued occupancy results in a reduction of the combustibles normally expected to be present in a unit, the importance of automatic fire protection within that unit or area is increased rather than diminished, particularly if work such as shop fitting is in progress.

Under these circumstances, surveillance by staff should be intensified to prevent any form of careless practice and to ensure that protective systems remain fully operative.

Any decommissioned area, unoccupied unit, or any unit that is in the process of being fitted out should be either:

a) physically separated from the rest of the building by construction having not less than 60 min fire resistance; or

b) protected by other fire protection measures as agreed by the relevant enforcing authorities.

In either case, the unused part of the building should be subject to routine inspection.

48.4.2 Buildings in disuse or decommissioned

NOTE Guidance on managing risks in such buildings is given in the FPA publication Code of practice for the protection of unoccupied buildings *[72].*

The management of buildings that are in disuse or that have been decommissioned should focus on the prevention of fire starting and should include:

- ensuring that all power supplies are disabled;
- removing any material that might self-heat;
- removing any material that might be subject to an arson attack;
- maintaining security to prevent arson attacks.

48.4.3 Buildings being demolished

There is a greater risk of fire not being detected or controlled at an early stage in a building where many or most of the fire protection systems are disabled or missing. The management of fire safety in such buildings should take account of this.

NOTE Attention is drawn to the Construction (Design and Management) Regulations 2007 [18] in respect of demolition works and particularly in respect of the health and safety file, which is expected to include details of any hazards anticipated during demolition. Additional guidance on demolition works is given in BS 6187 and:

- *Health and Safety Executive publication L 144 [68];*
- *Health and Safety Executive publication HSG 168 [69];*
- *Institution of Structural Engineers publication* Appraisal of existing structures *[71].*

Annex A (normative) Additional considerations for property and business continuity protection

A.1 General

The recommendations given in this British Standard are primarily concerned with the protection of life. The provision of fire safety systems for life safety do not necessarily give adequate protection to property or the business carried out in the building. Therefore, the aim of this annex is to ensure that the potential for property and business loss is assessed so that risks are understood and acceptable.

Smoke and fire spread are major causes of property, contents and business interruption losses and the detection and control of these aspects will reduce their effects. The inclusion of sprinklers as a significant measure to reduce fire severity and development would usually provide significant property protection, and could also result in significant reductions in other areas of fire precautions. The issues of life safety and property protection when addressed together result in mutual benefit.

The primary method for examining the potential for property and business loss should be a fire risk assessment. This should account for the fire safety provisions in the building and the level of fire prevention management (see Clause **8**). The risk assessment for property and business continuity protection could be an extension to other risk assessments carried out for life safety as required under various legislation.

By carrying out a property and business continuity protection risk assessment, the consequences of fire on property and business loss can be highlighted to the owner, occupier, operator, tenant, designers and insurers. The risk assessment should take into account the existing fire safety systems and equipment in the building, and the level of fire prevention management intended for the building. It should then be clear what overall fire safety systems and equipment are required, what function they have in relation to property protection and what management responsibilities are required to maintain and operate these systems.

A.2 Aims of a property and business continuity protection risk assessment

NOTE Further advice and guidance can be obtained from the FPA design guide Essential principles *[73].*

One aim of such a risk assessment is to provide a link between the provisions for life safety and those for property and business continuity protection. In consequence the risk assessment should ensure that, as far as is reasonably practicable, the design of fire precautions and fire prevention management provides adequate control against fire development in order to protect:

a) property:
   - contents;
   - fabric and building services;

b) business:
   - loss of trade;
   - loss of operational continuity;
   - loss of records.

A.3 Responsibilities

NOTE The responsibility for agreeing the level of fire precautions, and fire prevention management in relation to insurance, lies solely with the insurers or their agents and their client. The result of these discussions might result in a change of brief or increased fire precautions in the building. Consequently, discussions with the insurers should occur at an appropriate phase in the design and should allow for any contingency planning.

As part of the development of the brief, the responsibility for carrying out a property and business continuity protection risk assessment should be taken by one of the following:

- owner, occupier, operator, tenant or concessionaire, for self assessment;
- suitably competent member of the design team;
- insurer's fire surveyor;
- risk manager/engineer;
- fire safety engineer.

The level of detail required (see **A.5**) should also be decided upon when allocating responsibility.

Any changes in the design should be discussed with the relevant authorities to ensure that there is no adverse impact on life safety. If a conflict exists between the provisions for life safety and property protection that cannot be resolved, then life safety takes priority.

There is frequently a life safety benefit as a result of a property protection measure. It might be possible to remove or simplify some life safety measures, in negotiation with the relevant authorities, when more stringent property protection measures are adopted.

A.4 Acceptable level of risk

The acceptable level of risk to property or business should be established at an appropriate stage in the design. This acceptable level of risk to property or business should then be compared with the design criteria necessary for life safety. Any increases in performance standards required for property or business continuity protection can then be identified and incorporated in the design.

A.5 Risk assessment methodology

Initially, the appropriate type of risk assessment should be agreed. The risk assessment could range from a simple statement outlining the potential property and business losses which are acceptable to business managers and their insurers, through to a rigorous quantified analysis of probabilities and consequences of fire.

As the design develops it is possible that the level of detail will change, especially for fitting out. This might lead to a change in the type of risk assessment required.

Whatever method is employed, the aims of the risk assessment should be met so that all concerned are aware of the potential risks and the required performance of the fire safety systems and equipment and management of fire safety.

NOTE Whilst life safety takes priority in case of conflict, it is possible that improved property protection might replace a life safety feature without compromising overall safety.

The first stage in the process is to assess the level of property and business continuity protection inherent in the design to meet the life safety provisions. This might be sufficient for many buildings equipped with active suppression systems (see Clause **39**), compartmentation, structural fire protection, and provisions to prevent external fire spread.

The second stage is to identify any additional fire protection provisions. Care should be taken to identify any single points of failure that could have significant effects on business operations. Additional protection or some form of redundancy might then be required, not only for key elements of the business but also for services supporting that key element.

A.6 Qualitative risk assessment

A.6.1 General

For many buildings some form of qualitative risk assessment will be appropriate. There are a number of hazard and risk assessment techniques. These should be discussed and the technique to be used agreed at an appropriate stage of the design.

When the aims or objectives for property and business continuity protection have been agreed, then a strategy for achieving those aims can be developed. The strategy can be developed from the risk assessment, which will take into account various methods to prevent fire occurring and developing. These methods are referred to here as controls on fire development and they take into account both fire prevention management and the design of fire precautions.

Controls on fire development can be assessed against the way the fire is likely to start and then grow. The growth of the fire and the actions of various controls on fire development can be assessed in a sequential order known as a time line.

The following controls on fire development approximate to a time line for many fires:

- fire prevention management; control of ignition sources and combustible material; training of staff and work procedures; maintenance and upkeep of fire safety systems (**A.6.2**);
- detection and alarm; first aid fire-fighting (**A.6.3**);
- smoke management (**A.6.4**);
- compartmentation and structural fire protection (**A.6.5**);
- fire-fighting facilities; external and internal (**A.6.6**);
- external fire spread and building separation (**A.6.7**);
- automatic suppression systems.

As the fire grows, different controls to fire development will dominate the probability that the fire is controlled in size or extinguished. The success or failure of each control mechanism can be considered in the risk assessment of potential damage to the property and business. Any improvements in the management system can also be identified together with contingency plans if necessary.

A.6.2 Fire prevention management

*NOTE Recommendations for fire prevention management, control of ignition sources and combustible material, training of staff and work procedures, and maintenance and upkeep of fire safety systems are given in Section **9**.*

The first barrier to property and business loss is the level of fire prevention management in the building. This is to ensure that ignition hazards are controlled or eliminated, that operations in the building are carried out appropriately and that combustible loads are subject to control and good housekeeping.

A.6.3 Detection, alarm and first aid fire-fighting

If a fire occurs and grows then the first barrier to its development will be by first aid fire-fighting. The success of this might be dependent on the ability to detect a fire and raise the alarm, and on staff training in first aid fire-fighting. The likelihood of the fire starting when the building is occupied (e.g. daytime) or unoccupied (e.g. night time) should also be assessed.

A.6.4 Automatic fire suppression and smoke control

If first aid fire-fighting is unsuccessful and the fire continues to grow then the next barrier to fire development is likely to come from any automatic fire suppression systems in the building. When assessing the adequacy of the system, reference should be made to the design objectives of the system to ensure it is sufficient for the aims of property and business continuity protection (see **A.4**). Automatic fire suppression or control systems can be in the form of sprinklers, other automatic water based systems, fixed dry powder systems or gaseous suppression systems (see Clause **39**).

Smoke control systems can either be active or passive. Active smoke management systems can be turned on automatically via the detection and alarm system and take one or all of the following forms:

- mechanical and natural smoke extract with appropriate means to allow make up air. These are designed to either limit the extent of smoke spread and/or to reduce the build up of heat in the compartment;
- pressurization systems to prevent the flow of smoke from one area to another by raising the pressure in the protected space;
- depressurization systems to prevent the flow of smoke from one area to another by lowering the pressure in the fire-affected space;
- directional fans designed to force smoke in one direction.

With active suppression systems the fire can be assumed to be controlled or extinguished. Either way, a degree of smoke damage can be anticipated within the compartment or smoke reservoir depending on whether or not it is an active or passive smoke management system. The potential for smoke damage can be assessed qualitatively for its impact on property and/or business. Care should be taken that any single points of failure likely to effect business operations are identified.

A.6.5 Compartmentation and structural fire resistance

If there are no active fire suppression systems, or if for the purposes of an extreme event analysis it is decided to assume that the fire is not controlled by active means, then the next level of control on fire development will be fire compartments and fire resistance to the structure.

Compartmentation can take the following forms:

a) fixed horizontal and vertical barriers with designated fire resistance, including adequate fire-stopping; cavity barriers; dampers or seals; doors or shutters all of which are commensurate with the barrier in which they are housed;

b) a combination of fixed fire-resistant barriers and/or active systems.

When assessing the adequacy of the compartment and structural fire resistance, reference should be made to the design objectives to ensure it is sufficient for the aims of property or business continuity protection and day-to-day operation (see **A.4**).

If a building is compartmented, smoke and heat damage can be assumed to occur throughout the compartment. There is also a risk that the compartmentation could be breached as a result of inadequate fire-stopping between floor slabs and the external façade, or by external fire spread via the façade.

Care should be taken to identify single points of failure likely to affect business operations.

A.6.6 Fire-fighting facilities

Although fire-fighting facilities are included here as the fifth control to fire development, they could be equally applicable from any moment that a fire is detected.

The speed of response to the fire and availability of fire-fighting provisions play an important role in limiting the potential damage to property.

There are two factors to consider:

- provision for external fire-fighting;
- provision for internal fire-fighting.

The principal aim of these activities is life safety, and the facilities required are described in Section **6**. For most buildings it is expected that these provisions will also be adequate for property protection.

A.6.7 External fire spread and building separation

In terms of external fire spread between buildings, the acceptable risk to life is based on the relevant boundary being half the distance between buildings. Neighbouring buildings are assumed to have similar unprotected areas. For most buildings it is expected that these provisions will also be adequate for property protection.

For some buildings, however, the life safety calculations of unprotected areas in relation to the relevant boundary might not be sufficient for property protection when the buildings are on the same site. In this instance, the distance to the relevant boundary (see **36.2**) should be taken as the actual measured distance between the buildings.

Care needs to be taken however with buildings having glazed façades. Fire can spread through such façades from floor to floor and on the same floor across re-entrant angles, requiring the use of fire-resisting glass at critical locations.

A.7 Insurance industry guidance

The insurance industry has produced various guides which are directed at property protection (including FPA guide *Essential principles* [73] and guidance published by the Arson Control Forum [74], Arson Prevention Bureau [75] and Zurich Municipal [76]). Arson and vandalism are addressed by guidance produced by the Arson Control Forum [74] and the Arson Prevention Bureau [75].

Many insurers use the *LPC design guide for the fire protection of buildings* [39] as a basis for providing guidance to the building designer on what they require.

Annex B (normative) Recommendations for atria

B.1 General

NOTE Design solutions and exemplars for atria are given in Annex C. The recommendations in the present annex support the provisions identified in Annex C. Most of these recommendations depend on the particular solution adopted, and it needs to be ascertained from the appropriate figure/table in Annex C which recommendations are relevant to the particular design. ***B.9*** *and* ***B.10*** *deal with those recommendations that apply to all designs.*

This annex presents the general principles to be adopted in the design of a building containing one or more atria.

The recommendations given in this annex provide a range of options that can include one or more of the following:

a) effective planning and protection of escape routes from any area that might be threatened by fire;

b) limitation of fire development by the control of materials or the provision of automatic suppression systems (see Clause **39**);

c) provision of fire warning systems and, where appropriate, systems for the automatic detection of fire;

d) separation of an atrium from associated floor areas;

e) provision of smoke, pressure and temperature control systems to maintain the effectiveness of escape routes and access for fire-fighters;

f) effective management control.

The solutions are not exhaustive and other methods might exist by which an equivalent level of fire safety can be achieved. The wide range of designs possible in atrium buildings makes it impossible for this annex to cover every conceivable scheme and its associated fire risk, and the recommendations given in this annex might not be appropriate to all buildings. The principles of fire safety design should be taken into account when considering the design of any atrium building. All designs based on calculations to the extent recommended in this annex should be supported by documentation fully detailing the calculations and assumptions made, and the values of any input parameters (see also **B.6.2**).

The principles presented in this annex are applicable to all building types containing atria other than:

1) prisons or other buildings intended for the confinement of persons;

2) auditoria in theatres or similar places of entertainment;

3) malls in shopping complexes;

4) small premises;

5) buildings in occupancy characteristics A and B containing a two-storey atrium, with one of the two storeys being at ground level, which are designed for simultaneous evacuation with storey exits remote from the atrium.

One of the major differences between the fire precautions recommended for atrium and non-atrium buildings are the arrangements for restricting fire and/or smoke spread. Such arrangements contribute to the provisions for means of escape or the restriction of fire spread between buildings. In non-atrium buildings these restrictions are commonly based on physical subdivision; whilst this annex proposes other methods of restricting spread, appropriate to particular designs of atria.

Except where specifically stated otherwise, the provisions of standards appropriate to the equivalent non-atrium building should be applied in addition to the recommendations of this annex.

B.2 Fire in an atrium building

B.2.1 General

An atrium provides a route by which smoke and fire can spread from storey to storey much more rapidly than in the equivalent non-atrium building, and the volume of smoke can increase manyfold due to the entrainment of air into the rising plume. During this period the considerable quantities of smoke and corrosive fumes produced, if allowed to spread through the building via the atrium to other open storeys, can cause damage that is out of proportion to the scale of the initial fire.

Such spread of fire and smoke can have a significant effect upon the number of persons initially at risk, the time available for escape and the activities of fire-fighters.

B.2.2 Spread of fire and smoke

When an atrium has an enclosure that does not confine the smoke from a fire to the space in which it originated then, even if that enclosure is of fire-resisting construction, the buoyancy and expansion of the fire gases can cause smoke to pass into other adjacent spaces which, in the absence of the atrium, might otherwise not have been affected.

If a fire occurs and continues to develop on a storey directly open to an atrium, hot smoke rises to the ceiling level of that storey and spreads outwards from the fire to form a layer beneath the ceiling. If that storey opens directly onto an atrium, smoke flows from the ceiling layer into the atrium void, where it tends to rise upwards owing to its buoyancy. As the smoke rises through the atrium it entrains large quantities of cool air from its surroundings, reducing the temperature of the plume and increasing its mass and volume. As the smoke plume rises it cools and its buoyancy reduces to such an extent that at some height its temperature can fall to that of the surrounding air and it will cease to rise by its own buoyancy. In such circumstances a stable layer of smoky gases can form some distance below the atrium roof. Having risen to an upper limit, the smoke then tends to build downwards, producing a layer of increasing depth which spreads horizontally into any open storeys within the depth of the layer.

Because a substantial proportion of the smoke and toxic fumes arising from a fire on a storey open to an atrium spreads directly into the atrium void, the rate of smoke layer development on the fire floor is reduced. In a large atrium this can provide a significant increase in the time available for escape on the storey on which the fire started but can lead to a rapid build-up of smoke on any upper storeys open to the atrium, which will require immediate evacuation.

B.2.3 Enclosure

The enclosure of an atrium by imperforate construction (such as a glazed screen) can significantly reduce the probability of smoke damage to storeys removed from the fire. However, if the fire grows large, the temperature build-up within the atrium is likely to lead to failure of float and other annealed glasses, and smoke and flames can spread between storeys. If a fire continues to develop unchecked, the build-up of heat is likely to lead eventually to the failure of non-fire-resisting glazing systems used for the atrium enclosure. Therefore, to achieve an additional level of protection the provision of a fire-resisting enclosure to the atrium can be beneficial.

B.2.4 Fire-fighting

In order to assist the fire and rescue service in rescue, fire-fighting and in clearance of smoke after the fire, additional smoke clearance measures might be necessary. It should be noted that smoke control provisions provided specifically for fire and rescue service use are not generally appropriate for the purpose of protecting means of escape.

B.3 Occupancy and building characteristics

B.3.1 General

The development of the fire safety strategy for a building has to take into account not only the provisions for fire safety but also the design objectives of the scheme. The following building characteristics, which can significantly influence the fire protection measures needed, should be established as early as possible in the design process:

a) building occupancy type;

b) degree of separation between atrium and associated floor area;

c) size and geometry of the atrium;

d) use of the atrium base and control of fire load;

e) relationship of the building to site boundaries; and

f) height of the building.

B.3.2 Buildings in different occupation

The design of the atrium building should take into account the different type of occupancies within the building, and each category should have its associated fire safety measures. Each category should then be checked to ensure that any provision from one category does not adversely affect the fire safety of the other occupancy types.

B.3.3 Glazing elements

In the event of fire, where an enclosure is required, appropriately classified glazed assemblies are capable of providing smoke resistance or fire resistance (i.e. integrity or integrity and insulation), according to classification. Where smoke resistance is required then the glass performance will need to be evaluated against the expected maximum smoke temperatures.

B.3.4 Connection of atrium to below-ground storeys

There is essentially little difference in the potential for fire and smoke spread between an atrium penetrating below ground level and an atrium that is wholly above ground, and it is not necessary to separate the below-ground sections of an atrium and its associated floor areas from the upper storeys by means of fire-resisting construction. No specific recommendations are made for atria connecting with below-ground storeys, but it should be ensured that protected escape routes and fire-fighting provisions are in accordance with the recommendations for the equivalent non-atrium building.

B.3.5 Use of atrium base

It is often not possible to provide effective sprinkler protection to combustibles on an atrium base. Therefore in situations where sprinkler protection is recommended but cannot be provided to the atrium base, the fire load should be controlled. This is achieved by limiting the combustible materials to isolated islands. If an effective automatic suppression system is provided, the fire load can be considered as a controlled fire load.

For detailed guidance regarding the control of fire loading on the atrium base, see **B.8**.

B.4 Means of escape

B.4.1 General

The inclusion of active and passive fire and smoke control systems within an atrium is intended to ensure that the means of escape provided remain available to occupants throughout the evacuation of the building in fire conditions.

It is essential, therefore, that the provision of means of escape follows established guidance, appropriate to the risk concerned, other than where specifically allowed for within this annex.

B.4.2 Escape routes

When evacuating a building the occupants have a natural tendency to leave via the same route by which they entered. In planning for escape it is normally desirable that the escape routes coincide with circulation routes. However, in a building containing an atrium this is not always feasible and might not be desirable if it requires travel close to the edge of an open atrium.

Occupants of a building generally need to have alternative directions of escape, and the circumstances where a single direction of travel is acceptable are limited. This principle, and others such as maximum distances of travel and capacities of exits, apply equally to a building containing an atrium as to one that does not. In circumstances where the atrium is not separated from the accommodation by fire-resisting construction, it is necessary to consider escape within and from the atrium, and escape from the associated areas, as an entity. It is particularly important to consider the effect the atrium might have on escape from upper storeys open to the atrium in view of the potential for a fire in the atrium to affect those storeys.

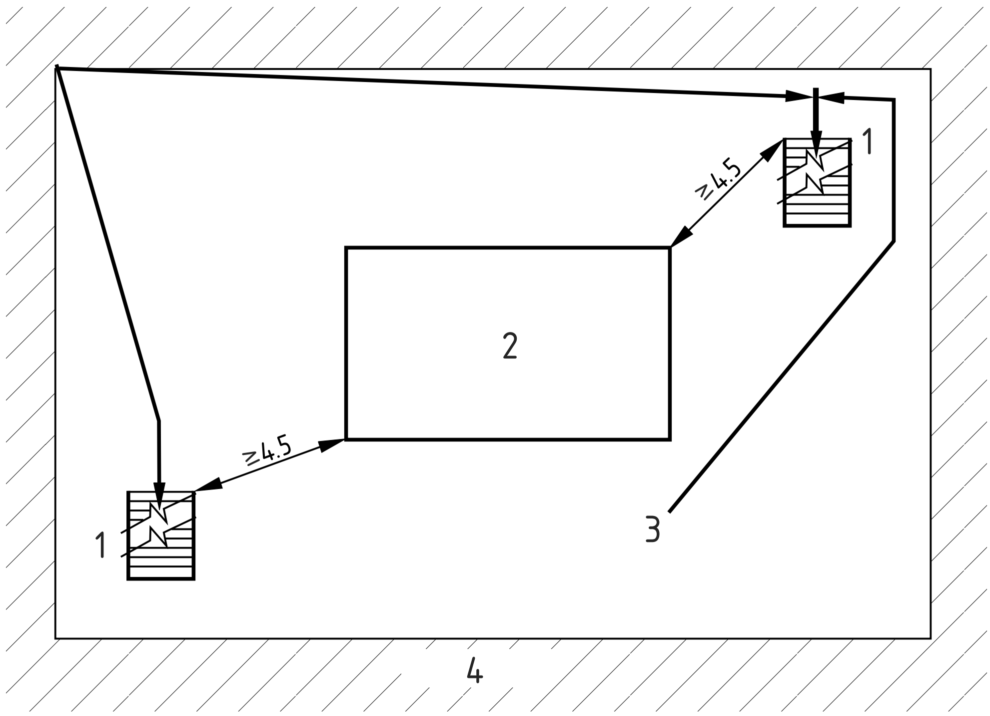
In a building where the accommodation is open to the atrium or not enclosed by smoke-retarding construction:

a) storey exits should be sited away from the atrium so that escape routes do not approach the atrium edge;

b) maximum travel distances from the atrium, together with the associated areas, to the nearest storey exit should not exceed the distances appropriate to the equivalent non-atrium building;

c) in category A and category B buildings, escape should be away from the atrium void and the subsequent escape route should not pass within 4.5 m of the atrium void (see Figure B.1).

Figure B.1 **Escape route on associated floor areas**



Key

1 Exit

2 Atrium void open or not enclosed by smoke-retarding construction

3 Escape away from atrium

4 Outer wall

B.4.3 Balcony escape

Escape via a balcony within the atrium space is acceptable without the need for an alternative protected escape route away from the atrium, provided that the balcony is protected from the effects of heat and smoke. Where there is an alternative protected escape route from the accommodation, these restrictions need not apply and open balcony escape routes are acceptable.

Where the means of escape is via a balcony within the atrium (i.e. where no alternative route from the accommodation is available):

a) the building should be equipped throughout with sprinklers (unless not required for the smoke control design);

b) escape within the atrium should be available in at least two directions with the travel distance within the atrium to the nearest storey exit not exceeding 18 m;

c) if the balcony is enclosed by smoke-retarding but not fire-resisting construction, a temperature control system should be provided;

d) if the balcony is open, a smoke exhaust ventilation system should be provided, such that any smoke layer is confined to a level not less than 3 m above the topmost balcony or bridge;

e) where the balcony is enclosed, fire-resisting and smoke-retarding construction should be to the same specifications to that of the atria;

f) the atrium base should only contain a controlled fire load.

B.4.4 Evacuation procedures

B.4.4.1 Simultaneous evacuation

Where there are open connections between storeys or the enclosure to an atrium is of non-smoke-retarding construction, it is unrealistic to expect the occupants to remain on an open storey for a prolonged time when there is a fire, even if sprinkler and smoke control systems are designed to maintain such storeys free from smoke and fire. Therefore, in view of the likely psychological response of the occupants to a fire threat, simultaneous evacuation should be used in most cases.

B.4.4.2 Phased evacuation

NOTE The appropriate degree of fire resistance is shown in the relevant decision tree in Annex C.

In high-rise buildings where the floor areas are separated from the atrium by smoke-retarding and fire-resisting enclosures, phased evacuation procedures may be adopted. Phased evacuation might also be acceptable in low-rise buildings when a smoke-retarding but non-fire-resisting enclosure is provided.

B.4.4.3 Evacuation phasing

NOTE Guidance on simultaneous and phased evacuation is given in ***12.3****.*

An atrium building may contain both areas subject to phased evacuation and areas subject to simultaneous evacuation. The most appropriate phasing of evacuation for any particular building needs to be determined on the basis of the mode of evacuation (phased, simultaneous or both), the nature of the occupants and the fire risk present.

B.4.5 Fire control centres

Although it is not a recommendation of this British Standard that a fire control centre is provided in all atrium buildings, because the need for such a facility will be determined generally by the complexity of the building and its associated building management systems, most atrium buildings are likely to contain some fire safety systems that might not be needed in an equivalent non-atrium building. Consequently, the provision of a fire control centre should be considered.

A fire control centre, however, is necessary for atrium buildings where a system of phased evacuation is proposed, to enable the fire and rescue service to assume control of an incident immediately on arrival.

B.5 Separation between the atrium and the associated floor area

B.5.1 General

In order to control the spread of fire and/or smoke, the construction separating the atrium and associated floor areas should be fire-resisting and/or smoke-retarding.

Smoke-retarding construction is only suitable when the smoke temperatures can be effectively controlled by the use of sprinklers and/or temperature control systems which will limit the growth of the fire.

B.5.2 Fire-resisting construction

Where the accommodation needs to be separated from the atrium by a fire-resisting construction, then either side of the construction should be capable of meeting the integrity criterion specified in BS 476-22 for a period of not less than 30 min, or the classification specified in the relevant part of BS EN 13501, unless otherwise recommended elsewhere in this annex.

B.5.3 Smoke-retarding construction

In many instances it is not necessary to enclose the atrium with fire-resisting construction. However, a smoke-retarding enclosure might be needed to prevent the early ingress of smoke to those levels that are not directly affected by fire. Some forms of construction which are fire-resisting (e.g. traditional roller shutters) would not be sufficiently impervious to smoke to be considered as smoke-retarding. Where smoke curtains are used, they should be in accordance with BS EN 12101-1.

In the absence of an appropriate method of test and performance criteria, such construction should not contain unsealed joints and permanently open or openable areas. Joints between such construction and any abutting element should be tight and preferably sealed with a filler conforming to BS EN 1366-3 or BS EN 1366-4 (e.g. plaster), a mastic, or a flexible strip (e.g. neoprene), as appropriate.

Any doors in an atrium, when tested in accordance with BS 476-31.1 with the threshold taped, and subjected to a pressure of 25 Pa, should have a leakage rate not exceeding 3 m^3/h per metre.

B.5.4 Glazing

B.5.4.1 General recommendations for overhead glazing

Overhead glazing should be designed to minimize the risk of injury due to falling glass. This generally requires the use of pvb (i.e. polyvinylbutyral) laminated safety glass on the inner pane facing into the atrium space. Relevant guidance on the limitations of other glass types is provided by BS 5516-2, as summarized below for fire safety purposes:

a) up to a height of 5 m above floor level

  1) single glazing: toughened glass, heat-soaked toughened glass, pvb laminate safety glass, or Georgian wired glass (i.e. with the wire mesh within the body of the glass);

  2) insulating glazed units: lower pane should be one of the above types. If the lower pane is either toughened or heat soaked toughened glass then the upper pane of the unit should also be one of the glass types given above;

b) at more than 5 m up to 13 m above floor level:

  1) single glazing: Georgian wired glass or a glazing including pvb laminated safety glass as the outer layer. Heat soaked toughened glass may be considered provided that the glass thickness is not more than 6 mm with a maximum pane size of 3 m^2;

  2) insulating glazed units: lower pane as given in b1). If the lower pane is toughened glass then the upper pane should also be according to b1);

c) at heights greater than 13 m above floor level:

  1) single glazing and the lower pane of insulating glass units: either Georgian wired glass or a glazing including pvb laminated safety glass as the inner pane.

B.5.4.2 Fire protection of glazed walls and the atrium roof

NOTE 1 The design solutions and exemplars in Annex C (Tables C.1 to C.3) can be used to determine the necessary fire resistance for vertical glazing of the atrium walls according to the risk profile and atrium height.

Glazed atrium walls and the atrium roof should conform to the following recommendations.

a) If one or more of the sides of the atrium form a vertical escape and access stair then the vertical glazing either side of the corner, for a distance of at least 3 m on both sides, should be a minimum of 30 min insulation and integrity for the full height of the atrium.

  NOTE 2 Higher performance classifications might be possible subject to risk profile; see Tables C.1 to C.3.

NOTE 3 Higher performance classifications might be possible subject to risk profile; see Tables C.1 to C.3.

b) When roof glazing is used in conjunction with a temperature control system which limits the temperature of hot gases and smoke in the atrium roof space, or when a smoke retarding construction is used to limit smoke contact with the roof in the absence of any temperature control system, then the overhead glazing should be either:

   1) part of a fire-resistant glazed system with a minimum 30 min integrity performance in a horizontal, or appropriate inclined, configuration (as classified in accordance with BS EN 13501-2 or as tested in accordance with BS 476-22); or

   2) Georgian wired or toughened glass (e.g. soda-lime-silica glass conforming to BS EN 12150-1 or BS EN 14179-1) that conforms to BS 7346-3 (smoke curtains), provided that the toughened glass can demonstrate conformity without failure when tested in a framed system for overhead glazing; or

   3) pvb laminated safety glass (conforming to BS EN ISO 12543-2), provided that the anticipated temperature of any hot gas or smoke likely to be in contact with the laminate glass layer, as demonstrated by design modelling, is no greater than 300 °C.

   When there is no temperature control system, nor smoke retarding construction, then the roof glazing should be part of a classified minimum 30 min integrity fire-resisting glazed system combined with a smoke retarding construction and fire-resisting glazing classified for at least 30 min integrity for the internal vertical glazed walls of the atrium.

*NOTE 4 For risk profiles A4, B4 and C4, see **6.4** and Table 4.*

c) Any façade glazing outside and above the atrium should be part of a fire-resisting glazed system for a distance of at least two floors above the atrium roof, with a minimum classification of 30 min integrity for risk profiles A1, A2, A3, B1 and B2, and a minimum of 30 min insulation with integrity for risk profiles B3, C1, C2 and C3.

B.6 Smoke and heat control systems

B.6.1 General

Smoke control systems are designed to move or control the smoke and fire effluent in a pre-determined manner in order that their threat to life can be minimized. Smoke control can be achieved in a number of different ways:

a) a smoke exhaust ventilation system, of which it is possible to identify two different types:

   1) to establish a stable smoke layer providing clear air to enable safe escape of the occupants;

   2) to dilute the smoke in order to maintain tenable conditions.

b) a smoke clearance system, to assist fire-fighters in removing smoke from the building in the aftermath of a fire;

c) a temperature control system, which reduces fire gas temperatures in the smoke layer formed within the atrium to permit the use of materials in the atrium façade which are not fire-resisting;

d) a pressure differential system, of which it is possible to identify the following types.

   1) *Atrium pressurization*. Where there is no appreciable fire-load in the atrium, and all storeys are separated from the atrium by fire-resisting construction, the atrium can be regarded as being fully analogous to a protected stairway and can be pressurized in a similar way relative to the accommodation to prevent ingress of smoke into the atrium from any storey.

   2) *Pressurization of the associated floor areas*. Where there is a sprinklered or controlled fire load in the atrium base, smoky gas can fill all or part of the atrium. Where storeys are separated from the atrium by fire-resisting construction and are also sprinklered, and where there is no smoke exhaust ventilation from the atrium, the adjacent accommodation spaces (and/or any stairwells or shafts communicating via doors into the atrium) may be pressurized relative to that atrium.

   3) *Atrium depressurization*. Where there is a controlled fire load in the atrium base, and where some or all higher storeys are separated from the atrium by fire-resisting construction, and where there is smoke exhaust ventilation for the atrium, it might be feasible to reduce the pressures in the atrium sufficiently to prevent smoke entering adjacent spaces through leakage paths.

HVAC ductwork used in conjunction with a smoke control system presents a risk in that inlet air and exhaust air could spread any smoke and fire within the atrium building. Careful consideration, therefore, needs to be given to fire protection, integrity of construction and routeing of ductwork used for smoke and heat control systems.

B.6.2 Calculation procedures

NOTE Guidance on calculation procedures for the design of smoke and heat control systems can be found in a number of documents, e.g. BS 7346, BRE Report 368 and CIBSE Guide E [37].

It is important that designers establish that the calculation procedures used are relevant to the circumstances in which they are intended to be used. The procedures and calculations should be fully documented.

B.6.3 Smoke exhaust ventilation systems

A smoke exhaust ventilation system for an atrium should:

a) maintain a clean layer of not less than 3 m above the topmost open occupied storey, or 2.5 m above the floor of fire origin;

b) ensure that the smoke layer temperature does not exceed 200 °C;

c) ensure that, where the smoke layer descends below closed storeys, smoke cannot leak into these floors; and, where applicable, ensure by dilution, that the optical density per metre will not exceed 0.1 at all points on the topmost storey open to the atrium. This measure is intended to ensure that visibility on the open storeys does not reduce below 8 m to 10 m, which is deemed adequate for safe use of the escape routes.

B.6.4 Temperature control systems

*NOTE It is possible, by careful design, to combine a temperature control system of this type with a smoke exhaust ventilation system meeting the recommendations of **B.6.3** (for example, so that storeys below the design layer base can be open to the atrium).*

The designer of the smoke control system should identify the materials on the atrium façade having the lowest critical temperature for failure, and which, upon failure, would allow the integrity of the atrium façade to be breached. The guidance given in **B.5.4** on the behaviour of different types of glasses should be followed.

B.6.5 Pressure differential system

The three different options for designing pressure differential systems are identified in **B.6.1**d). The following recommendations apply to one or more of the options. Following each recommendation, the option(s) to which it applies is identified.

a) The building should be protected with a sprinkler system designed and installed in accordance with the life safety provisions of BS EN 12845 (new systems) or BS 5306-2 (existing systems), except where the atrium is less than 30 m high, the atrium is separated from the associated areas by fire-resisting construction, and there is a pressure differential system protecting the associated areas from smoke in the atrium and the fire safety engineering design solutions do not require the presence of sprinklers.

   This recommendation applies to atrium pressurization, atrium depressurization and pressurization of associated floor areas.

b) Where the atrium might contain smoke, and it is desired to pressurize adjacent accommodation storeys and/or stairwells and/or shafts, the height of the neutral pressure plane in the atrium should be assessed by calculation (see BS 7346-4), allowing for normal building leakage.

   This recommendation applies to atrium pressurization, atrium depressurization and pressurization of associated floor areas.

c) The minimum design pressure difference across a closed door (or other leakage path) between an atrium and an adjacent pressurized space should be 50 Pa for heights up to 10 m above the neutral pressure plane, and 75 Pa for heights between 10 m and 25 m above the neutral pressure plane.

d) Any part of the enclosure separating the atrium from the associated storey areas, which is more than 25 m above the calculated neutral pressure plane, should be of smoke-retarding construction as well as having a fire resistance of not less than 30 min, irrespective of any other requirements.

   The two recommendations c) and d) apply to pressurization of associated floor areas.

e) Where there is no combustible content in the atrium and the adjacent spaces are separated from the atrium by a fire-resisting construction, smoke ingress into the atrium can be prevented by pressurizing the atrium on the same basis as if it were a pressurized stairwell, in accordance with the relevant sections in BS EN 12101-6.

   This recommendation applies to atrium pressurization.

f) Where smoke exhaust is used to reduce the pressure in an atrium containing thermally-buoyant smoky gases, the design objective should be to raise the neutral pressure plane above the highest vulnerable leakage path, allowing for external wind pressures explicitly in the design calculation.

This recommendation applies to atrium pressurization and atrium depressurization.

B.7 Fire alarm and warning systems

In all atrium buildings where significant numbers of the public are likely to be present or where phased evacuation is adopted, the provision of a voice alarm system is recommended (except in premises providing medical or nursing care), together with warnings provided in alternative formats.

Fire alarms in most smaller atrium buildings are best operated in a "single stage" mode in which the actuation of a call point or detector gives an instantaneous warning from all fire alarm sounders for an immediate evacuation.

It is possible that smoke from a fire in an unoccupied area could spread via the atrium and rapidly hazard the escape from other levels within the building. Therefore, to ensure safety throughout an atrium building, a comprehensive automatic fire detection and alarm system should be installed.

B.8 Controlling fire load on the atrium base

B.8.1 General

Where it is necessary to control the fire load within the atrium:

a) if the total weight of combustibles on the atrium base exceeds 160 kg, the materials should be confined to isolated islands;

b) each island should:

    1) contain a maximum of 160 kg of combustible material;

    2) cover a maximum floor area of 10 m^2;

    3) be separated from other areas of combustible materials by at least 4 m (except where those areas are protected by a sprinkler system);

c) all wall and ceiling linings should have at least a Class 1 surface spread of flame when tested in accordance with BS 476-7;

d) when tested in accordance with BS 5852, all upholstered furniture should resist ignition by the smouldering source (ignition source 0) and the flaming source (ignition source 5);

NOTE 1 Attention is drawn to the provisions of the Furniture and Furnishings (Fire) (Safety) Regulations 1988 [77] in respect of filling materials.

e) all textiles (drapes and curtains) should meet the requirements of BS 5867-2.

NOTE 2 For further guidance see BS 5852, BS 7176, BS EN 1021-1 and BS EN 1021-2.

B.8.2 Sprinkler protection to atrium base

Where this British Standard recommends sprinkler protection to an atrium base, the objective is to limit the heat output of the fire to 2.5 MW convective heat flux.

Sprinklers should be designed and installed in accordance with BS EN 12845 (new systems) or BS EN 5306-2 (existing systems). In atria, the effectiveness of sprinklers will diminish with their height above the atrium base. The design and installation should take this into account to ensure that they are capable of achieving the control of the design sized fire at the relevant sprinkler height.

B.9 Restricting the spread of fire to adjacent sites

If the atrium building is sprinklered, the area of fire involvement will be reduced to such an extent that the potential for fire spread to adjacent buildings can be regarded as being comparable to that of an equivalent non-atrium building that is compartmented at each level and protected by a sprinkler system.

In an unsprinklered atrium building, space separation needs to be calculated on the basis that all storeys not separated from the atrium by fire-resisting construction (capable of meeting the integrity criteria of BS 476-22 for at least 30 min) could be involved in the fire.

NOTE If more than one storey is likely to be involved in a fire, a larger radiating area can be expected and hence a greater separation distance (or reduction in unprotected areas) is normally needed.

B.10 Smoke clearance for fire-fighting

B.10.1 General

The fire and rescue service might need to release smoke and heat from a building after the fire has been suppressed. Ventilation for this purpose is usually obtained by opening windows to provide cross ventilation and smoke clearance. In an atrium building, the spread of smoke to a number of storeys can make it more difficult to open windows on every storey affected by smoke. In such circumstances, a mechanical or natural ventilating system capable of clearing the smoke from the atrium and the affected floor area should be provided.

Where a smoke control system is provided for means of escape purposes, it is not generally necessary to provide additional facilities specifically for the fire and rescue service. However, where such a system is not provided, the provision of smoke clearance facilities for operation by the fire and rescue service is recommended.

Stand-alone manual override facilities should be provided that will afford the fire and rescue service direct control of the smoke control and normal ventilation systems within the building.

B.10.2 Atria not exceeding 18 m in height

Natural exhaust vents should be provided in the atrium roof. The total area of vents should be not less than 10% of the maximum plan area of the atrium.

B.10.3 Atria of any height

A mechanical smoke ventilation system should be provided within the atrium to provide replacement air changes every hour based upon the total volume of the atrium, including the largest floor open to the atrium with an inlet at low level, as follows:

a) four air changes per hour in sprinklered buildings where the atrium base has a controlled fire load (see **B.8**);

b) six air changes per hour in unsprinklered buildings.

B.10.4 Ventilation and smoke controls for the fire and rescue service

In order to assist the fire and rescue service in rescue, fire-fighting and clearance of smoke after the fire has been extinguished, it has become normal practice to provide switches at suitable locations by which fire and rescue service or other authorized personnel can override the operation of smoke exhaust fans and ventilators and alter the configuration of the normal air handling system. Careful consideration should be given as to the extent of such provisions.

Annex C (informative) Design solutions and exemplars for atria

C.1 General

NOTE Recommendations for the design of atrium buildings are given in Annex B.

This annex gives a range of design solutions for atrium buildings in occupancy characteristics A, B and C.

The annex employs a decision tree process which takes the user through a series of questions for determining the appropriate design solutions. Following each decision tree is a table which identifies a number of solutions for each category. The tables do not identify the complete range of solutions determined by the decision trees and are not intended to be used in place of the decision trees.

The overall decision process is illustrated in Figure C.1. Processes for specific occupancy characteristics are given in **C.2** to **C.4**.

Each decision tree comprises essentially two elements: a fundamental question and a series of suggested solutions. Each decision tree process is structured to follow, where possible, a common pattern related to the technical issues that need to be considered. These are:

a) consideration of the appropriate evacuation procedure;

b) the type of fire alarm/automatic fire detection system to be provided;

c) the type of separation between the atrium and the remainder of the accommodation;

d) the type of smoke control system to be provided;

e) the use of the atrium base; and

f) the provision of automatic suppression systems.

In employing the decision tree process, the user is expected to strictly follow the line of decisions and resulting solutions given, and not to pick solutions from branches of the tree that are not part of the decision process.

C.2 Occupancy characteristic A

The decision processes for occupancy characteristic A (occupants who are awake and, predominantly, are familiar with the building) are illustrated in Figures C.1 to C.6 and Table C.1. The corresponding exemplars are illustrated in Figures C.7 to C.16.

Figure C.1a **Occupancy characteristic decision process – Initial decisions**

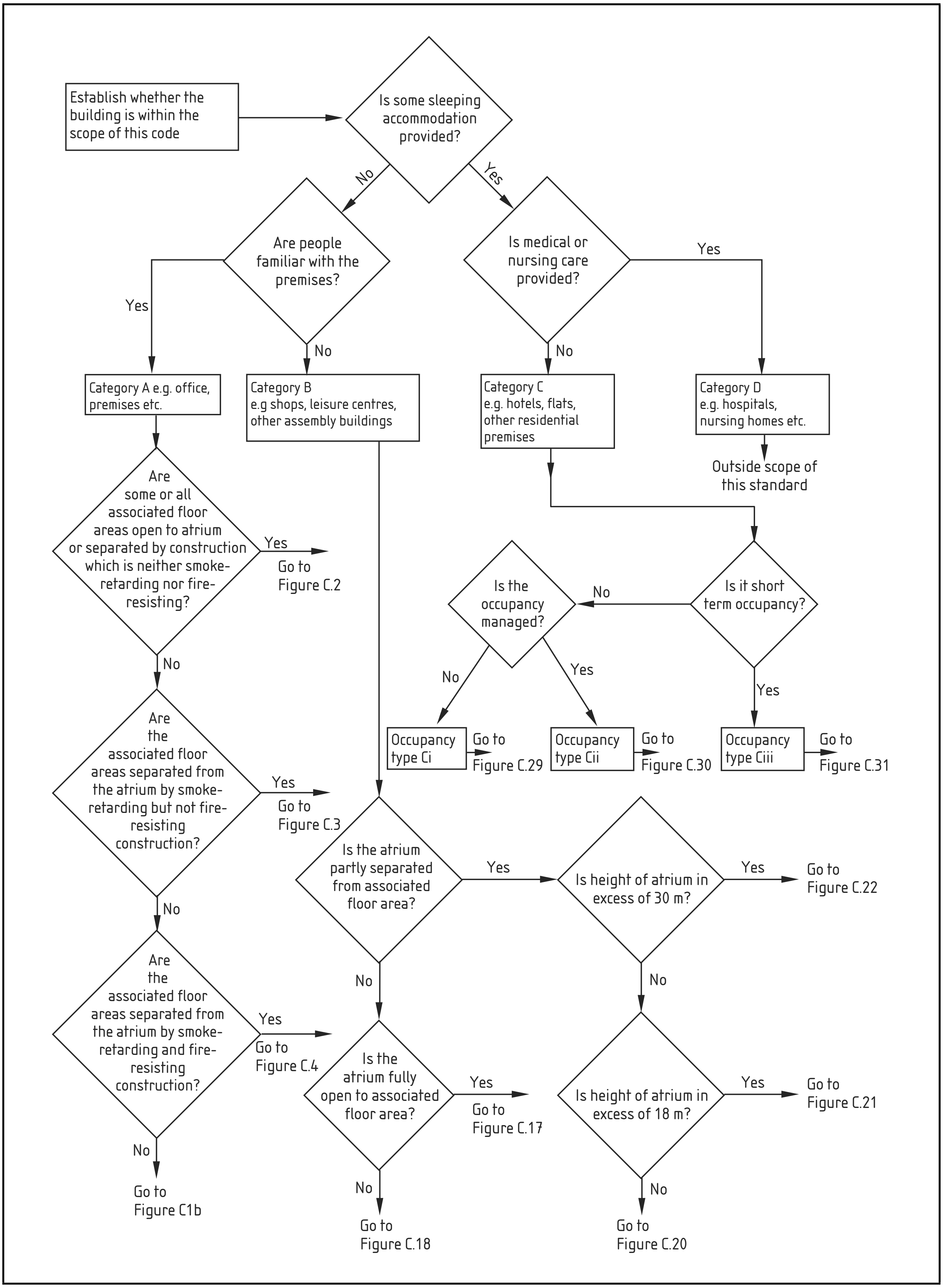


Figure C.1b **Occupancy characteristic decision process – Initial decisions** *(continued)*

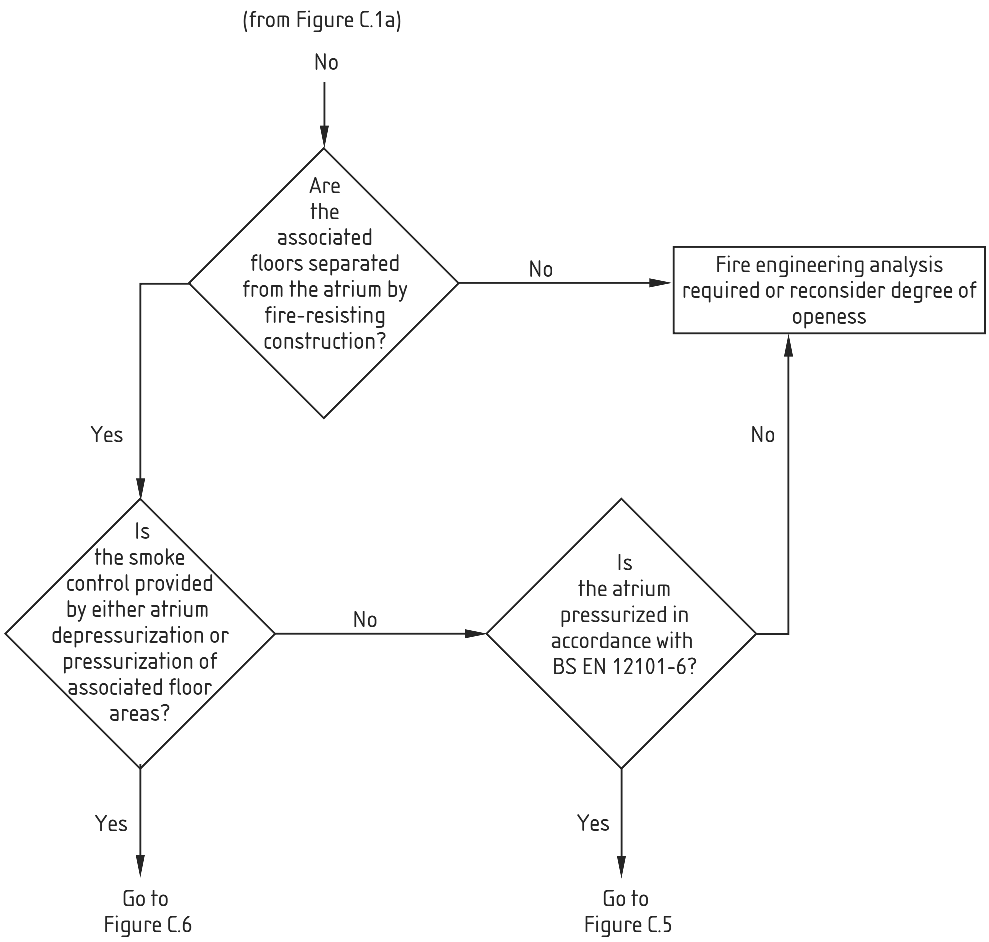


Figure C.2 **Occupancy characteristic decision process – Occupancy characteristic A – Atrium partially or fully open**

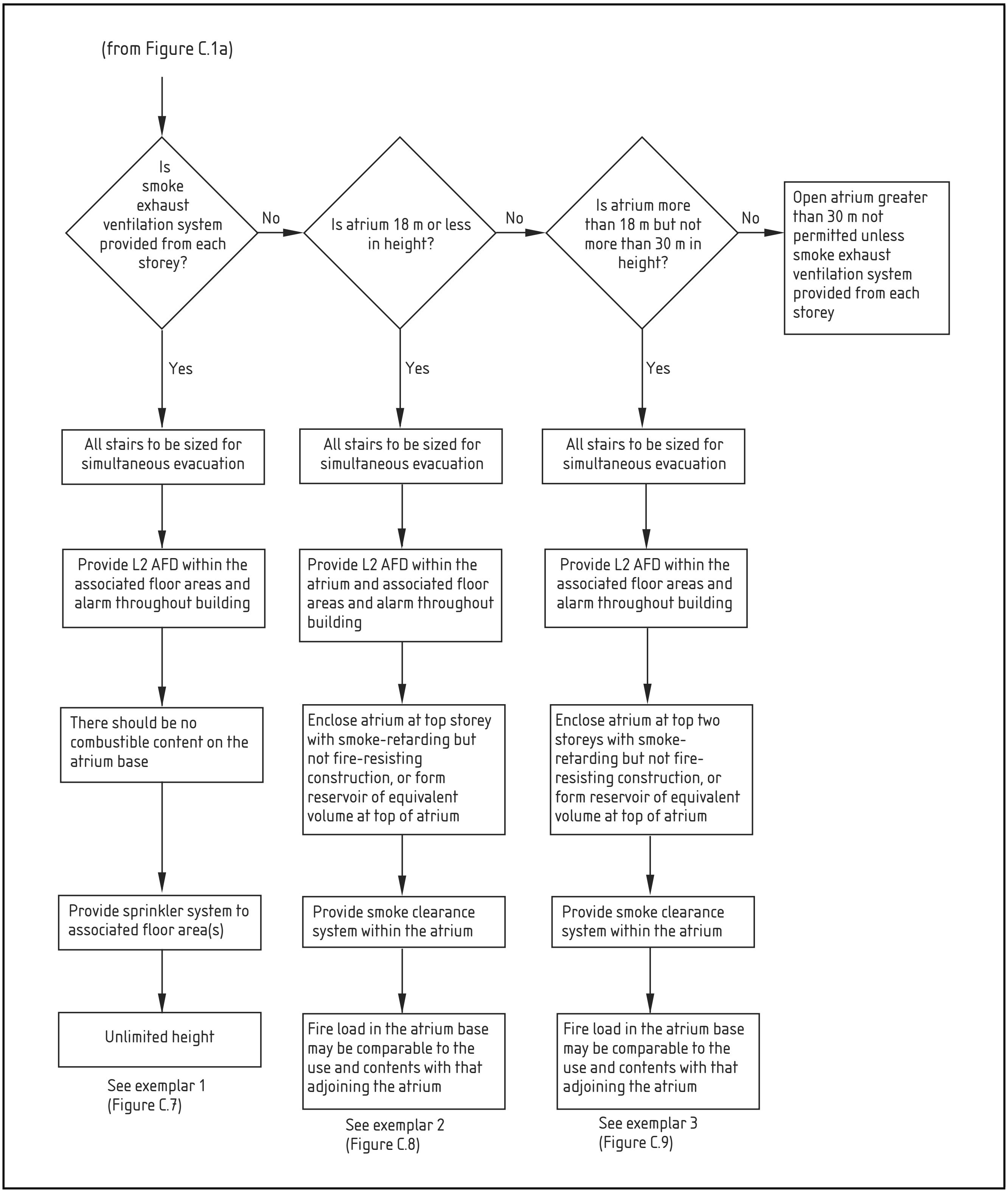


Figure C.3 **Occupancy characteristic decision process – Occupancy characteristic A – Atrium enclosed with smoke-retarding construction**

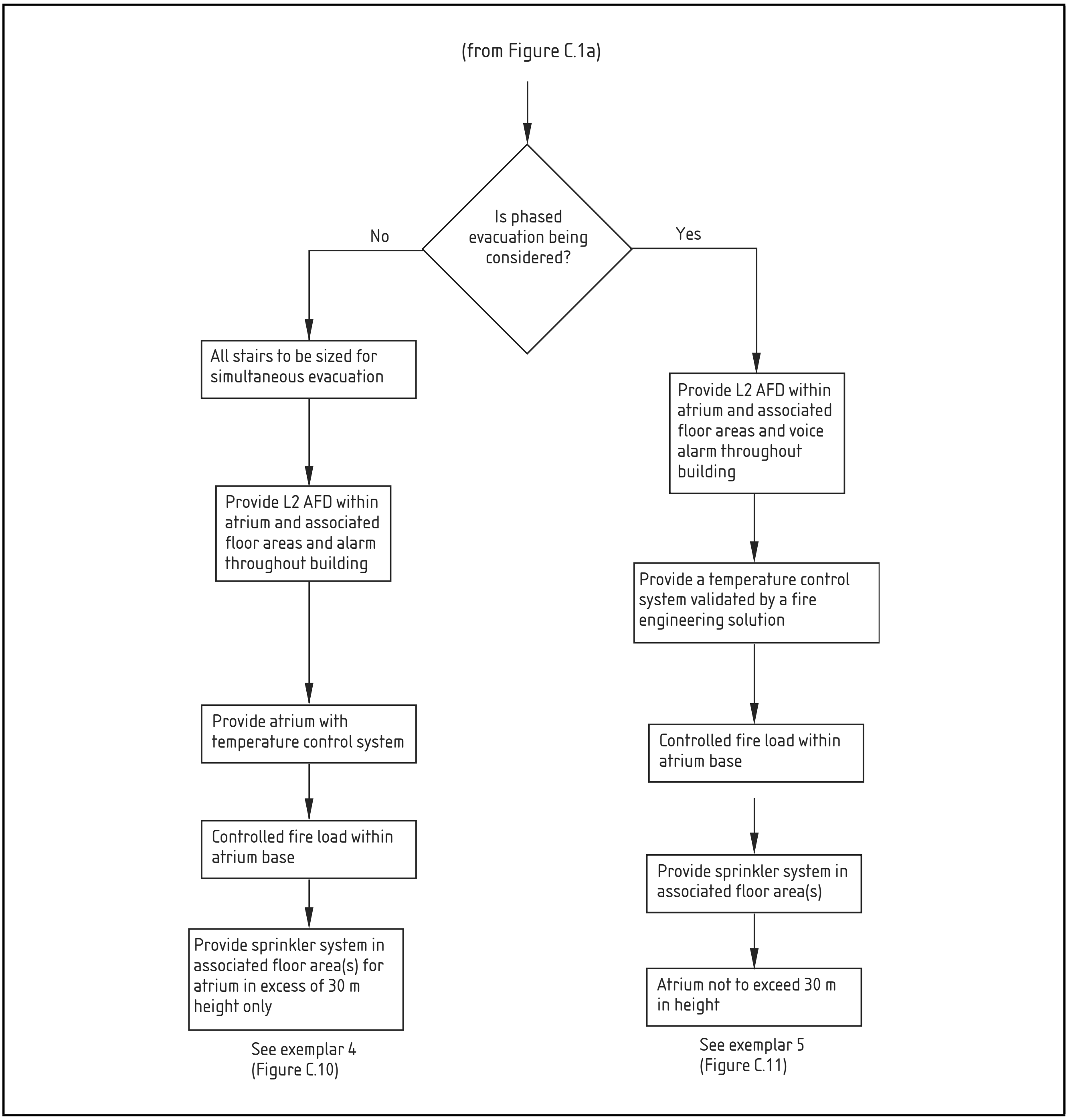


Figure C.4 **Occupancy characteristic decision process – Occupancy characteristic A – Atrium enclosed with smoke-retarding and fire-resisting construction**

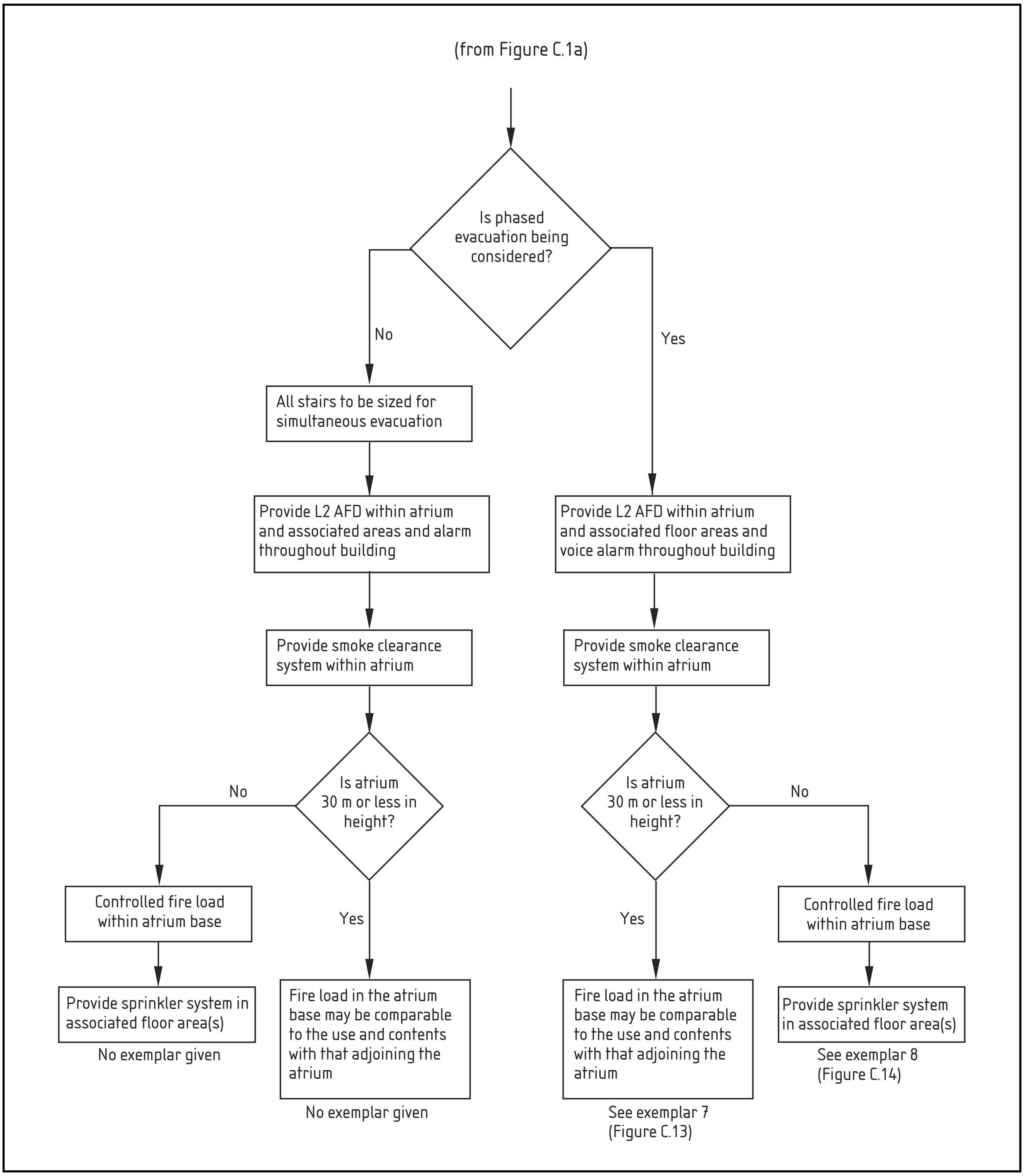


Figure C.5 Occupancy characteristic decision process – Occupancy characteristic A – Atrium enclosed with fire-resisting construction and using pressurization

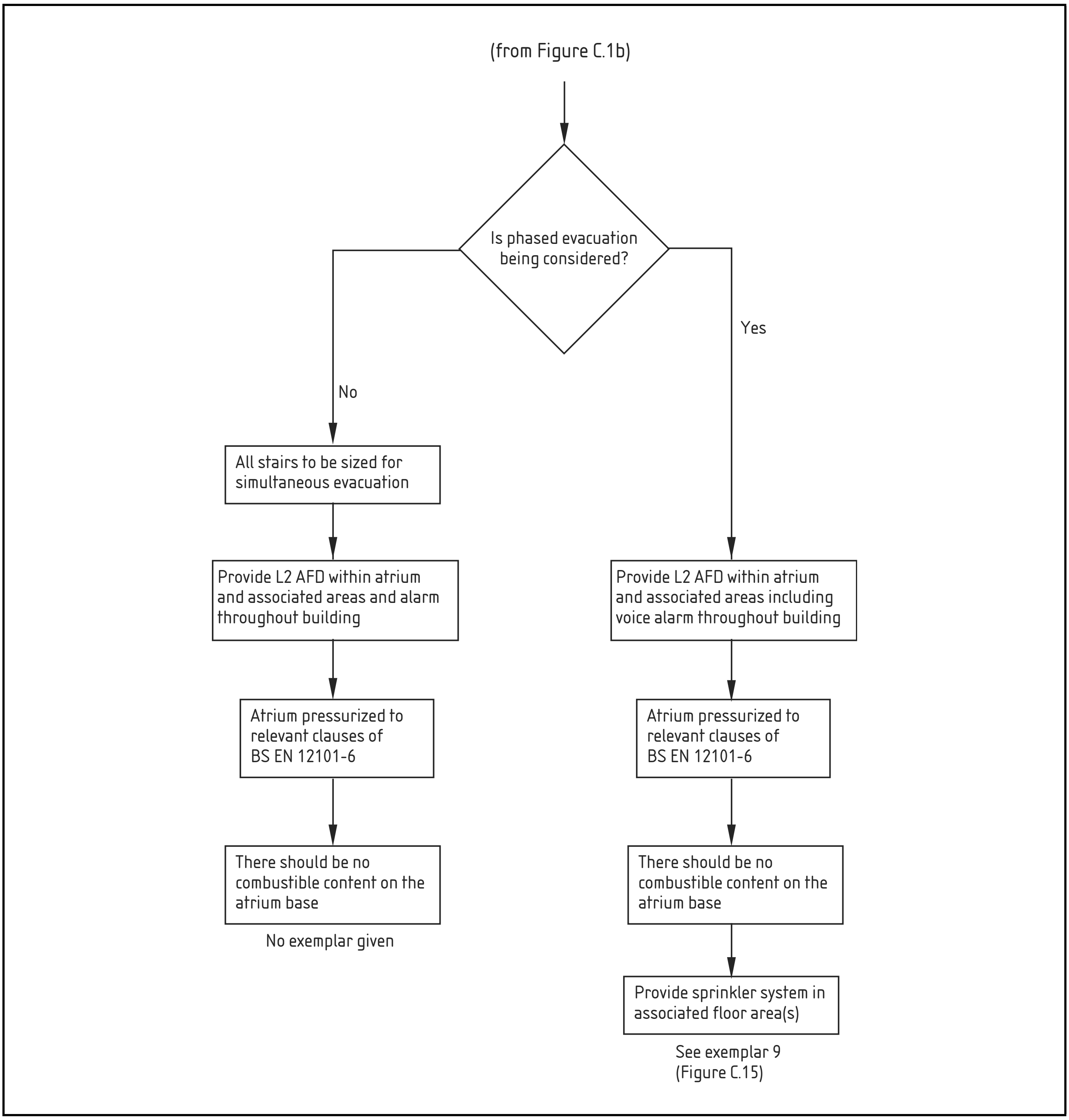


Figure C.6 **Occupancy characteristic decision process – Occupancy characteristic A – Atrium enclosed with fire-resisting construction and using pressure differential smoke control**

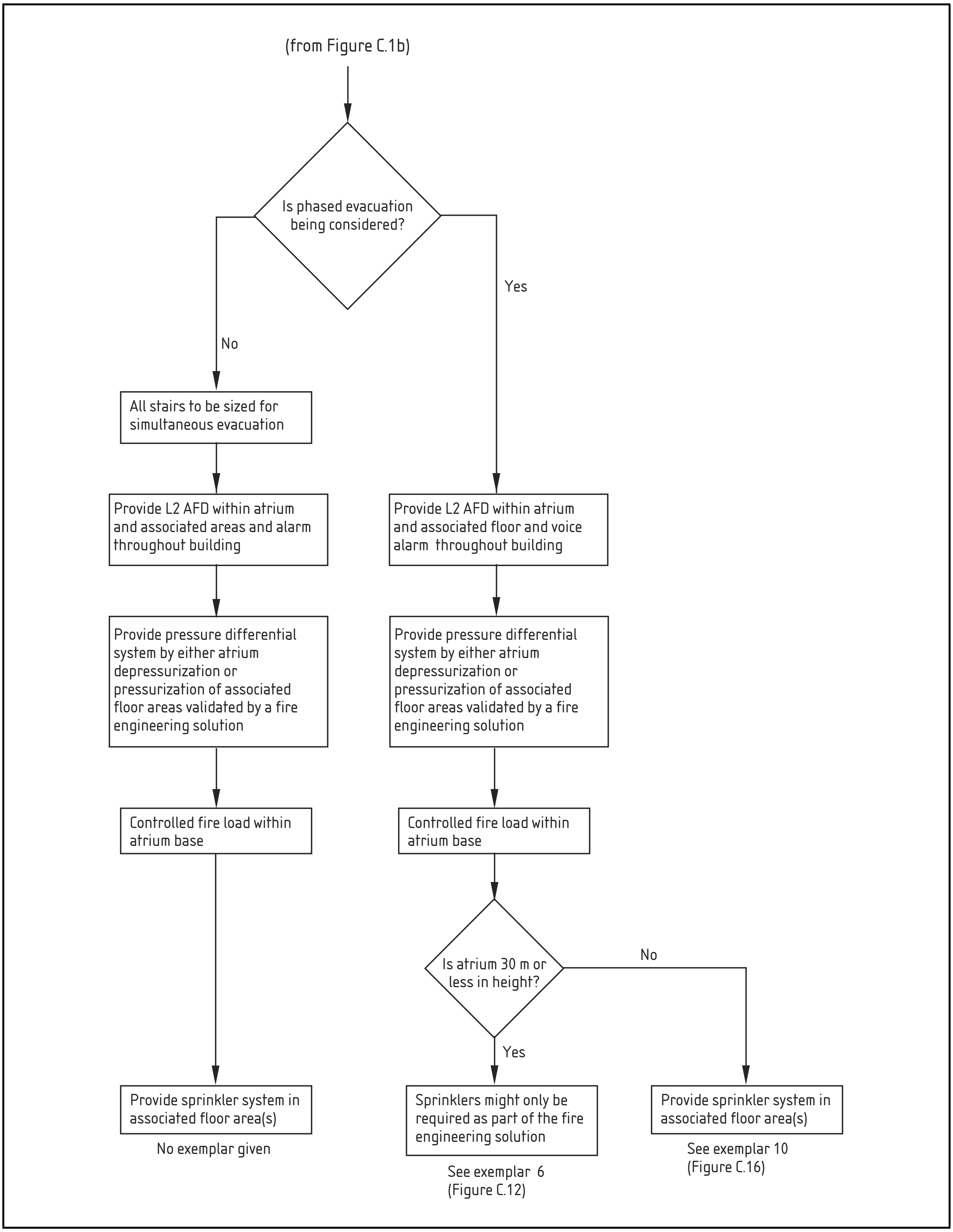


Table C.1 **Possible solutions – Occupancy characteristic A**

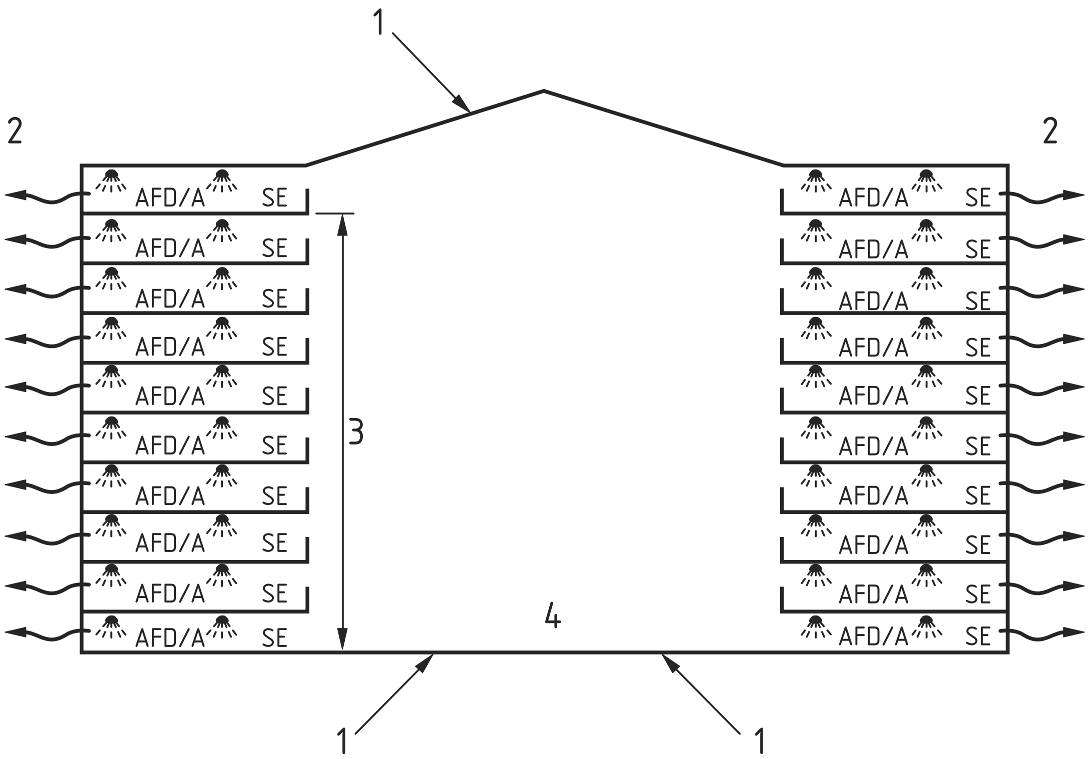
Atrium height m	**Atrium/accommodation method of separation**	**Smoke control system**	**Associated areas sprinkler system**	**Fire alarm and warning system**	**Use of atrium base**	**Reference/notes**	**Exemplar/ figure**
Evacuation strategy: simultaneous							
⩽18 [A)]	Enclosed or open: + reservoir – see Note 1	Smoke clearance	No	Provide L2 AFD [B)] within atrium and associated areas and alarm system throughout	Use and contents comparable with that adjoining the atrium	Note 1. Enclose top storey with smoke retarding but not fire-resisting construction or form reservoir of equivalent volume at top of atrium	Exemplar 2 (Figure C.8)
>18⩽30	Enclosed or open: + reservoir – see Note 2	Smoke clearance	No	Provide L2 AFD [B)] within atrium and associated areas and alarm system throughout	Use and contents comparable with that adjoining the atrium	Note 2. Enclose the two top storeys with smoke-retarding but not fire-resisting construction or form reservoir of equivalent volume at top of atrium	Exemplar 3 (Figure C.9)
>30	Open	Smoke exhaust per storey	Yes	Provide L2 AFD [B)] within atrium and associated areas and alarm system throughout	No combustible content		Exemplar 1 (Figure C.7)
	Enclosed: smoke-retarding	Temperature control	Yes	Provide L2 AFD [B)] within atrium and associated areas and alarm system throughout	Controlled fire load		Exemplar 4 (Figure C.10)

Table C.1 **Possible solutions – Occupancy characteristic A** (*continued*)

Atrium height m	**Atrium/accommodation method of separation**	**Smoke control system**	**Associated areas sprinkler system**	**Fire alarm and warning system**	**Use of atrium base**	**Reference/notes**	**Exemplar/ figure**
Evacuation strategy: phased							
⩽30	Enclosed: smoke-retarding	Temperature control	Yes	Provide L2 AFD [B] to atrium and associated areas, including voice alarm throughout	Controlled fire load		Exemplar 5 (Figure C.11)
	Enclosed: fire resistance 30 min integrity and smoke-retarding	Smoke clearance	No	Provide L2 AFD [B] to atrium and associated areas, including voice alarm throughout	Use and contents comparable with that adjoining the atrium		Exemplar 7 (Figure C.13)
	Enclosed: fire resistance 30 min integrity	Pressure differential system: see Note 3	No [C]	Provide L2 AFD [B] to atrium and associated areas, including voice alarm throughout	Controlled fire load	Note 3. Provide fire engineering solution by either atrium depressurization or pressurization of associated floor areas	Exemplar 6 (Figure C.12)
>30	Enclosed: fire resistance 30 min integrity and pressure differential system	Pressure differential system: see Note 4	Yes	Provide L2 AFD [B] to atrium and associated areas, including voice alarm throughout	Controlled fire load	Note 4. Provide fire engineering solution by either atrium depressurization or pressurization of associated floor areas	Exemplar 10 (Figure C.16)
	Enclosed: fire resistance 30 min integrity and smoke-retarding	Smoke clearance	Yes	Provide L2 AFD [B] to atrium and associated areas, including voice alarm throughout	Controlled fire load		Exemplar 8 (Figure C.14)
	Enclosed: fire resistance 30 min integrity and pressure differential system	Pressure differential system: see Note 5	Yes	Provide L2 AFD [B] to atrium and associated areas, including voice alarm throughout	No combustible content	Note 5. Atrium pressurization by applying all relevant clauses of BS EN 12101-6	Exemplar 9 (Figure C.15)

A) This table is not applicable for buildings of two storeys.
B) L2 AFD = Automatic fire protection system type L2 (see BS 5839-1:2002+A2:2008).
C) Sprinklers might be needed as part of a fire engineering solution.

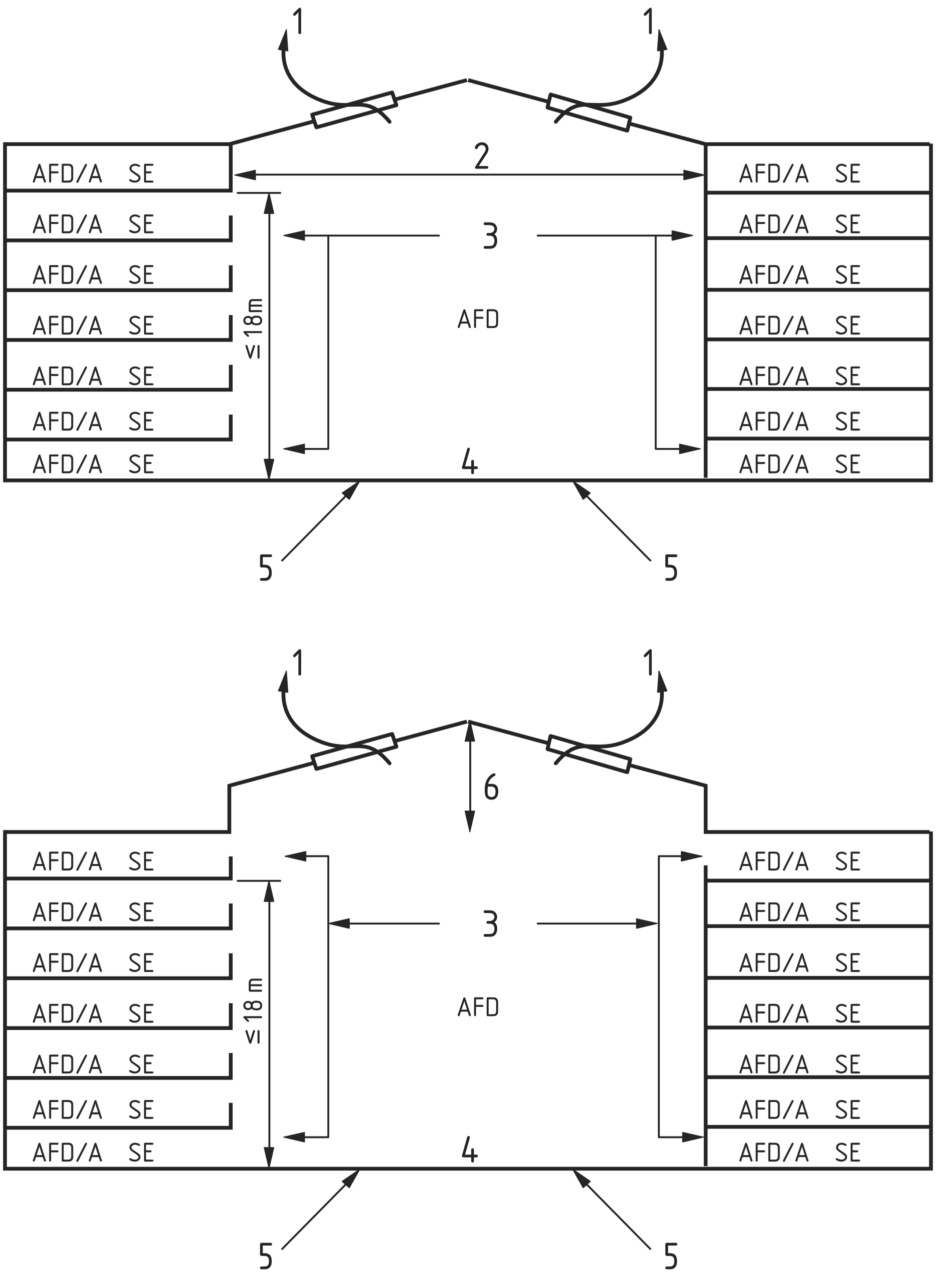
Figure C.7 **Exemplar 1 – Occupancy characteristic A – Greater than 30 m, simultaneous evacuation**



Key

1 Make-up air
2 Smoke exhaust per storey
3 Unlimited height
4 Atrium base: no combustible content
AFD/A L2 automatic fire detection within associated floor area and fire alarm throughout the building
SE Simultaneous evacuation
Sprinkler protection

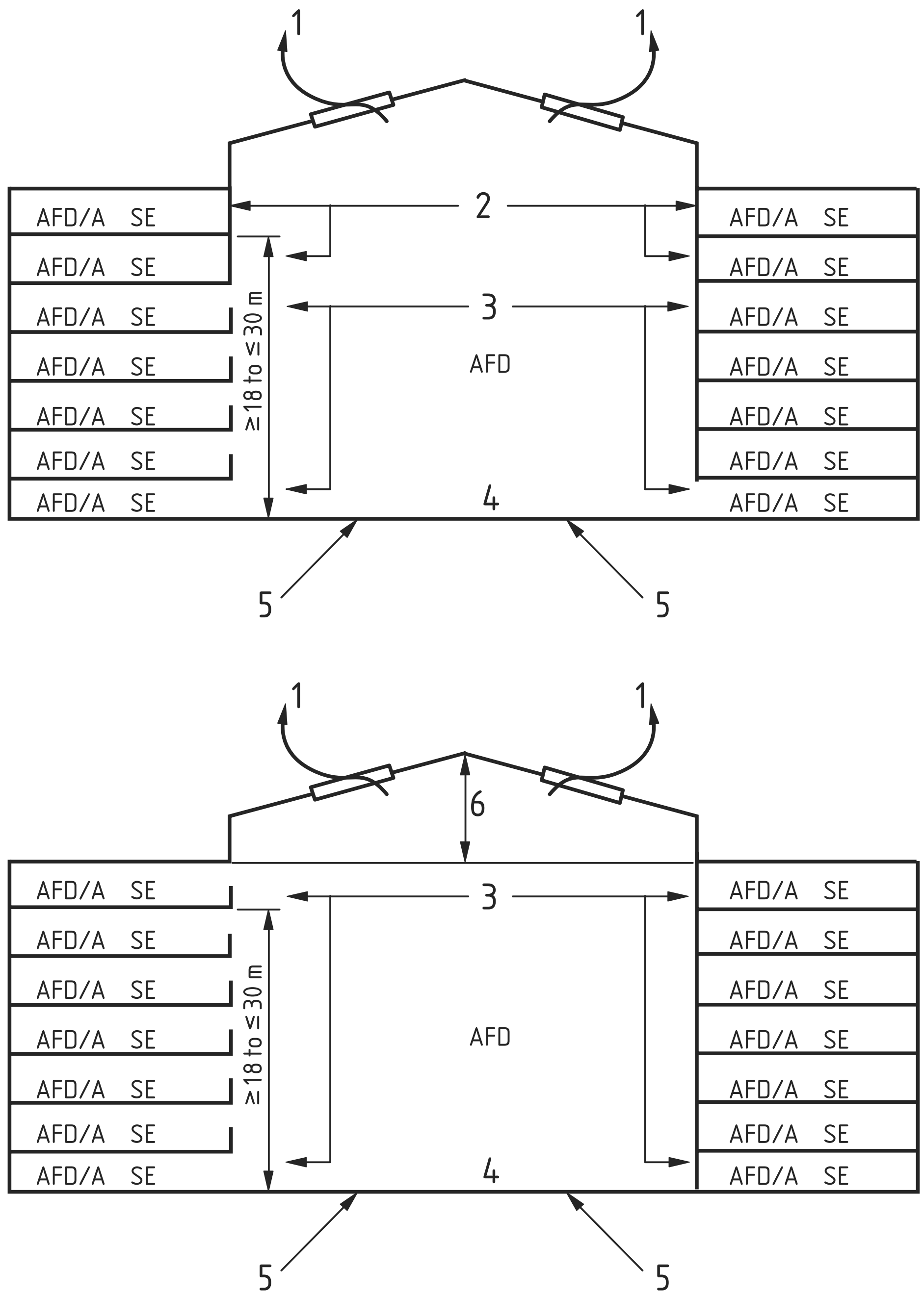
Figure C.8 **Exemplar 2 – Occupancy characteristic A – Open or enclosed, simultaneous evacuation, 18 m or less in height**



Key

1	Smoke clearance system
2	Smoke-retarding enclosure but not fire-resisting
3	Open or enclosed
4	Atrium base: use and contents comparable with that adjoining the atrium
5	Make-up air
6	Smoke reservoir
AFD	Automatic fire detection connected to the building fire alarm system
AFD/A	Automatic fire detection within the atrium and associated floor areas and alarm throughout the building
SE	Simultaneous evacuation

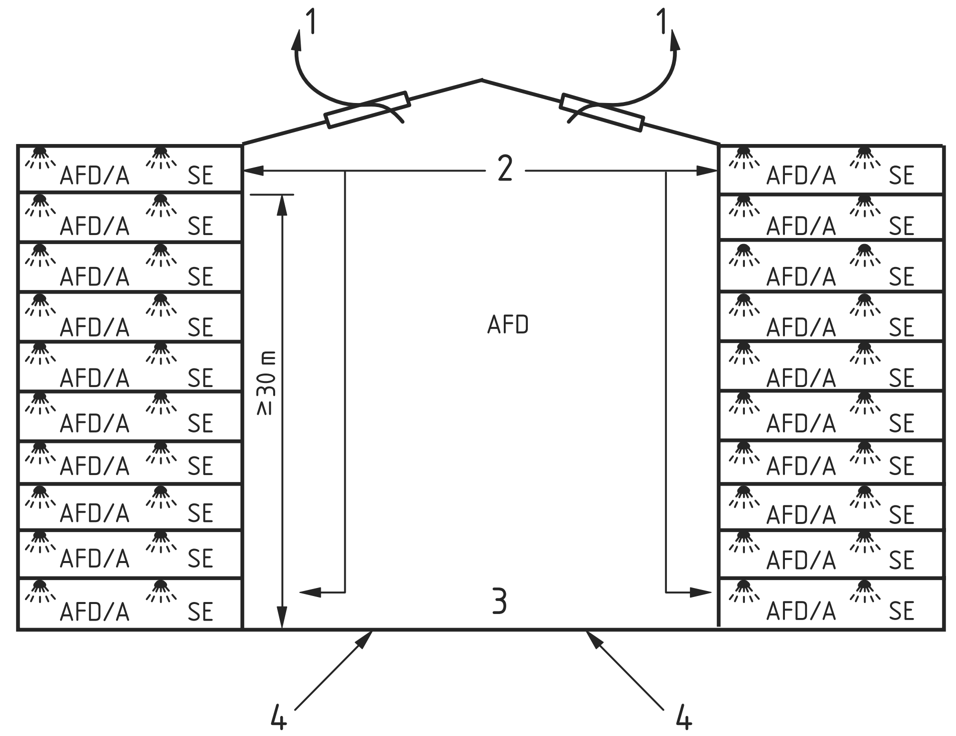
Figure C.9 **Exemplar 3 – Occupancy characteristic A – Open or enclosed, simultaneous evacuation, more than 18 m but not more than 30 m in height**



Key

1	Smoke clearance system
2	Smoke-retarding enclosure but not fire-resisting
3	Open or enclosed
4	Atrium base: use and contents comparable with that adjoining the atrium
5	Make-up air
6	Smoke reservoir
AFD	Automatic fire detection connected to the building fire alarm system
AFD/A	Automatic fire detection and alarm throughout the building
SE	Simultaneous evacuation

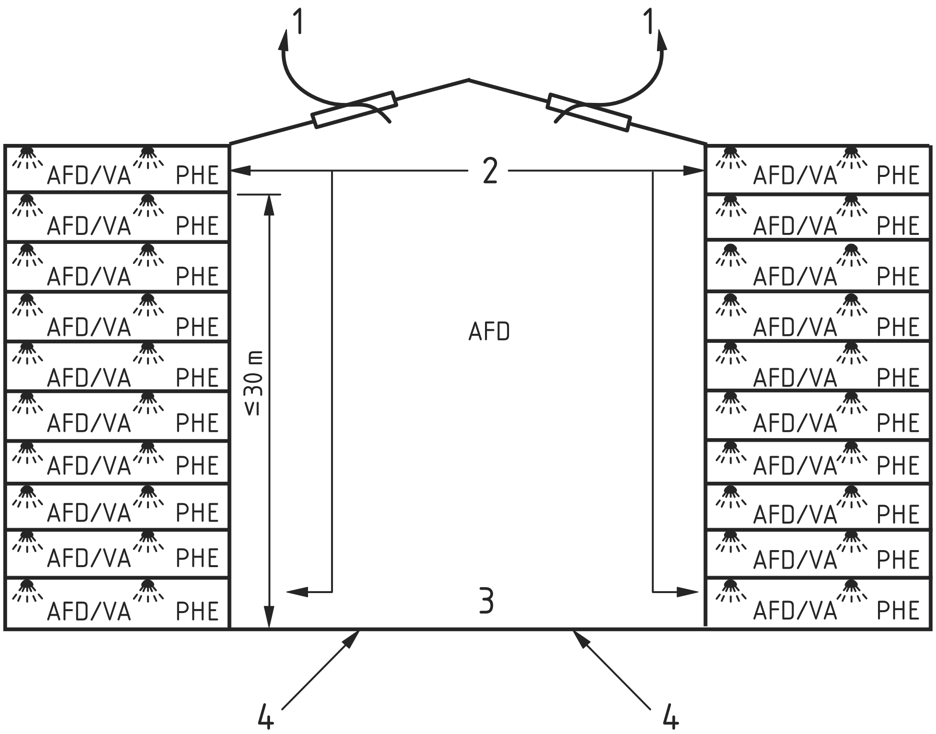
Figure C.10 **Exemplar 4 – Occupancy characteristic A – Greater than 30 m, simultaneous evacuation**



Key

1	Temperature control system
2	Enclosed smoke-retarding construction
3	Atrium base: controlled fire load
4	Make-up air
AFD	Automatic fire detection connected to the building fire alarm system
AFD/A	L2 automatic fire detection within the atrium and associated areas and alarm throughout the building
SE	Simultaneous evacuation
(sprinkler symbol)	Automatic sprinkler protection

Figure C.11 **Exemplar 5 – Occupancy characteristic A – Enclosed 30 m or less in height, phased evacuation**

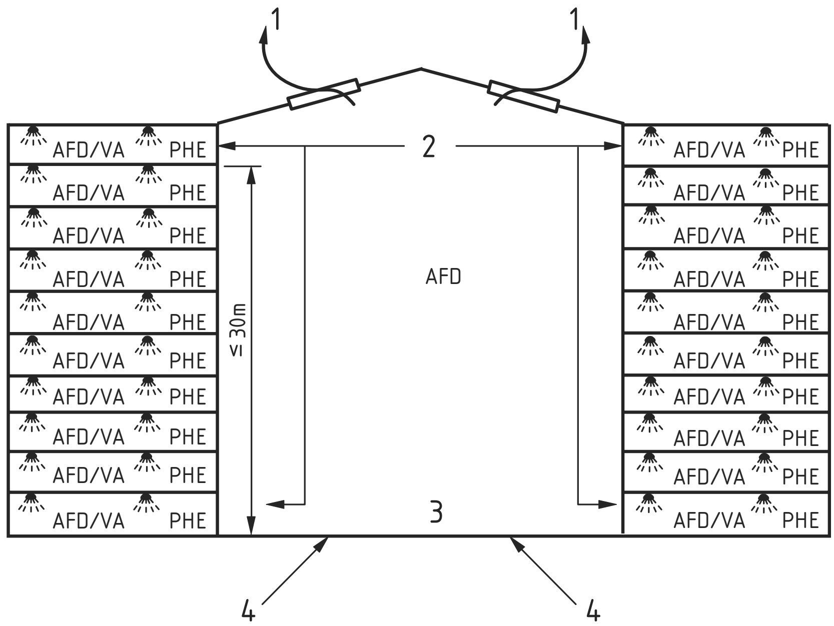


Key

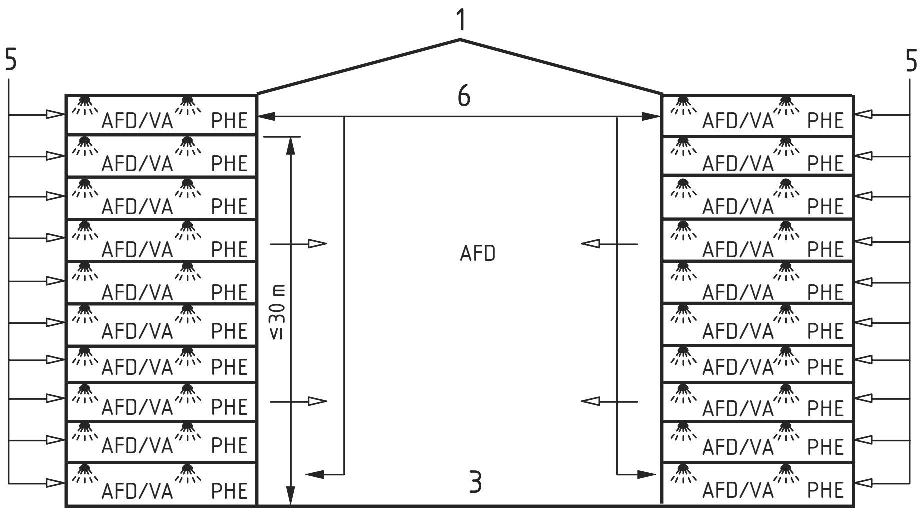
1	Temperature control system
2	Enclosed smoke-retarding construction
3	Atrium base: controlled fire load
4	Make-up air
AFD	L2 automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
PHE	Phased evacuation
(sprinkler symbol)	Automatic sprinkler protection

NOTE Not applicable for atria uniting two storeys only.

Figure C.12 **Exemplar 6 – Occupancy characteristic A – Enclosed 30 m or less in height, fire-resisting, pressure differential, phased evacuation**



a) Pressure differential systems using atria depressurization



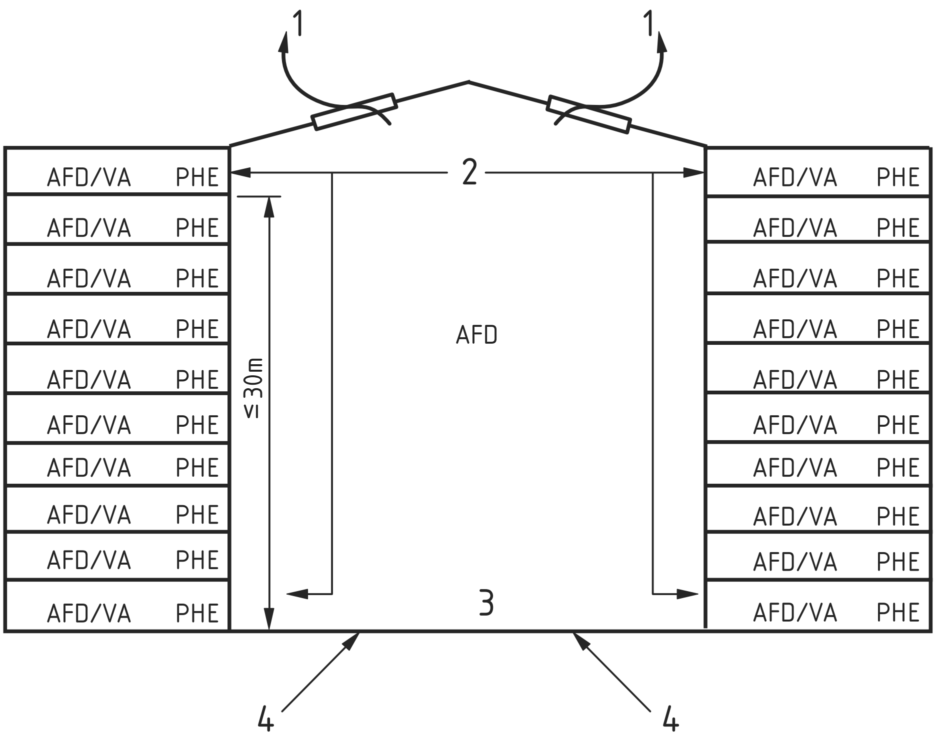
b) Pressure differential systems to pressurize the associated floor areas

Key

1	Pressure differential smoke control system
2	Enclosed fire-resisting construction
3	Atrium base: controlled fire load
4	Make-up air
5	Pressurization of associated floor areas
6	Smoke-retarding enclosure
AFD	Automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
PHE	Phased evacuation
	Automatic sprinkler protection only needed as part of a fire engineering solution

*NOTE Pressure differential systems using smoke exhaust ventilation to depressurize the atrium with a high neutral plane method [see **B.6.1**d)3) and **B.6.5**b)].*

Figure C.13 **Exemplar 7 – Occupancy characteristic A – Enclosed 30 m or less in height, fire-resisting, smoke-retarding, phased evacuation**



Key

1 Smoke clearance system

2 Enclosed fire-resisting (30 min integrity) and smoke-retarding construction

3 Atrium base: use and contents comparable with that adjoining the atrium

4 Make-up air

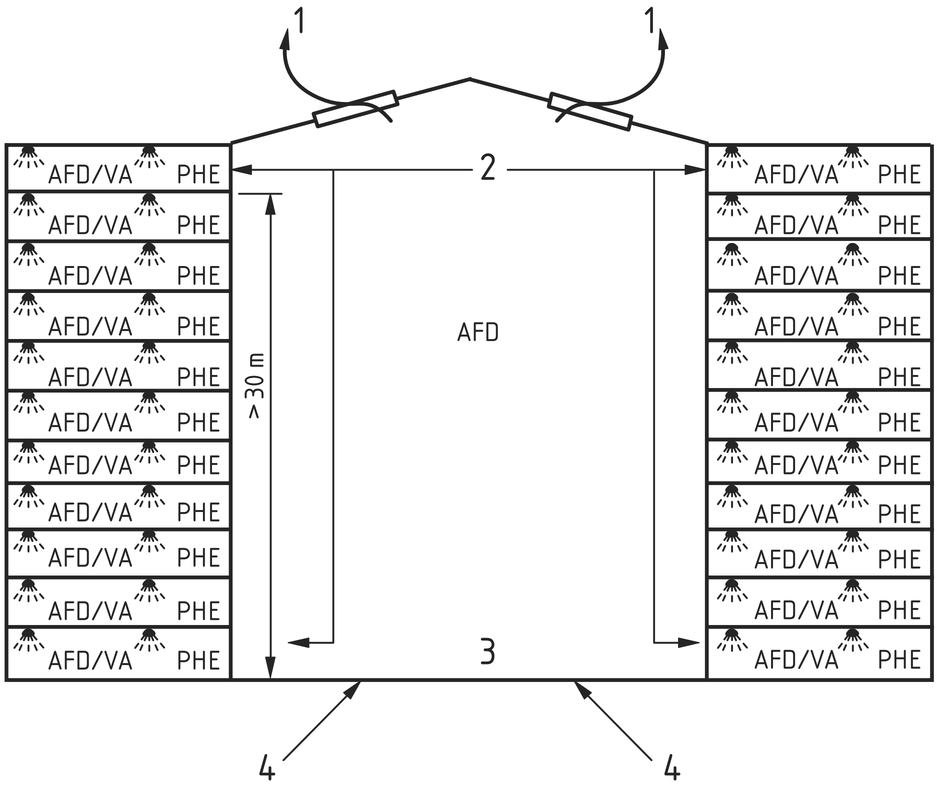
AFD Automatic fire detection connected to the building fire alarm system

AFD/VA L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building

PHE Phased evacuation

NOTE Not applicable for atria uniting two storeys only.

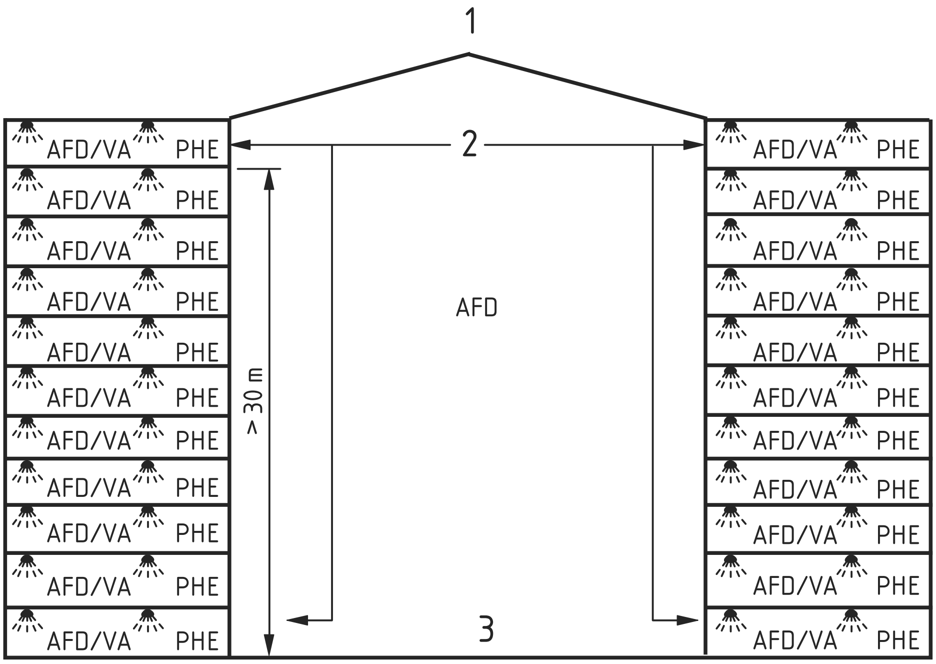
Figure C.14 **Exemplar 8 – Occupancy characteristic A – Enclosed greater than 30 m in height, fire-resisting, pressurization, smoke-retarding, phased evacuation**



Key

1	Smoke clearance system
2	Enclosed fire-resisting (30 min integrity) and smoke-retarding construction
3	Atrium base: controlled fire load
4	Make-up air
AFD	Automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
PHE	Phased evacuation
	Automatic sprinkler protection

Figure C.15 **Exemplar 9 – Occupancy characteristic A – Enclosed greater than 30 m in height, pressurization, fire-resisting, phased evacuation**

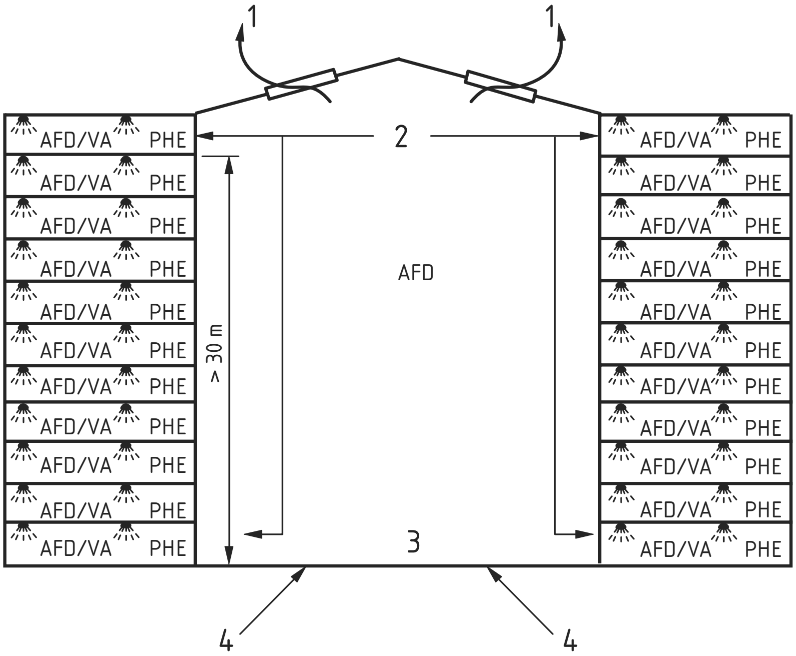


Key

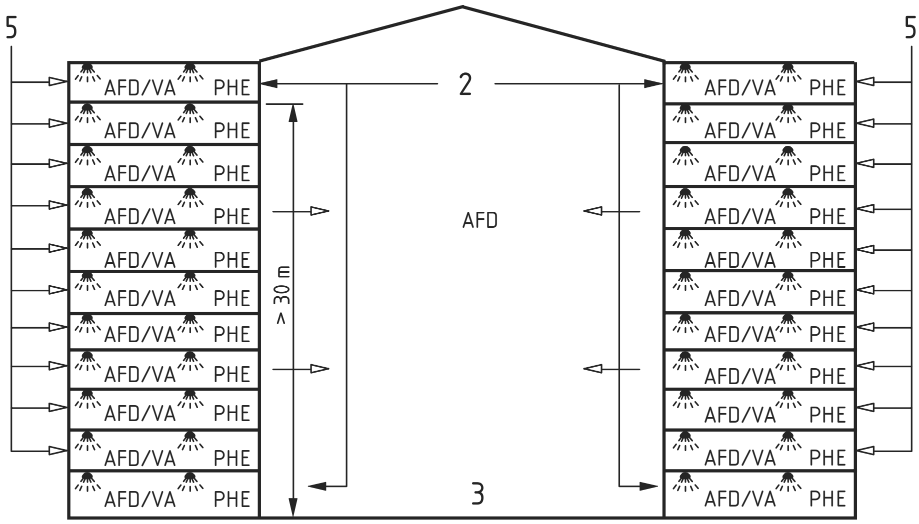
1	Pressure differential smoke control system
2	Enclosed fire-resisting construction (30 min integrity)
3	Atrium base: no combustible content
AFD	Automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
PHE	Phased evacuation
(sprinkler symbol)	Automatic sprinkler protection

*NOTE Pressurization by applying all the relevant clauses of BS EN 12101-6 [see **B.6.1**d)1) and **B.6.5**a)].*

Figure C.16 **Exemplar 10 – Occupancy characteristic A – Enclosed greater than 30 m in height, fire-resisting, pressure differential, phased evacuation**



a) Pressure differential systems using atria depressurization



b) Pressure differential systems to pressurize the associated floor areas

Key

1	Atrium depressurization
2	Enclosed fire-resisting construction (30 min integrity)
3	Atrium base: controlled fire load
4	Make-up air
5	Pressurization of associated floor areas
AFD	Automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
PHE	Phased evacuation
(sprinkler symbol)	Automatic sprinkler protection

NOTE Pressurization of the adjacent spaces as there is no possibility of adjusting the neutral plane [see ***B.6.1****d)2) and* ***B.6.5****c)].*

C.3 Occupancy characteristic B

The decision processes for occupancy characteristic B (occupants who are awake but might be unfamiliar with the building) are illustrated in Figures C.17 to C.22 and Table C.2. The corresponding exemplars are illustrated in Figures C.18 to C.29.

Figure C.17 **Occupancy characteristic decision process – Occupancy characteristic B – Atrium open**

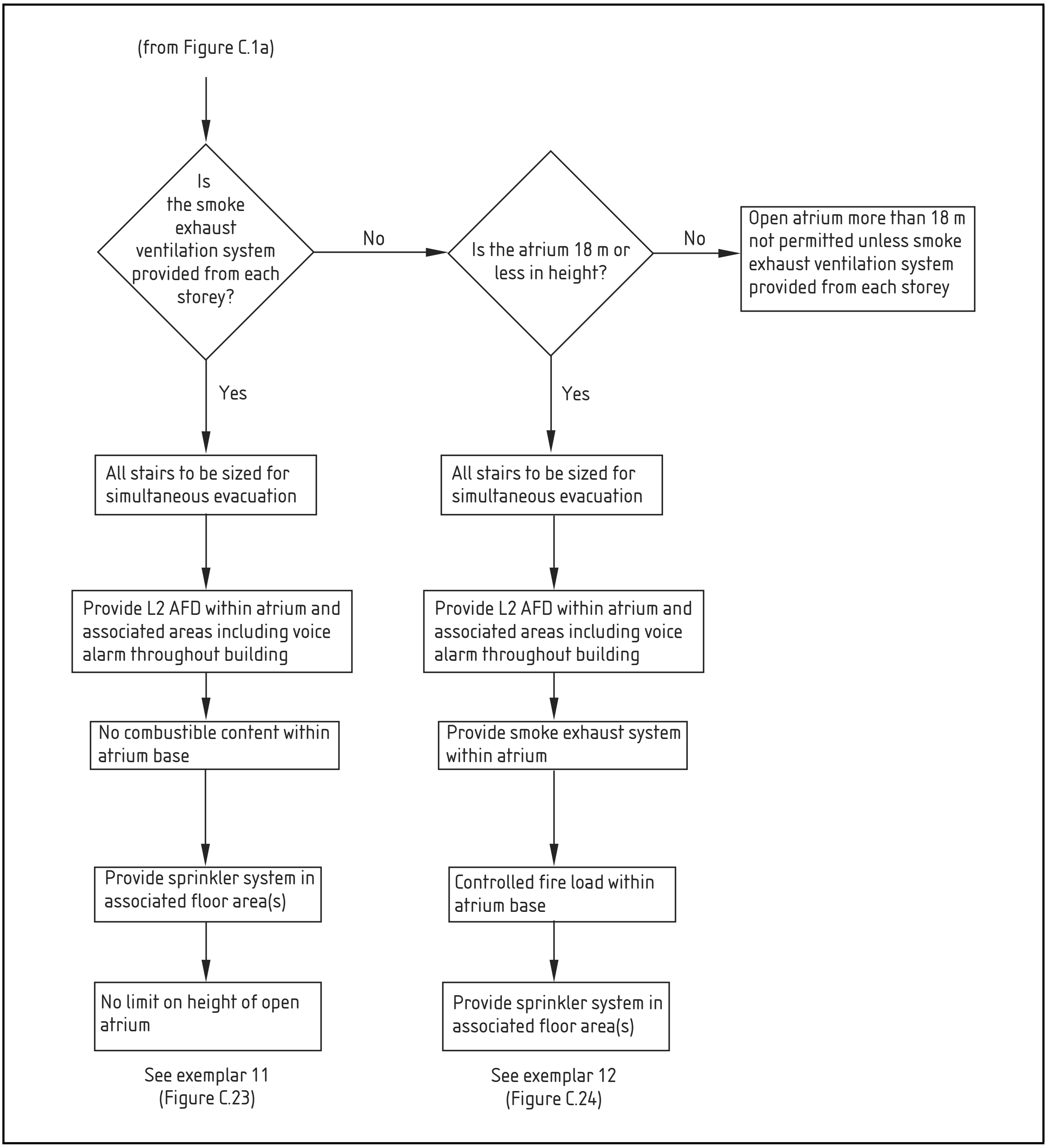


Figure C.18 Occupancy characteristic decision process – Occupancy characteristic B – Atrium less than 30 m in height, enclosed

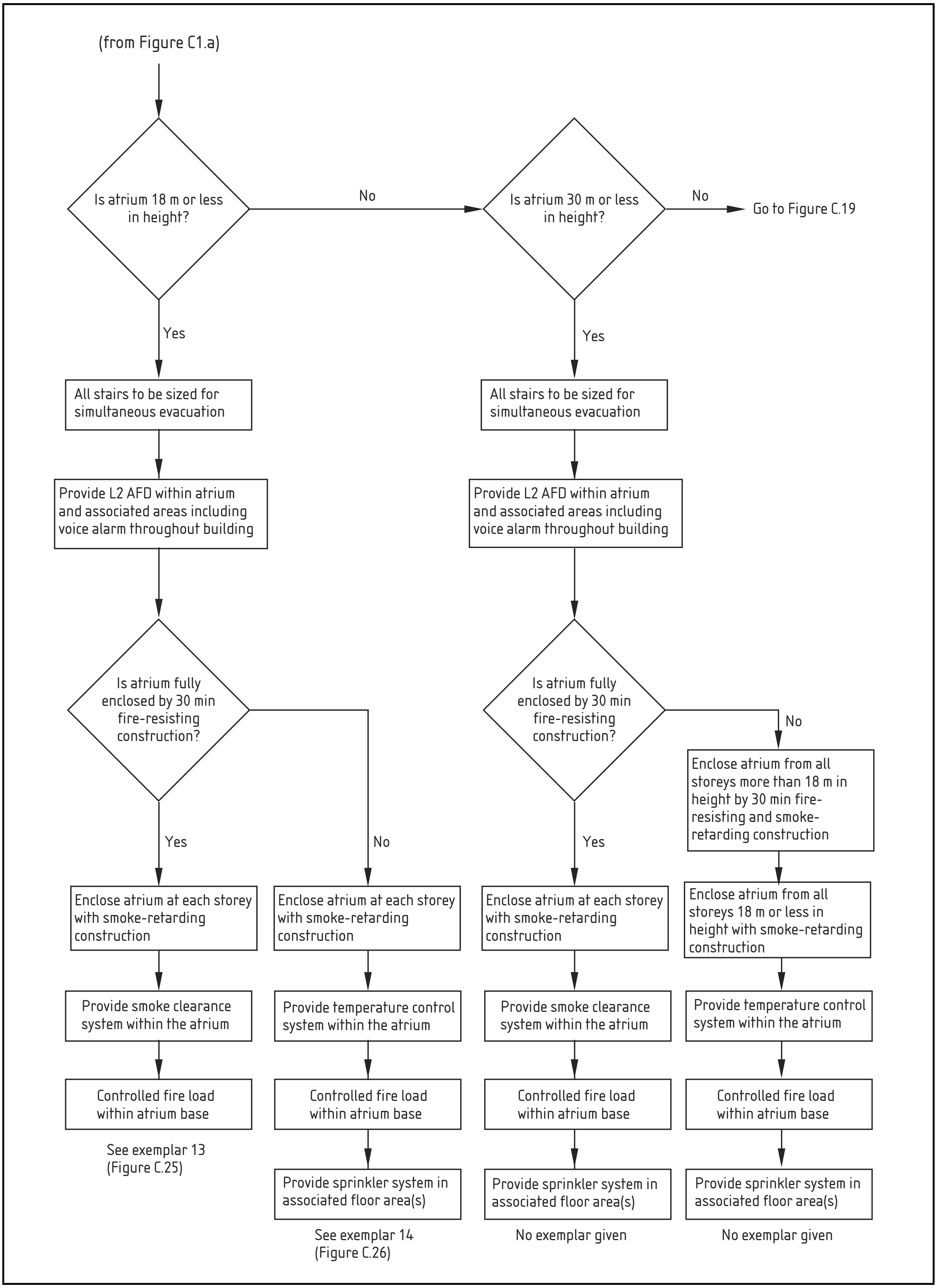


Figure C.19 **Occupancy characteristic decision process – Occupancy characteristic B – Atrium over 30 m in height, enclosed**

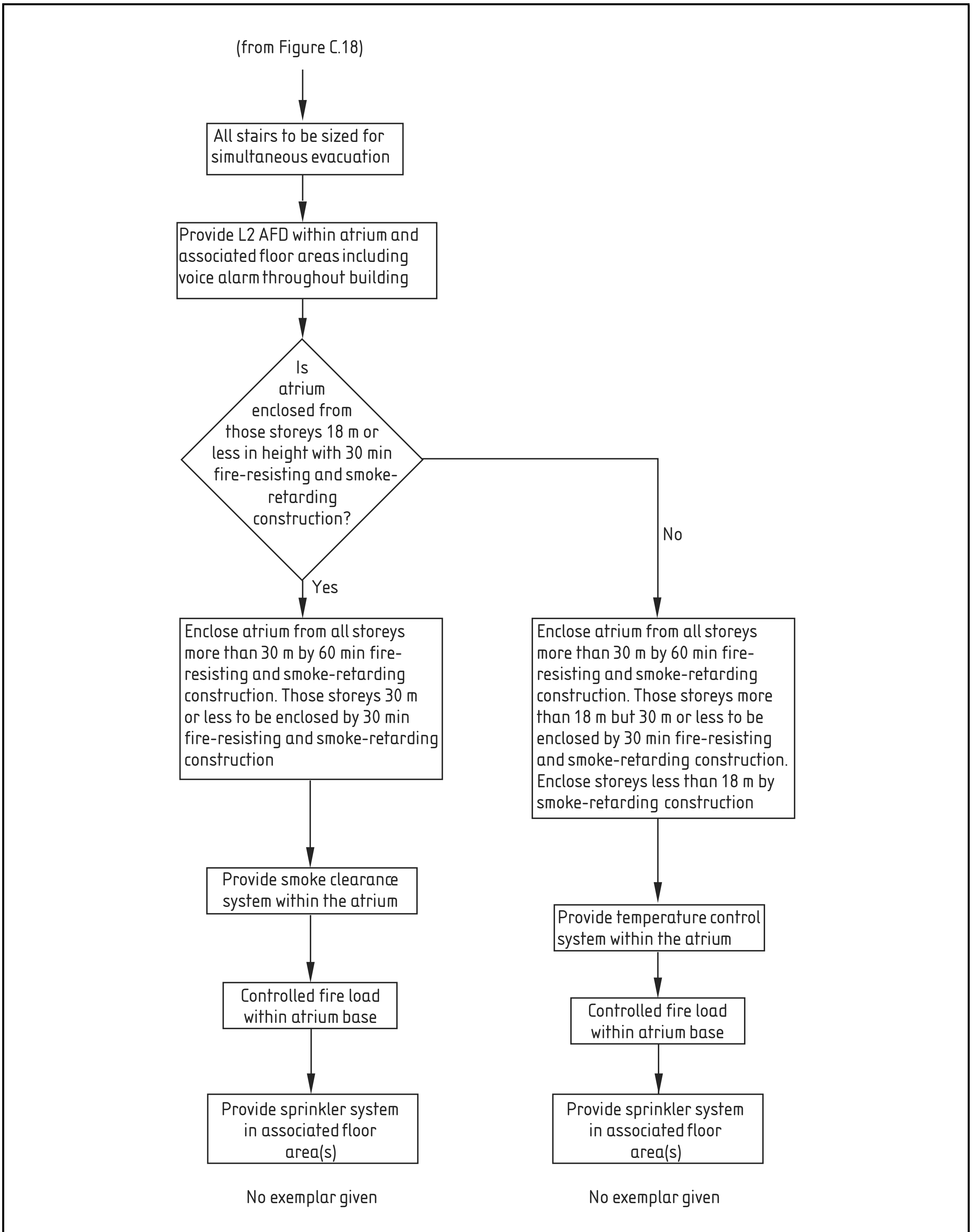


Figure C.20 **Occupancy characteristic decision process – Occupancy characteristic B – Atrium 18 m or less in height, partly enclosed**

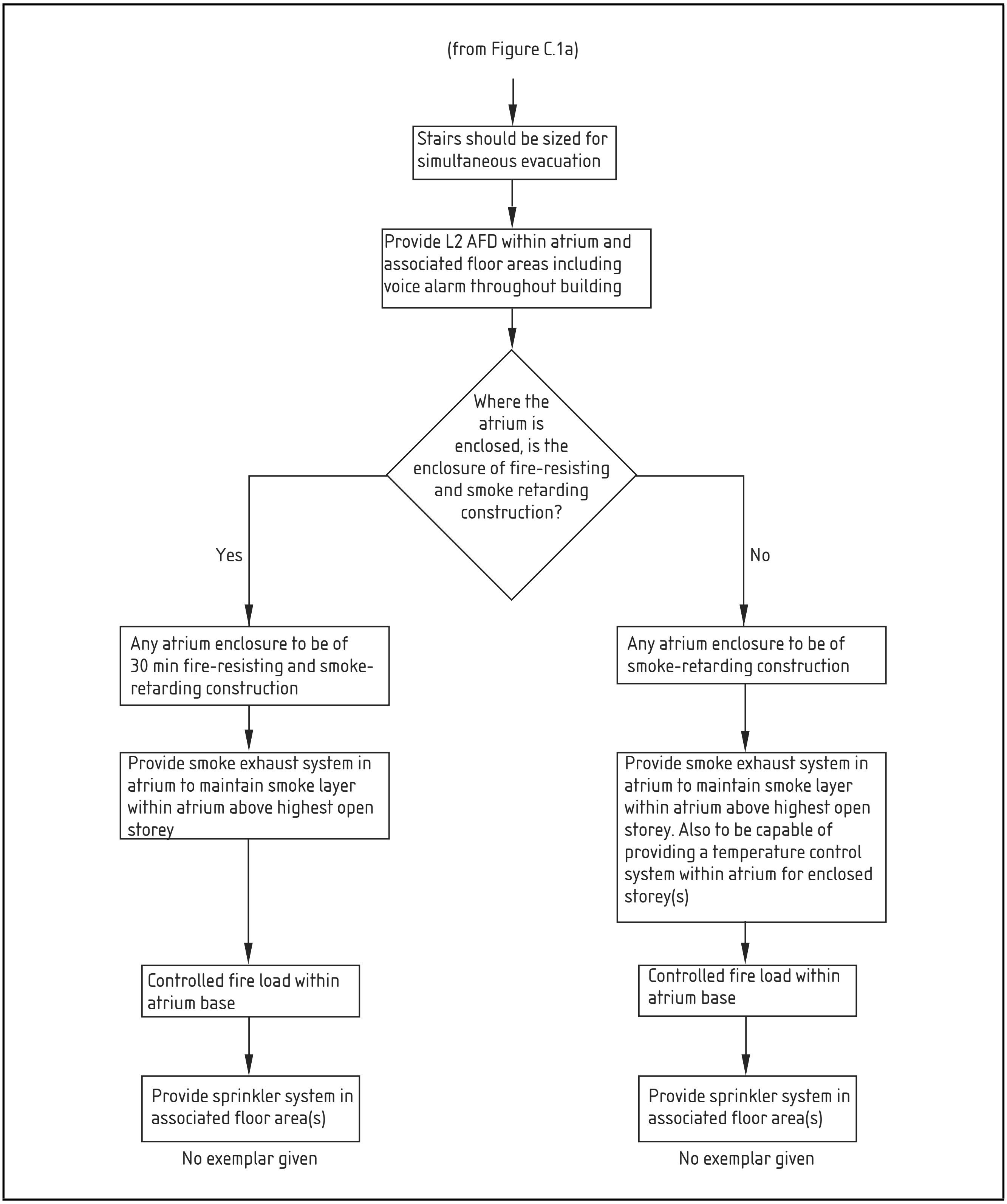
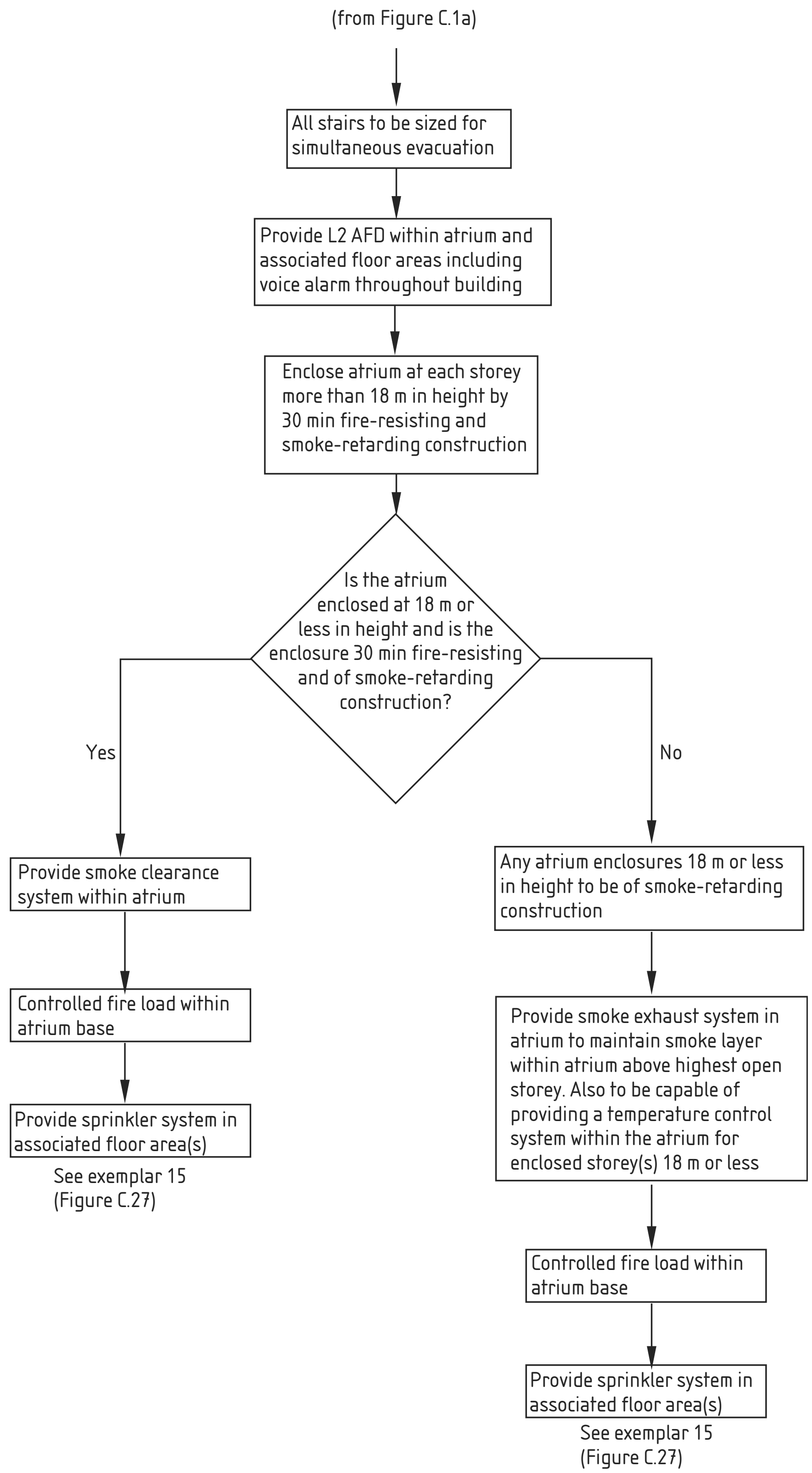


Figure C.21 **Occupancy characteristic decision process – Occupancy characteristic B – Atrium 18 m to 30 m in height, partly open**



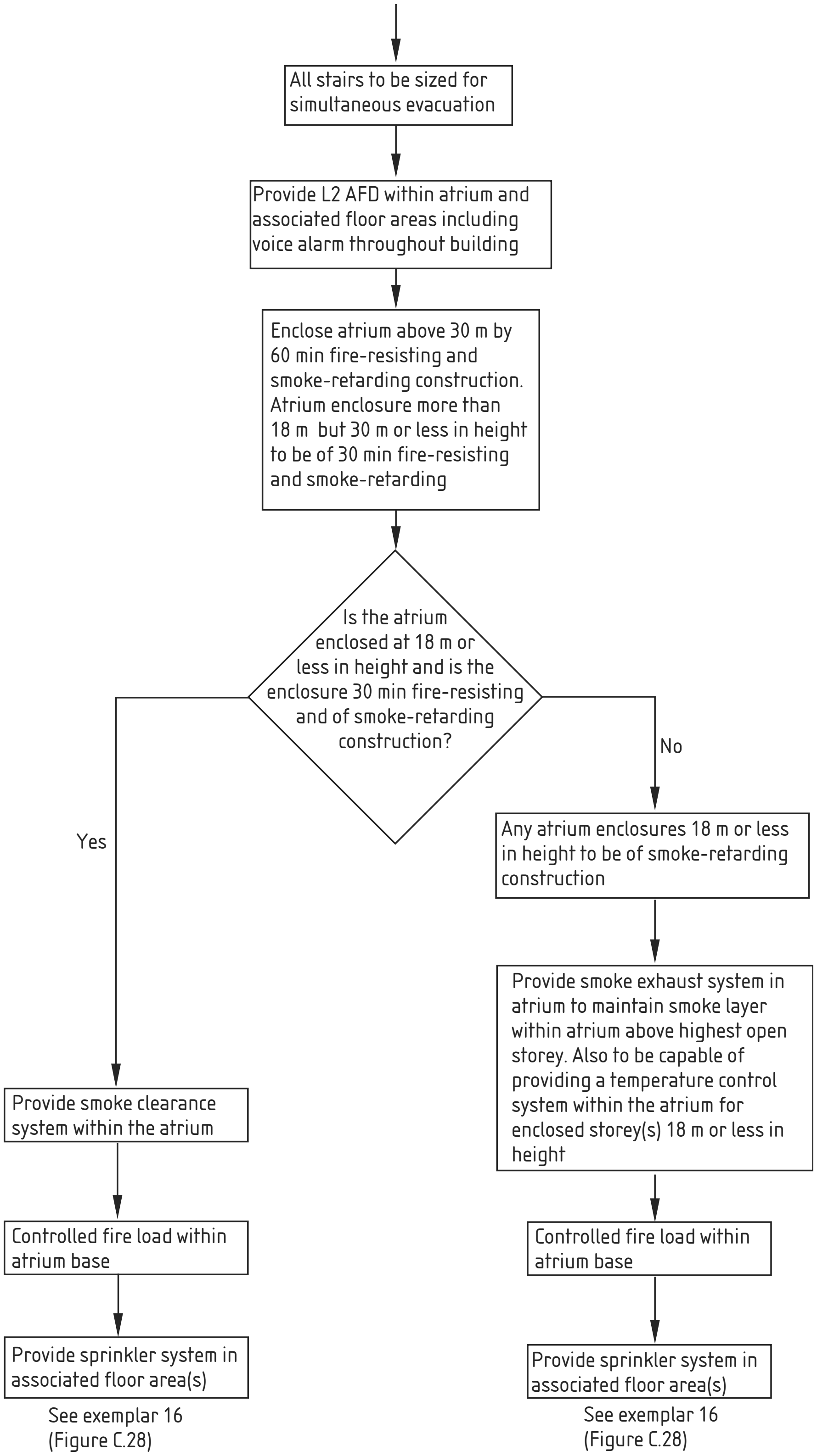
NOTE Alternatively all storeys within 18 m of the floor level of the highest storey abutting the atrium may be designed as if the atrium were 18 m high provided that:

a) storeys below are enclosed with 30 min fire resistance and are smoke-retarding;

b) smoke exhaust is installed; and

c) the atrium base has no combustible content (see exemplar 15).

Figure C.22 **Occupancy characteristic decision process – Occupancy characteristic B – Atrium more than 30 m in height, partly enclosed**



NOTE Alternatively all storeys within 30 m of the floor level of the highest storey abutting the atrium may be designed as if the atrium were 30 m high provided that:

a) storeys below are enclosed with 60 min fire resistance and are smoke-retarding;

b) smoke exhaust is installed; and

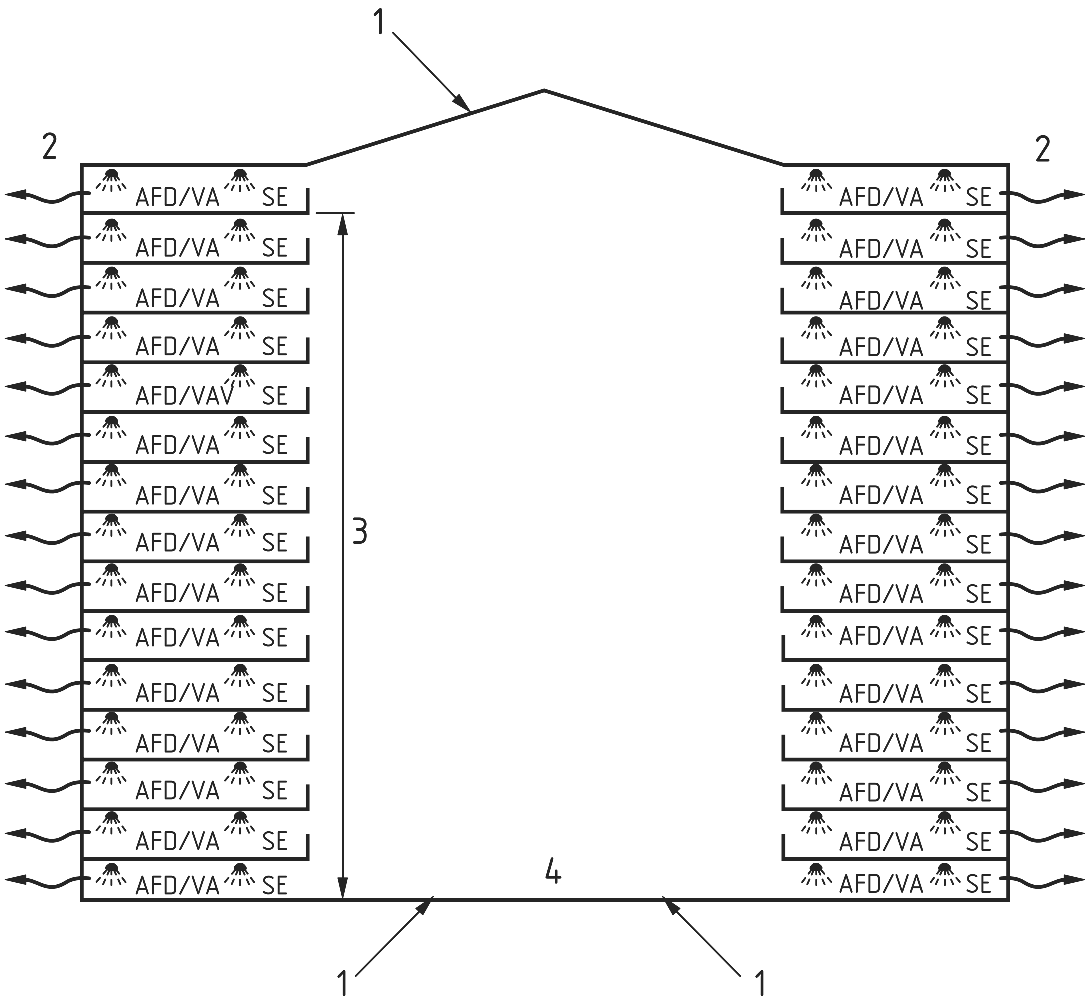
c) the atrium base has no combustible content (see exemplar 16).

Table C.2 **Possible solutions – Occupancy characteristic B**

Atrium height m	Atrium/accommodation method of separation	Smoke control system	Accommodation sprinkler system	Fire alarm and warning system	Use of atrium base	Exemplar/figure
Evacuation strategy: simultaneous						
⩽18 A)	Open	Smoke exhaust	Yes	Provide L2 AFD D) to atrium and associated areas, including voice alarm throughout	Controlled fire load	Exemplar 12 (Figure C.24)
	Enclosed: smoke-retarding	Temperature control	Yes	Provide L2 AFD D) to atrium and associated areas, including voice alarm throughout	Controlled fire load	Exemplar 14 (Figure C.26)
	Enclosed: fire resistance 30 m integrity and smoke-retarding	Smoke clearance	No B)	Provide L2 AFD D) to atrium and associated areas, including voice alarm throughout	Controlled fire load	Exemplar 13 (Figure C.25)
>18⩽30 B)	All storeys above 18 m to be enclosed: 30 min fire resistance and smoke-retarding	Appropriate for atrium/ accommodation enclosure for floors below 18 m	Yes	Provide L2 AFD D) to atrium and associated areas, including voice alarm throughout	Controlled fire load	Exemplar 15 (Figure C.27)
>30 C)	All storeys above 30 m to be enclosed: fire resistance 60 min integrity and smoke-retarding	Appropriate for atrium/ accommodation enclosure for floors below 18 m	Yes	Provide L2 AFD D) to atrium and associated areas, including voice alarm throughout	Controlled fire load	Exemplar 16 (Figure C.28)
Unlimited	Open	Smoke exhaust per storey	Yes	Provide L2 AFD D) to atrium and associated areas, including voice alarm throughout	No combustible content	Exemplar 11 (Figure C.23)

A) This table is not applicable for buildings of two storeys.
B) For storeys 18 m or less in height, the method of separation and appropriate smoke control should be as recommended above.
C) For storeys less than 30 m in height, the method of separation and associated smoke control should be as recommended above, as appropriate.
D) L2 AFD: Automatic fire detection system type L2 (see BS 5839-1:2002+A2:2008).

Figure C.23 **Exemplar 11 – Occupancy characteristic B – Unlimited height, open, simultaneous evacuation**

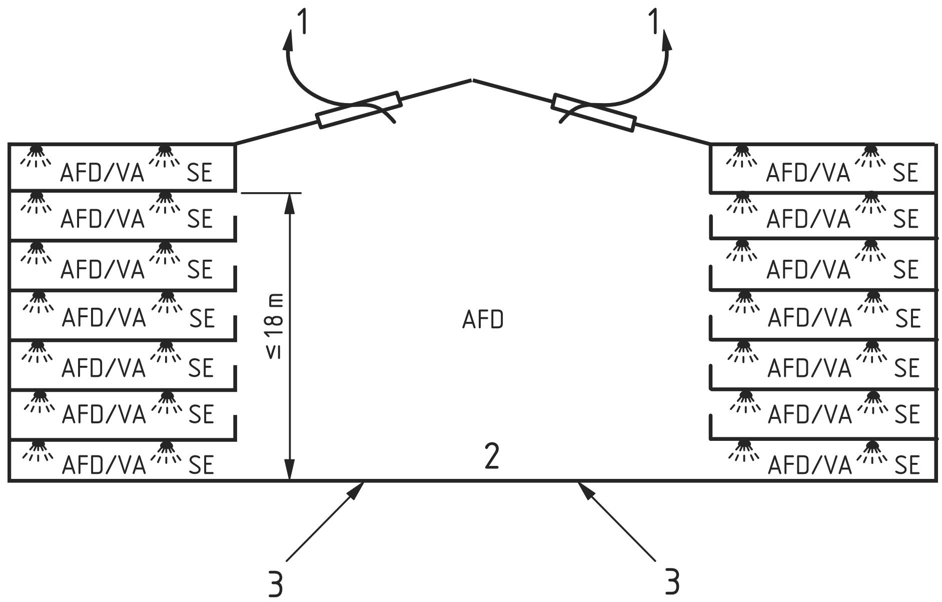


Key

1	Make-up air
2	Smoke exhaust per storey
3	Unlimited height
4	Atrium base: no combustible content
AFD/VA	L2 automatic fire detection and voice alarm throughout the building
SE	Simultaneous evacuation
(sprinkler symbol)	Automatic sprinkler protection

NOTE Not applicable for atria uniting two storeys only.

Figure C.24 **Exemplar 12 – Occupancy characteristic B – 18 m or less in height, open, simultaneous evacuation**

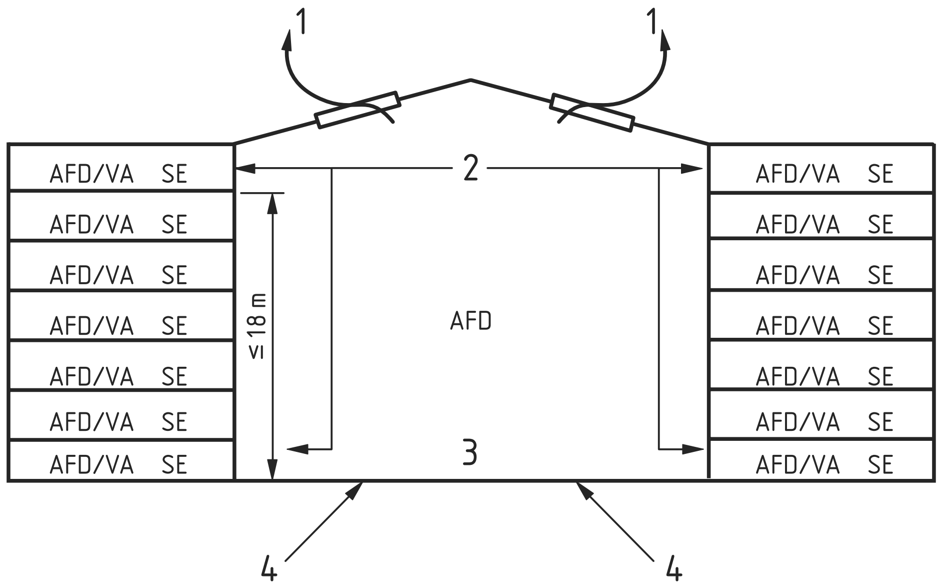


Key

1	Smoke exhaust system
2	Atrium base: controlled fire load
3	Make-up air
AFD	Automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
SE	Simultaneous evacuation
(sprinkler symbol)	Automatic sprinkler protection

NOTE Not applicable for atria uniting two storeys only.

Figure C.25 **Exemplar 13 – Occupancy characteristic B – 18 m or less in height, enclosed, fire-resisting, simultaneous evacuation**

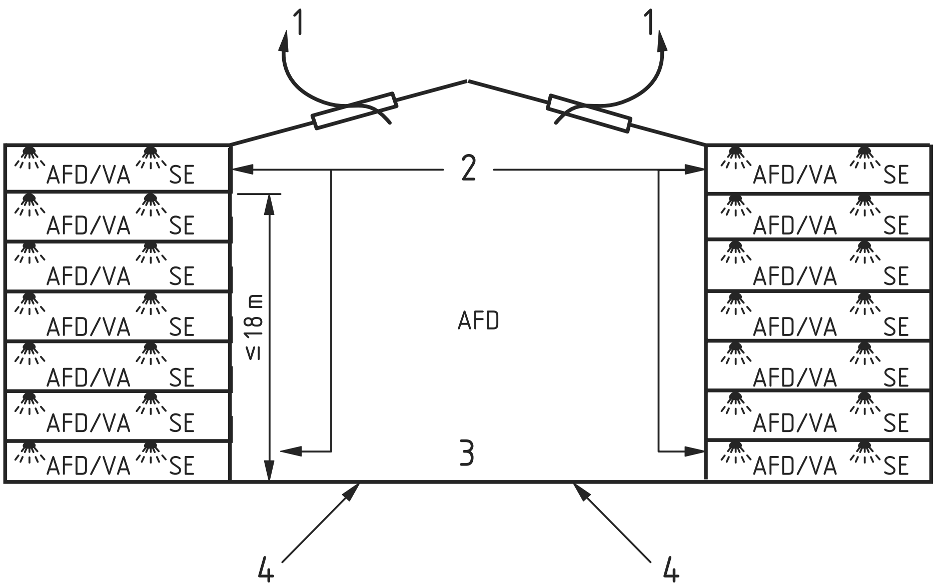


Key

1 Smoke clearance system
2 Enclosed fire-resisting (30 min integrity) and smoke-retarding construction
3 Atrium base: controlled fire load
4 Make-up air
AFD Automatic fire detection connected to the building fire alarm system
AFD/VA L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
SE Simultaneous evacuation

NOTE Not applicable for atria uniting two storeys only.

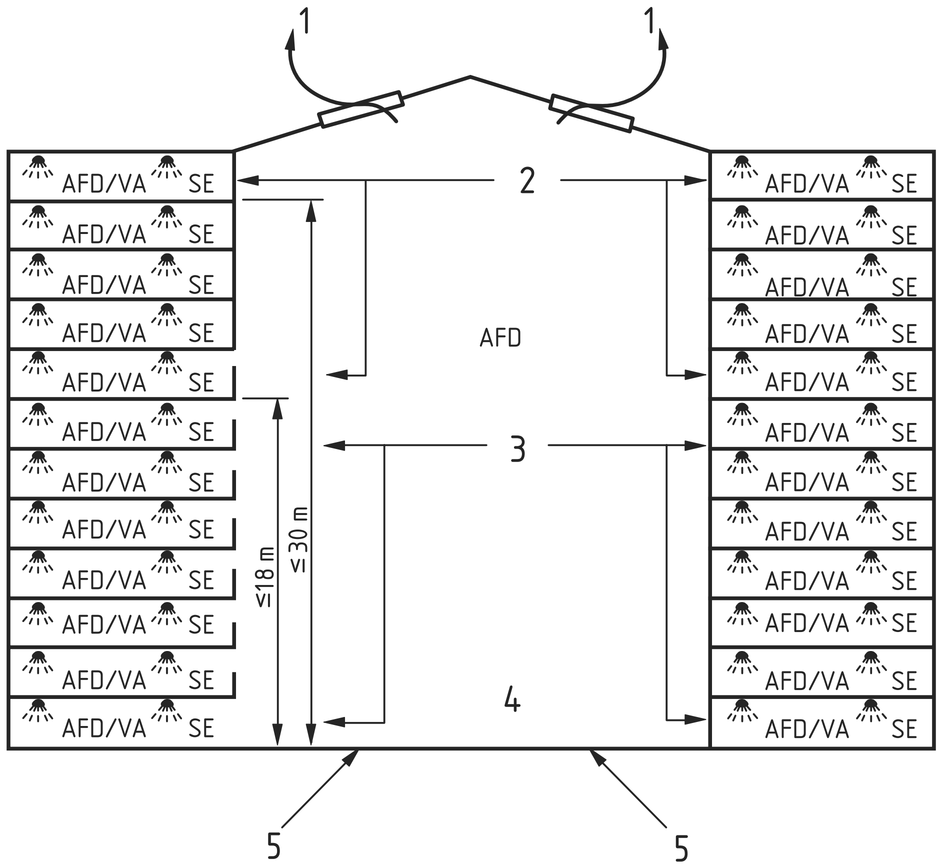
Figure C.26 **Exemplar 14 – Occupancy characteristic B – 18 m or less in height, enclosed, smoke-retarding, simultaneous evacuation**



Key

1	Temperature control system
2	Enclosed smoke-retarding construction
3	Atrium base: controlled fire load
4	Make-up air
AFD	Automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
SE	Simultaneous evacuation
	Automatic sprinkler protection

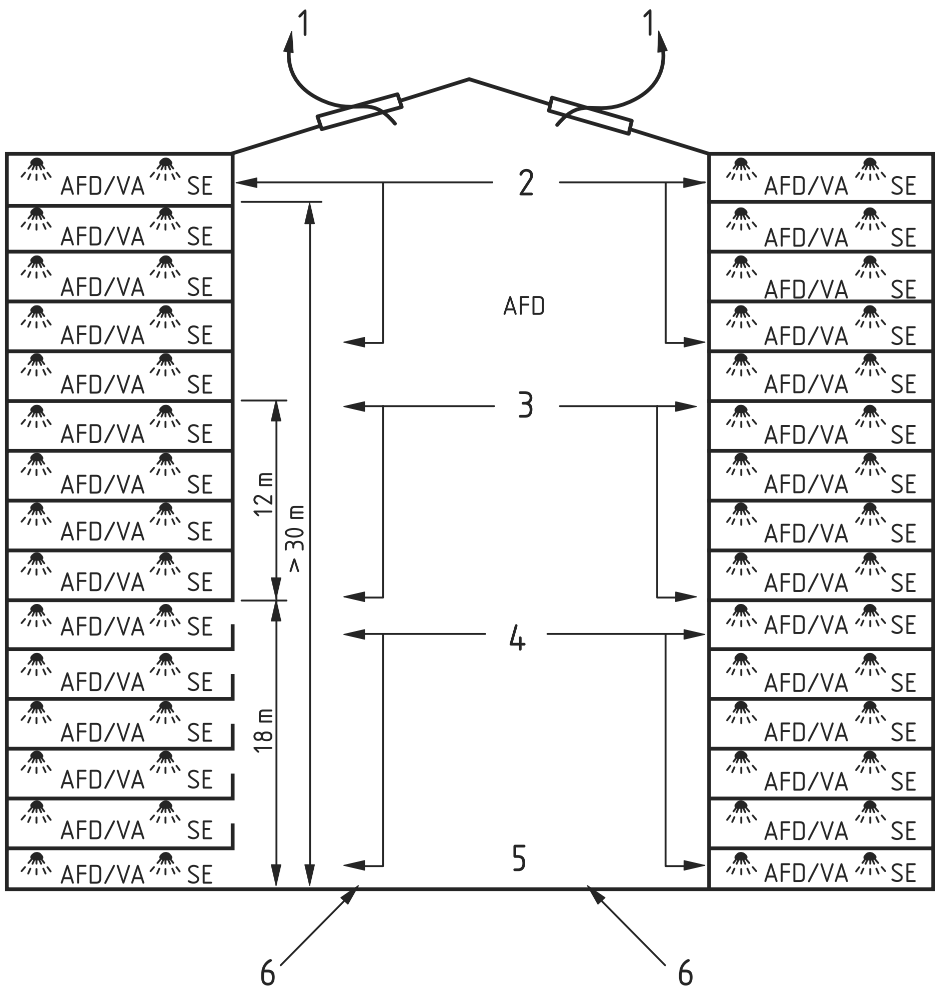
Figure C.27 **Exemplar 15 – Occupancy characteristic B – Partly open, 30 m or less, simultaneous evacuation**



Key

1	Smoke control system
2	Enclosed fire-resisting (30 min integrity) and smoke-retarding construction
3	Open or enclosed subject to appropriate smoke control provision
4	Atrium base: controlled fire load
5	Make-up air
AFD	Automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
SE	Simultaneous evacuation
(sprinkler symbol)	Automatic sprinkler protection

Figure C.28 **Exemplar 16 – Occupancy characteristic B – Partly open, greater than 30 m in height, simultaneous evacuation**



Key

1	Smoke control system
2	Enclosed fire-resisting (60 min integrity) and smoke-retarding construction
3	Enclosed fire-resisting (30 min integrity) and smoke-retarding construction
4	Open or enclosed subject to appropriate smoke control provision
5	Atrium base: controlled fire load
6	Make-up air
AFD	Automatic fire detection connected to the building fire alarm system
AFD/VA	L2 automatic fire detection within the atrium and associated floor areas and voice alarm throughout the building
SE	Simultaneous evacuation
	Automatic sprinkler protection

C.4 Occupancy characteristic C

The decision processes for occupancy characteristic C (occupants who are likely to be asleep) are illustrated in Figures C.30 to C.32 and Table C.3. The corresponding exemplars are illustrated in Figures C.33 to C.38.

Figure C.29 **Occupancy characteristic decision process – Occupancy characteristic Ci**

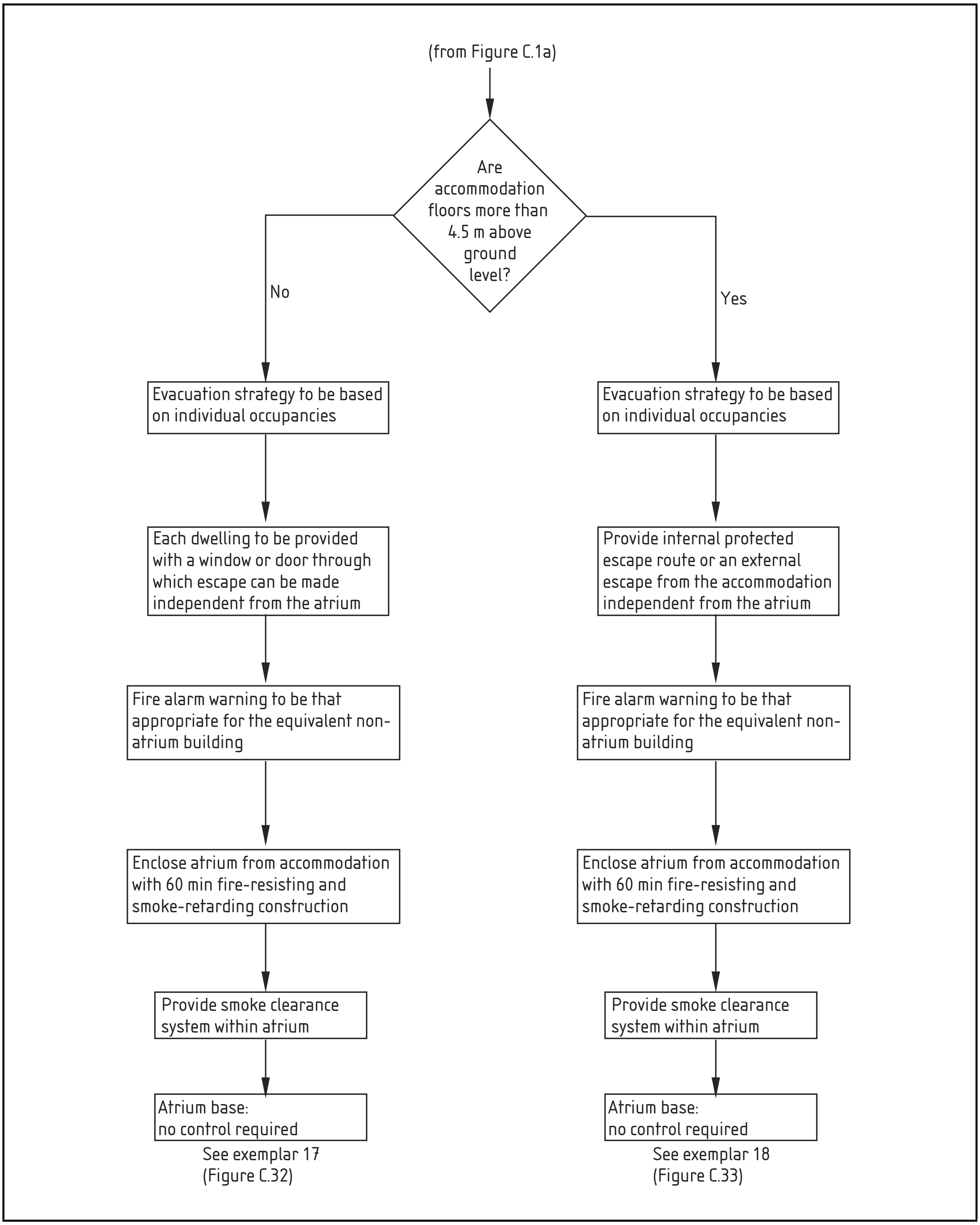


Figure C.30 **Occupancy characteristic decision process – Occupancy characteristic Cii**

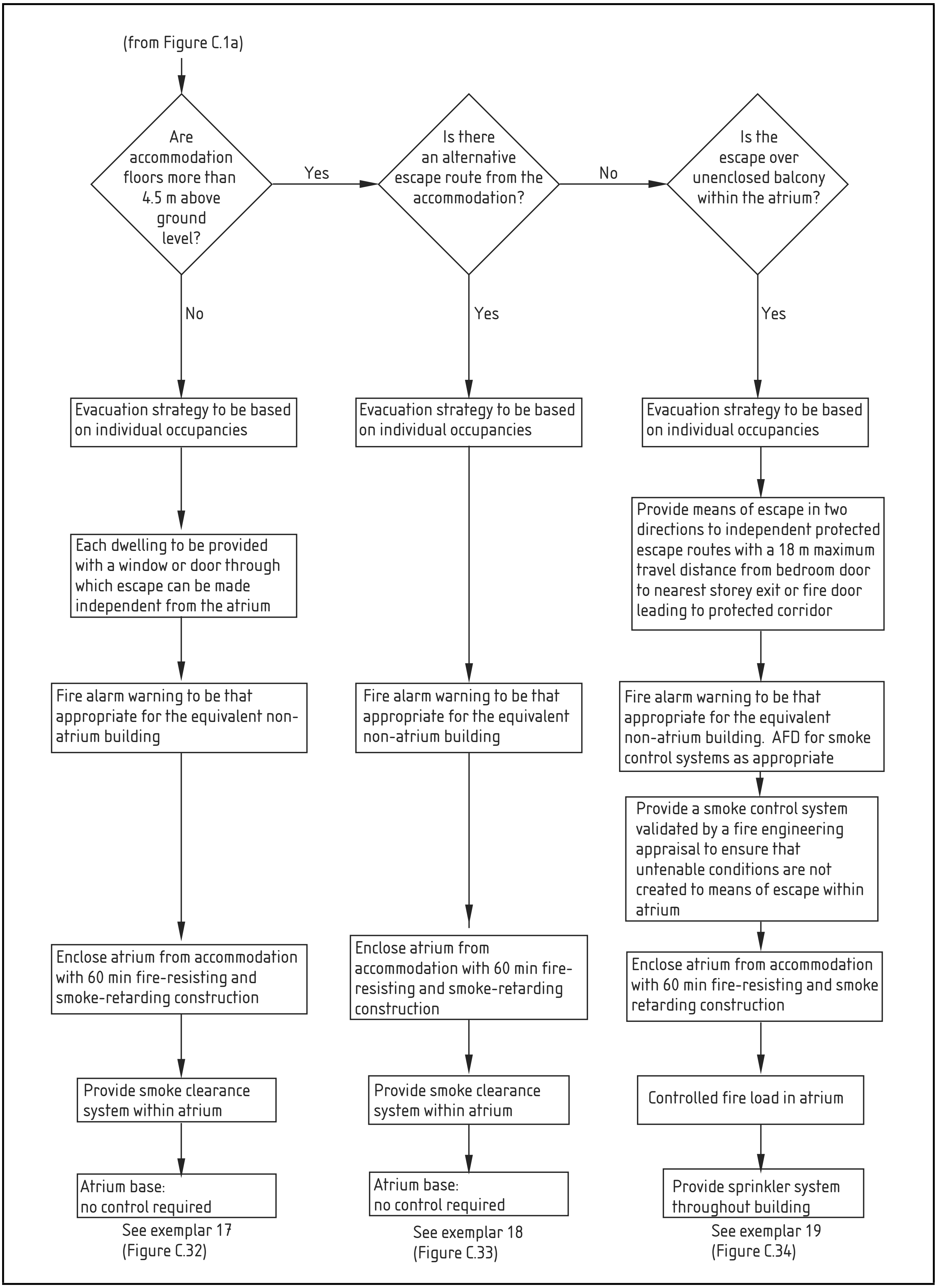


Figure C.31 **Occupancy characteristic decision process – Occupancy characteristic Ciii**

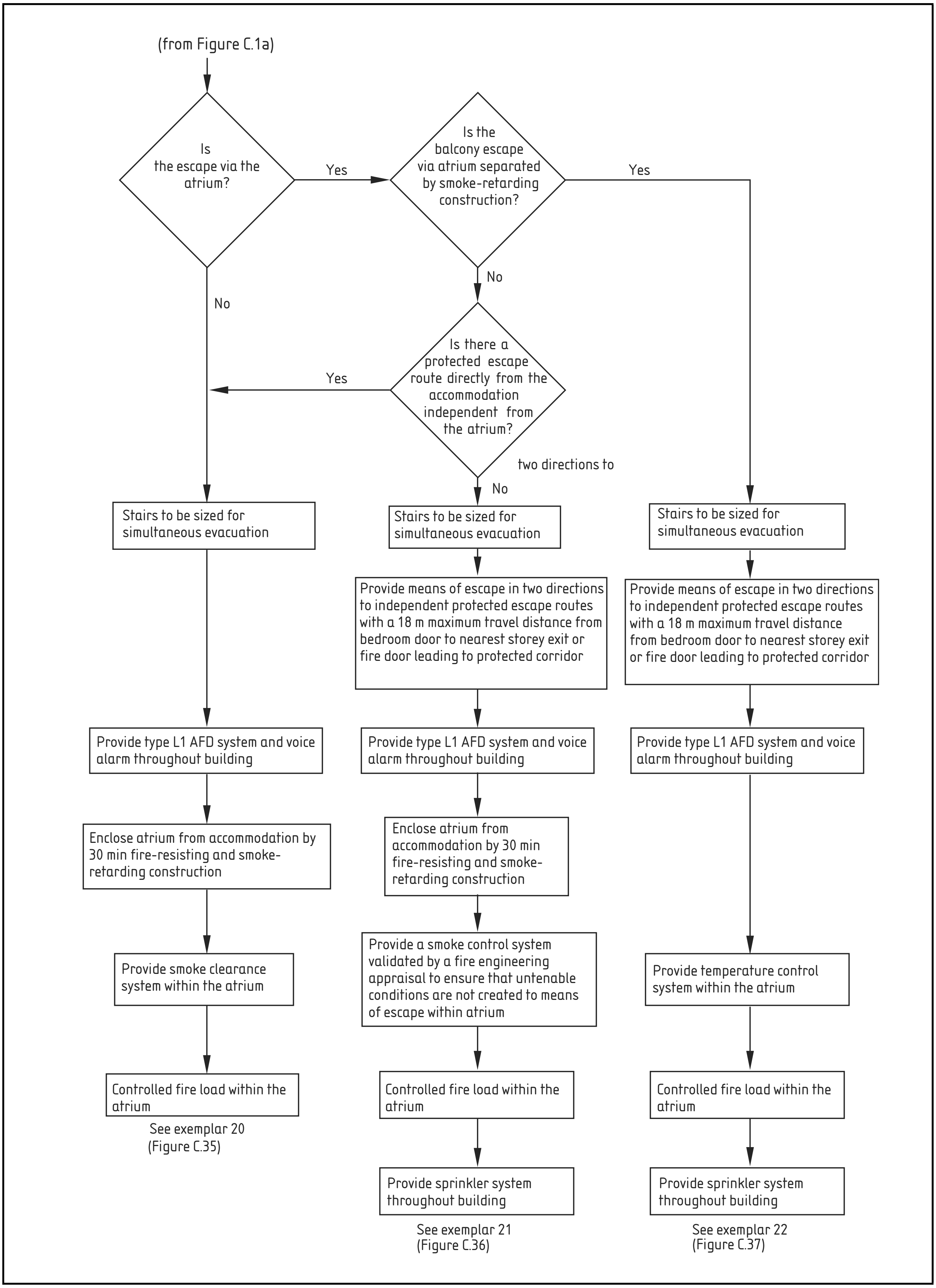


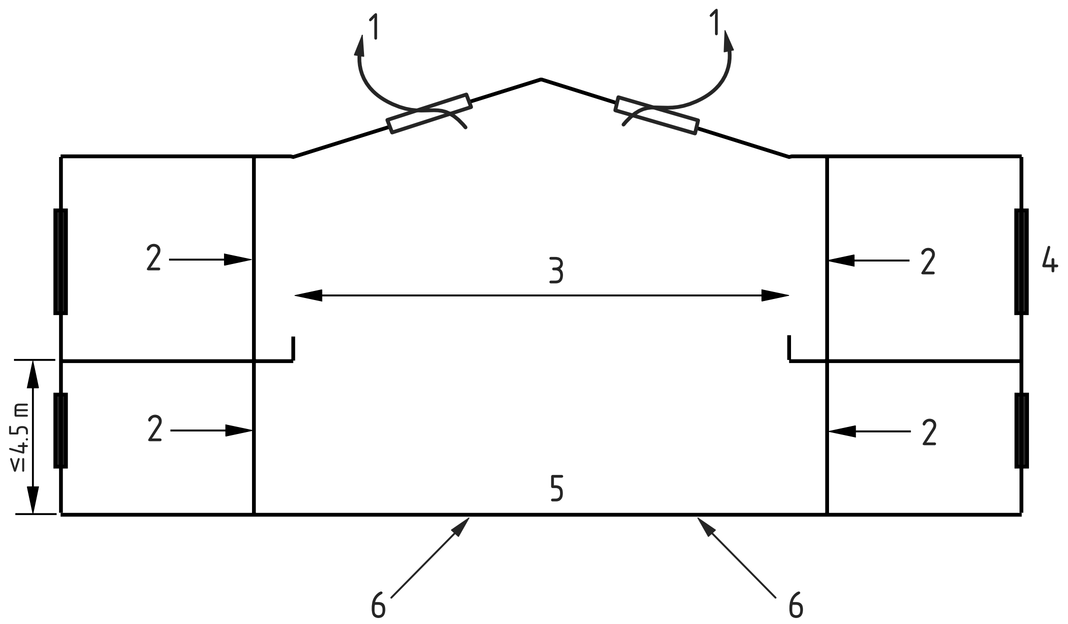
Table C.3 **Possible solutions – Occupancy characteristic C**

Atrium/accommodation method of separation	Means of escape provision	Smoke control system	Associated areas sprinkler system	Fire alarm and warning system	Use of atrium base	Exemplar/ figure
Occupancy characteristic Ci						
Enclosed: 60 min fire-resisting (integrity and insulation) and smoke-retarding	Where accommodation storeys are not more than 4.5 m above ground level, each flat should have a window or door through which escape could be made independent from the atrium	Smoke clearance	No	Appropriate for the equivalent non-atrium building	No control required	Exemplar 17 (Figure C.32)
	Where accommodation storeys are more than 4.5 m above ground level, each flat should be provided with an internal protected escape route or an external escape route direct from the accommodation	Smoke clearance	No	Appropriate for the equivalent non-atrium building	No control required	Exemplar 18 (Figure C.33)
Occupancy characteristic Cii						
Enclosed: 60 min fire-resisting (integrity and insulation) and smoke-retarding construction	Where escape from the accommodation is to be via the atrium, means of escape in two directions to independent protected escape routes should be provided. There should be an 18 m maximum travel distance from front door to nearest storey exit or a fire door leading to a protected corridor	Smoke control system designed to ensure that untenable conditions are not created in means of escape in atrium (see **B.6.2**)	Yes	Appropriate for the equivalent non-atrium building. Automatic fire detection for atrium, smoke control as appropriate	Controlled fire load	Exemplar 19 (Figure C.34)
Occupancy characteristic Ciii						
30 min fire-resisting (integrity and insulation) and smoke-retarding construction	A protected escape route directly from the accommodation independent from the atrium	Smoke clearance	No	Type L1 AFD system, and voice alarm throughout the building	Controlled fire load	Exemplar 20 (Figure C.35)

Table C.3 **Possible solutions – Occupancy characteristic C** (*continued*)

Atrium/accommodation method of separation	**Means of escape provision**	**Smoke control system**	**Associated areas sprinkler system**	**Fire alarm and warning system**	**Use of atrium base**	**Exemplar/ figure**
30 min fire-resisting (integrity and insulation) construction	Where escape from the accommodation is via a balcony, which is separated from the associated floor area by smoke-retarding construction, means of escape in two directions to independent protected escape routes should be provided. There should be an 18 m maximum travel distance from bedroom door to nearest storey exit or a fire door leading to a protected corridor	Smoke control system designed to ensure that untenable conditions are not created in means of escape in atrium	Yes	Type L1 AFD system, and voice alarm throughout the building	Controlled fire load	Exemplar 21 (Figure C.36)
Smoke-retarding construction	Where escape from the accommodation is via a balcony, which is separated from the associated floor area by smoke-retarding construction, means of escape in two directions to independent protected escape routes should be provided. There should be an 18 m maximum travel distance from bedroom door to nearest storey exit or a fire door leading to a protected corridor	Temperature control	Yes	Type L1 AFD system, and voice alarm throughout the building	Controlled fire load	Exemplar 22 (Figure C.37)

Figure C.32 **Exemplar 17 – Occupancy characteristics Ci and Cii – Long term, low-rise**

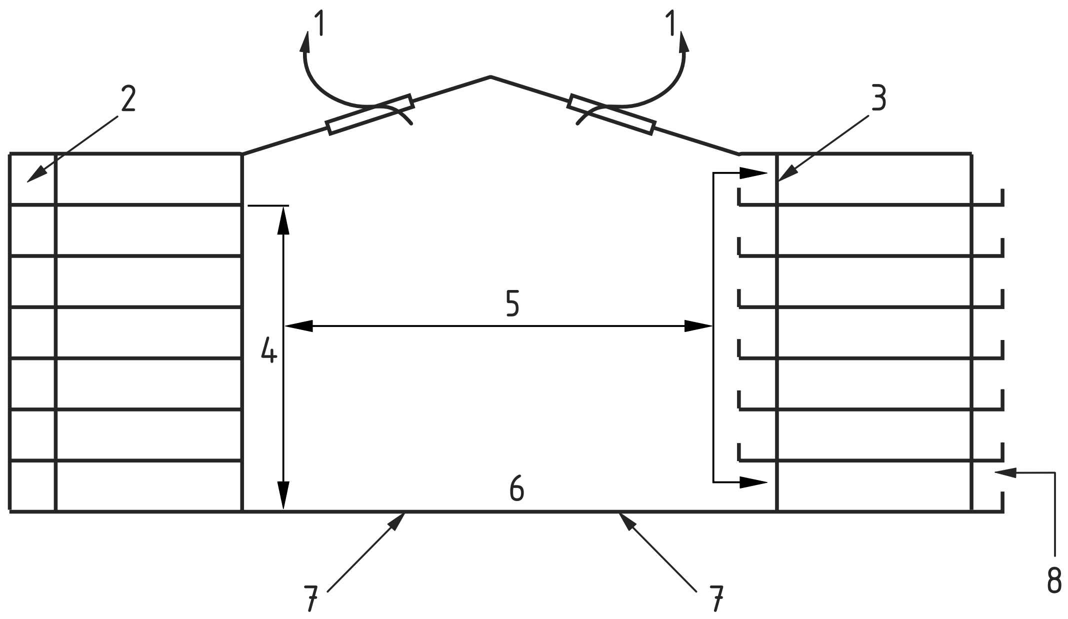


Key

1 Smoke clearance system
2 Accommodation with 60 min fire-resisting (integrity and insulation) and smoke-retarding construction
3 Unenclosed balconies
4 External wall
5 Atrium base: no control required
6 Make-up air

The fire alarm and warning should be appropriate for the equivalent non-atrium building.

Figure C.33 **Exemplar 18 – Occupancy characteristics Ci and Cii – Long term occupancy, unlimited heights**

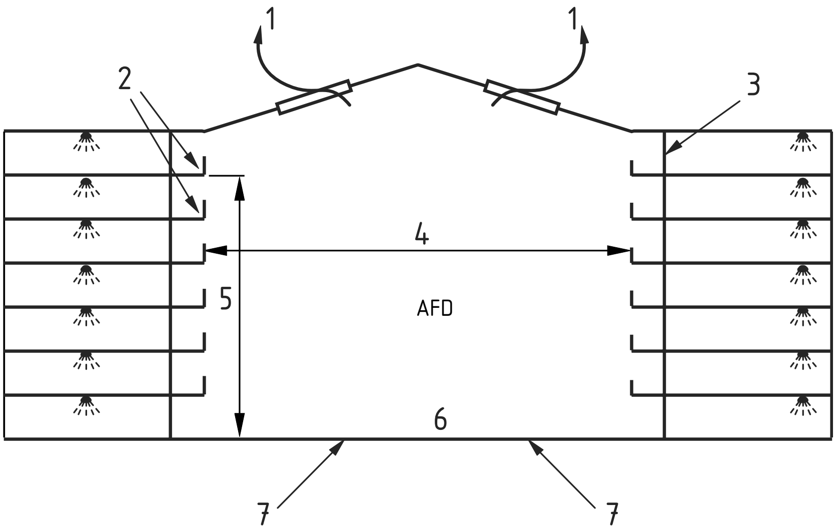


Key

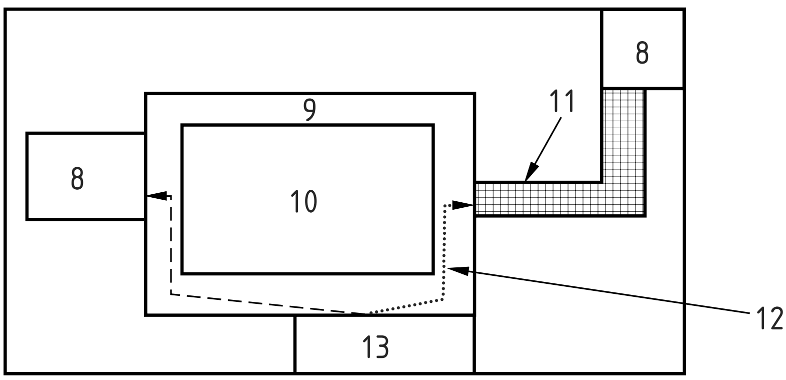
1 Smoke clearance system
2 Protected internal escape route
3 Accommodation with 60 min fire-resisting (integrity and insulation) and smoke-retarding construction
4 Unlimited height
5 Unenclosed balconies
6 Atrium base: no control required
7 Make-up air
8 External escape

The fire alarm and warning should be appropriate for the equivalent non-atrium building.

Figure C.34 **Exemplar 19 – Occupancy characteristic Cii – Long term occupancy, unlimited height, managed**



a) Section



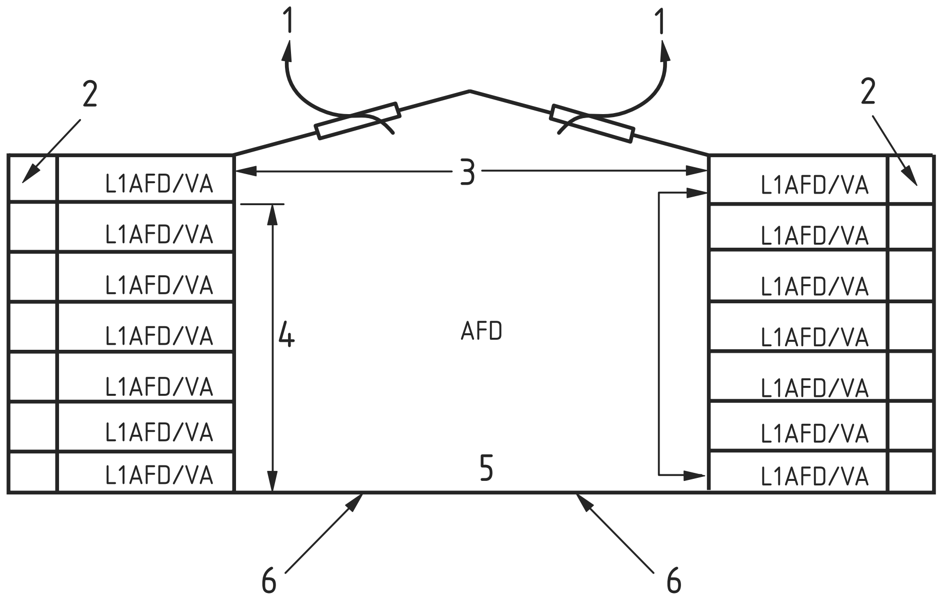
b) Plan

Key

1	Smoke control system validated by a fire engineering appraisal to ensure that untenable conditions are not created to means of escape in atrium
2	Means of escape in two directions to independent, protected escape routes
3	Accommodation with 60 min fire-resisting (integrity and insulation) construction
4	Unenclosed balconies
5	Unlimited height
6	Atrium base: controlled fire load
7	Make-up air
8	Storey exit
9	Unenclosed balcony
10	Atrium
11	Protected corridor
12	Maximum travel distance of 18 m from bedroom door to nearest protected corridor or stairway
13	Flat
AFD	Automatic fire detection appropriate to the smoke control system
	Automatic sprinkler protection
········►	Escape route
— — ►	Alternative route

The fire alarm and warning should be appropriate for the equivalent non-atrium building.

Figure C.35 **Exemplar 20 – Occupancy characteristic Ciii – Short term occupancy, protected escape route**

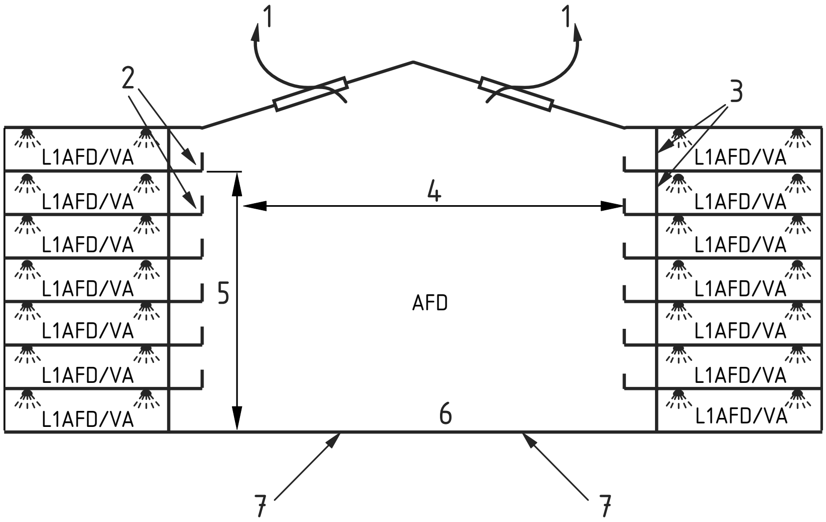


Key

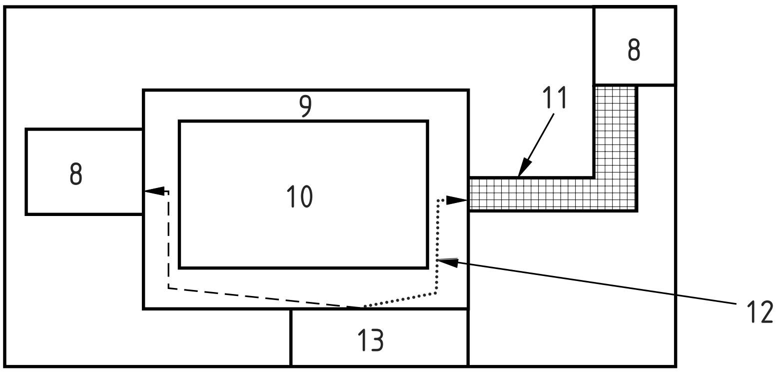
1	Smoke clearance system
2	Protected escape route directly from accommodation independent of atrium
3	30 min fire-resisting and smoke-retarding construction
4	Unlimited height
5	Atrium base: controlled fire load
6	Make-up air
AFD	Automatic fire detection connected to the building fire alarm system
L1AFD/VA	L1 automatic fire detection [A)] and voice alarm throughout the building

[A)] Automatic fire detection conforming to the L1 standard as specified in BS 5839-1:2002+A2:2008.

Figure C.36 **Exemplar 21 – Occupancy characteristic Ciii – Short term occupancy, unenclosed balcony escape route**



a) Elevation



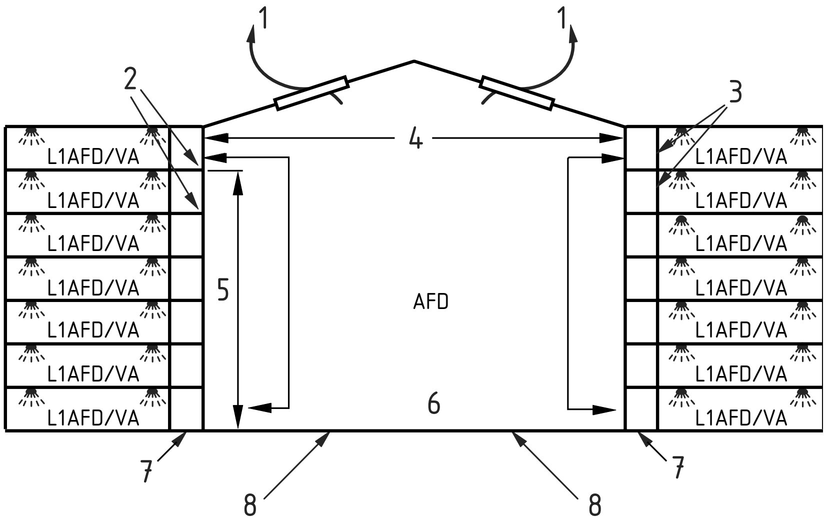
b) Plan

Key

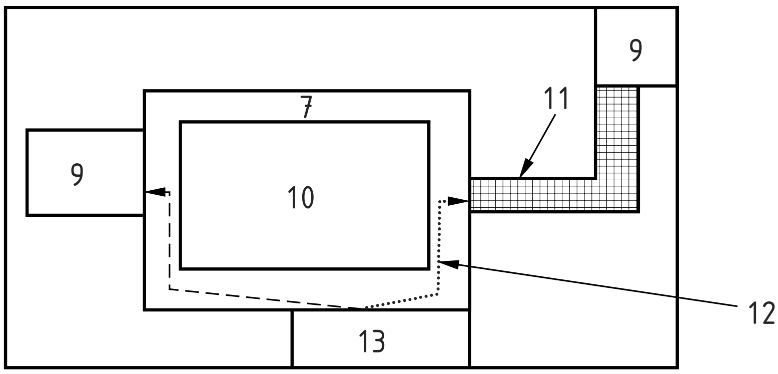
1	Smoke control system designed to ensure that untenable conditions are not created to means of escape in atrium (see **B.6.2**)
2	Means of escape in two directions to independent, protected escape routes
3	Accommodation with 30 min fire-resisting (integrity and insulation) construction
4	Unenclosed balconies
5	Unlimited height
6	Atrium base: controlled fire load
7	Make-up air
8	Storey exit
9	Unenclosed balcony
10	Atrium
11	Protected corridor
12	Maximum travel distance of 18 m from bedroom door to nearest protected corridor or stairway
13	Bedroom
AFD	Automatic fire detection connected to the building fire alarm system
L1AFD/VA	L1 automatic fire detection [A] and voice alarm throughout the building
(sprinkler symbol)	Automatic sprinkler protection
········►	Escape route
— — ►	Alternative route

[A] Automatic fire detection conforming to the L1 standard as specified in BS 5839-1:2002+A2:2008.

Figure C.37 **Exemplar 22 – Occupancy characteristic Ciii – Short term occupancy, enclosed balcony escape route**



a) Elevation



b) Plan

Key

1	Temperature control system
2	Means of escape in two directions to independent, protected escape routes
3	Accommodation with 30 min fire-resisting (integrity and insulation) construction
4	Enclosed balcony escape with smoke-retarding construction
5	Unlimited height
6	Atrium base: controlled fire load
7	Enclosed balcony
8	Make-up air
9	Storey exit
10	Atrium
11	Protected corridor
12	Maximum travel distance of 18 m from bedroom door to nearest protected corridor or stairway
13	Bedroom
AFD	Automatic fire detection connected to the building alarm system
L1AFD/VA	L1 automatic fire detection [A)] and voice alarm throughout the building
(sprinkler symbol)	Automatic sprinkler protection
·········►	Escape route
– – ►	Alternative route

[A)] Automatic fire detection conforming to the L1 standard as specified in BS 5839-1:2002+A2:2008.

Annex D (normative) Recommendations for theatres, cinemas and similar venues

D.1 General

In theatres, cinemas and similar venues, escape routes should be designed so that in the event of a fire they are capable of enabling the occupants to evacuate the whole building.

NOTE 1 The provisions recommended in this annex might be more onerous than those required to meet building regulations.

NOTE 2 Further guidance on these buildings is given in Technical standards for places of entertainment *[78].*

D.2 Discharge from stairs and final exits

Where an escape route or routes from one or more tiers in a theatre, cinema or similar venue discharge into a foyer, the foyer should be enclosed with fire-resisting construction.

Where escape routes from different auditoria within a theatre, cinema or similar venue, e.g. from different cinemas within a multi-cinema complex, discharge into a common foyer, the foyer should be enclosed with fire-resisting construction and protected lobbies should be provided between the foyer and the escape routes discharging therein.

The foyer may be part of an escape route from an assembly area only if the other escape route(s) from that area lead directly to a place of ultimate safety.

The width of a final exit should be not less than that of the escape route leading to it.

Any external portion of an escape route between a final exit and street level, e.g. across a concourse or pedestrian walkway, should be clearly defined and if necessary guarded with protective barriers in accordance with BS 6180.

Final exits should be so sited that they are clear of any risk from fire and/or smoke.

Transformer chambers, boiler rooms and similar areas of risk should not have openings near any exits from the building.

D.3 Seating and gangways

D.3.1 General

The limitations on travel distance (see **D.3.2**) control the maximum spacing of exits but the actual seating layout might call for some adjustment of exits so that they are conveniently sited for the gangways. Traditionally, the number of seats in a row has been limited to an arbitrary figure, although a good seating layout can assist orderly movement to the exits. Where gangways are provided at each end of the rows of seating, the number of seats in a row is relatively unimportant provided that travel distances are complied with and generous seatways are provided (see also **D.3.3**). Routes and exit spacings should take into account the provision made for wheelchair spaces, and the numbers of wheelchair users and ambulant disabled people likely to be present in the building (see also BS 8300).

Exits sited towards the back of the seating can reduce travel distance and possibly assist planning, although it might be necessary to provide some form of smoke control to prevent smoke logging of the routes leading to the exits. In a sports arena, where the risk from the activity area is negligible, exits may be sited so that spectators move towards the activity area.

D.3.2 Seat layout and travel distances

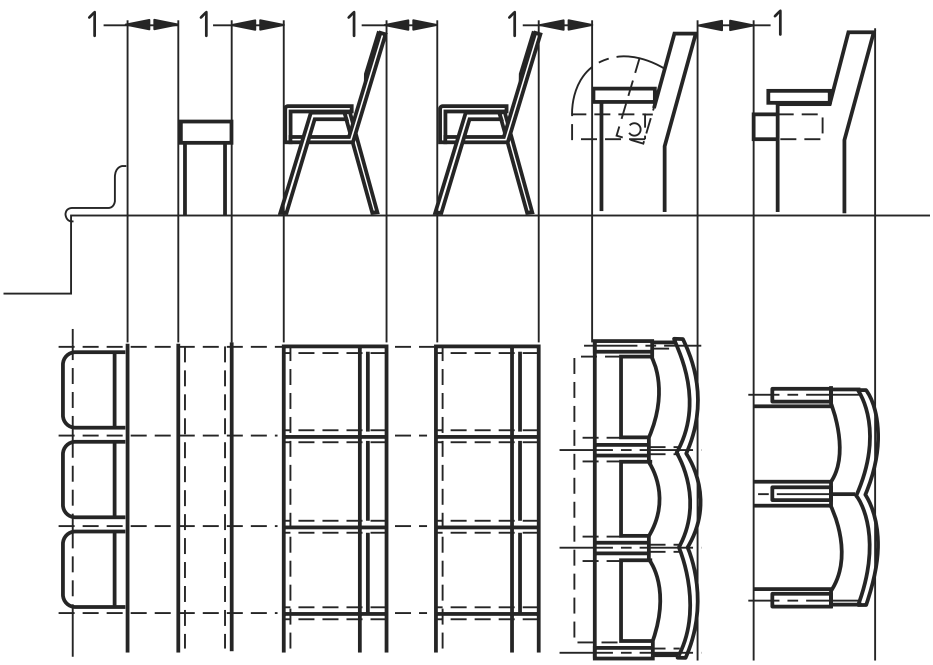
NOTE 1 Seatways in front of blocks of seating may be up to 900 mm in width without being treated as a gangway.

Seatways provide the initial parts of escape routes and hence need to be of sufficient width to enable all persons in a row easy movement towards the gangway(s). Seatway widths (see Figure D.1) should be not less than 300 mm and should be constant throughout the length of the row. Where seats tip up automatically, the seatway width should be measured between the back of one seat unit and the maximum projection of the seat unit behind when the seat is in the up position.

NOTE 2 An example of the application of Table D.1 is shown in Figure D.2.

The number of seats in a row should be in accordance with Table D.1.

Figure D.1 **Determination of seatway**



Key

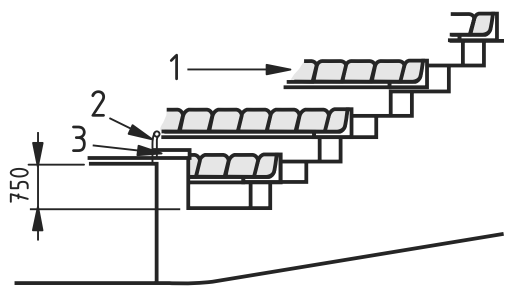
1 Seatway

Table D.1 **Number of seats in a row**

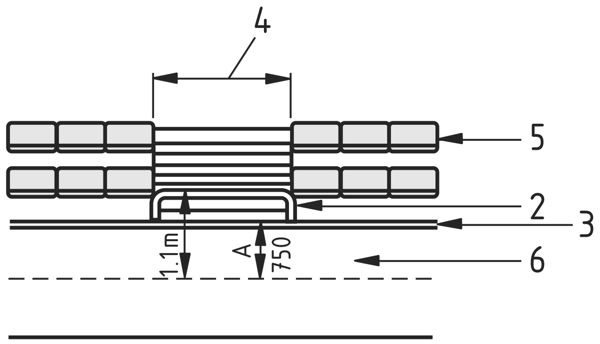
Seatway width	**Maximum number of seats in a row**	
mm	**Gangway on one side**	**Gangway on two sides**
300 to 324	7	14
325 to 349	8	16
350 to 374	9	18
375 to 399	10	20
400 to 424	11	22
425 to 449	12	24
450 to 474	12	26
475 to 499	12	28
500 or more	12	Limited by the travel distance (see Table D.2)

Figure D.2 **Example illustrating protection of balconies with fixed seating**

Dimensions in millimetres, unless otherwise stated



a) Section



b) Elevation

Key

1 Fixed seating forming part of a balcony
2 Guard rail
3 Coping not less than 230 mm wide
4 Gangway
5 Fixed seating
6 Balcony front

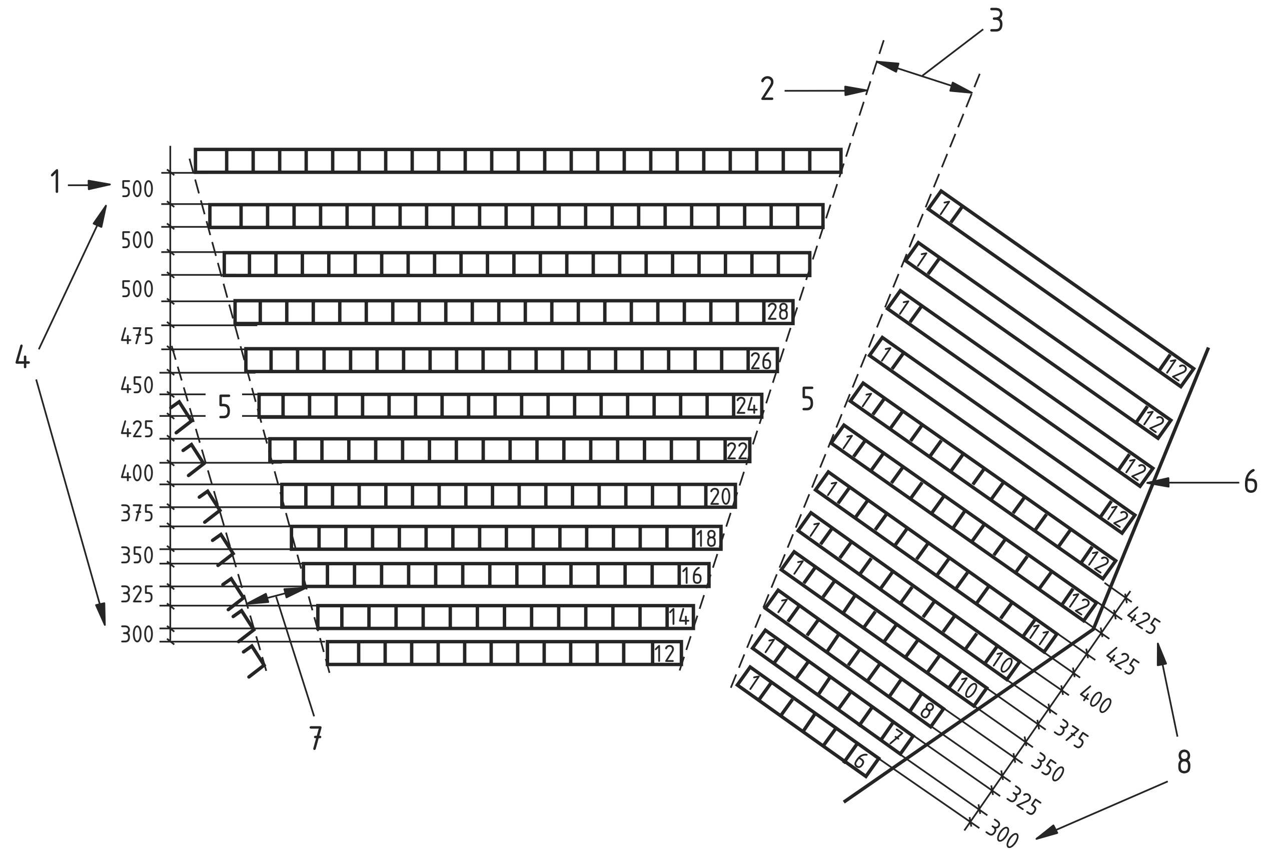
If the coping is less than 230 mm wide then dimension A should be 790 mm.

The slope of a tier of seating should not exceed 35° above the horizontal.

Balconies should be guarded with protective barriers in accordance with BS 6180 (see also Figure D.3).

Figure D.3 **Seatway width and number of seats in a row**

Dimensions in millimetres



Key

1 Minimum for rows of any length over 28 seats
2 Maximum length of row determined by travel distance to an exit
3 Width of gangway increasing in direction of escape
4 Minimum seatway in rows with a gangway on each side
5 Gangway
6 Maximum number of seats in a row with a gangway on one side only
7 Length of rows adjusted to preserve uniform gangway width
8 Minimum seatway in rows with a gangway on one side only

Dining facilities are frequently provided within auditoria (e.g. theatre restaurants) and in sports arenas (e.g. hospitality boxes). Where these facilities are provided for a closely seated audience:

a) the travel distances should be not more than the maximum distances given in Table D.2;

b) tables should be arranged so that there is no encroachment on the seatway width;

c) the chairs should be swivel-mounted for easy use;

d) there should be no more than 12 seats in a row.

Table D.2 **Maximum travel distances**

Available direction of escape	**Areas with seating in rows** m	**Open floor areas** m
In one direction only	15	18
In more than one direction	32 [A)]	45 [B)]

[A)] This may include up to 15 m in one direction only.
[B)] This may include up to 18 m in one direction only.

D.3.3 Gangways

Gangways should be carefully detailed to provide an unhindered flow towards the exits. Gangways may be flat, sloping or stepped. Where stepped, excessively long flights should be avoided, particularly where the seating is at the maximum slope (35° above the horizontal; see **D.3.2**).

Stepped gangways should not be treated as stairs. Consideration should be given to the provision of central handrails to stepped and sloping gangways.

Central handrails should be discontinuous, with gaps every few rows to improve access to seats and to permit crossing from one side of the gangway to the other. The addition of an intermediate rail below the main handrail facilitates use by children.

Gangways should conform to the following specific recommendations.

a) Gangways should be not less than 1 100 mm wide, unless used by not more than 60 persons in which case they should not be less than 900 mm wide.

b) There should be no projections which would diminish the clear width of the gangway, other than any handrails each intruding not more than 100 mm. If a handrail intrudes more than 100 mm into a gangway, for the purposes of calculating the capacity of the gangway the gangway width should be regarded as reduced by the amount that the intrusion exceeds 100 mm. Central handrails with a width not exceeding 100 mm should be ignored when determining gangway width.

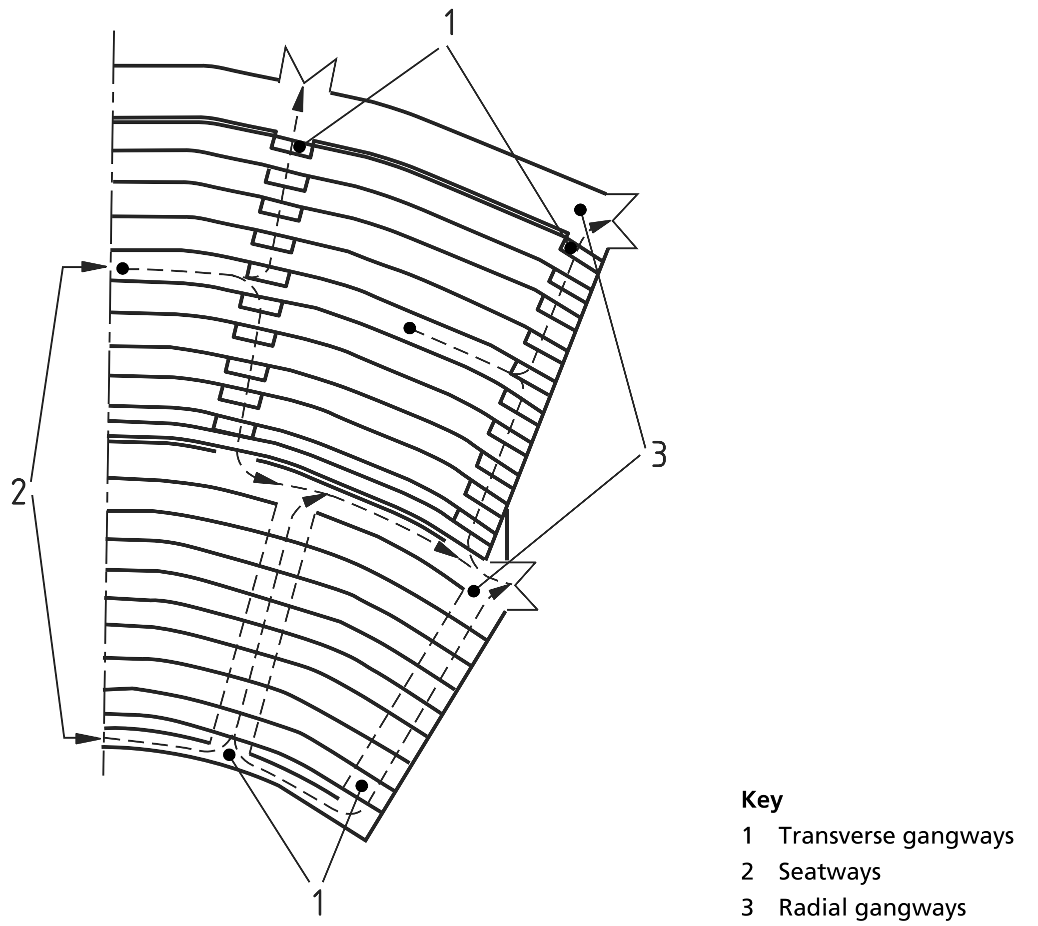
c) The ends of all rows of seats should be so aligned as to maintain a uniform width throughout the length of a gangway, unless the escape flow would be in one direction only (i.e. access to any alternative means of escape is along the rows), in which case the gangway may widen towards the storey exit.

d) Where a gangway provides access to a wheelchair space, the escape route from that space should be suitable for wheelchair users (see BS 8300).

e) Storey exits provided within the body of a seating layout should be approached from the side by transverse gangways.

f) Transverse and radial gangways in auditoria with tiered seating should not cross each other (i.e. any intersections should be "T" junctions) (see Figure D.4). Connections between transverse and radial gangways should be offset to ensure a smooth flow to the exits.

Figure D.4 **Transverse and radial gangways**



NOTE In some auditoria, the seating rake is a parabola and, as long as the variation in step rise is uniform, adjacent steps are deemed to be of equal height.

g) In stepped tiers, the height of each step in a gangway should be not less than 100 mm and should not exceed 190 mm. Where there are two or more rises to each row of seats each step should be of equal height.

h) The number of steppings in a tier uninterrupted by cross-gangways should not exceed 40 if the rake exceeds 25°.

i) Where exits are approached from a stepped gangway, there should be a landing the width of the exit and at least 1 100 mm deep immediately in front of the exit doors.

j) Stepped side gangways should be provided with a handrail fixed at a height of 840 mm measured vertically from the centre of the steps and projecting not more than 100 mm from the wall. If the gangway is at the side of a tier which does not extend up to a wall, the edge of the tier should be protected by a balustrade or guardrail to a height of not less than 1 100 mm above the centre of the steps.

k) There should be no change of level between a seatway and the adjacent gangway. The gangway should not be stepped (or sloped with a differing slope) where the seatway meets the gangway. This does not preclude steps from the seatway to the gangway so long as handrails are provided. Any steps from a seatway should be at right angles to the line of travel along the seatway.

l) The nosings of stepped gangways should be made very conspicuous. This is particularly important in entertainment areas where light levels might be low. Markings using LEDs are particularly efficient.

D.3.4 Fixing of seats for closely seated audiences

Seating should be securely located in position to avoid gangways and exits being obstructed by displaced and overturned seats, especially in a hurried evacuation.

Seating may be permanent or temporary depending on the use of the assembly area but the recommendations for layout and gangways apply in either case.

Where the seating layout is permanent, all seating (except for chairs in boxes and similar small enclosures) should be firmly fixed to the floor. All seats on telescopic or retractable units and tiered platforms of any type should also be securely fixed.

Temporary seating consists of three types.

a) *Retractable or telescopic seating (normally used in a multi-purpose hall or sports arena)*. This may be a fixed installation drawn out from the surrounding enclosure or the whole unit may be moveable to form a number of seating layouts. Retractable or telescopic seating, when in the extended position, should be provided with locking devices to prevent movement.

b) *Demountable seating*. This comprises tiered seating assembled from kits of parts, and disassembled after use.

c) *Rows of portable seating*. This may be provided in the activity area of a sports arena or on the open space of a multi-purpose hall and may be provided on a structure to provide satisfactory sight lines.

Temporary seating should conform to the following recommendations.

1) Seating for more than 50 persons laid out on the floor area should be secured together in lengths of not fewer than four seats.

2) If seating for more than 250 persons is required, provision should be made for fixing to the floor the rows of seating flanking the front, the back and the cross gangways and the seats near exits, although only the end seats of the rows need to be fixed to the floor if all the seats are secured together.

NOTE Where the fixing of seating to the floor is impracticable or undesirable (e.g. on polished dance floors), floor bars instead of screws may be used. Floor bars should have a cambered top surface so as to avoid the risk of tripping by persons using the seating. This form of securing seating is not recommended where a very lively audience is anticipated, such as at a pop concert.

3) Where seats are secured together, it should not be possible to separate them, nor for a row to "snake", merely by pushing one or more seats in a row.

Access should be available beneath all temporary tiered seating to clear any accumulated rubbish.

The underside surfaces of all plywood decks to temporary seating should be Class 0. All surfaces of side panels, back panels and fascias to temporary tiered seating should be Class 0.

D.3.5 Fire rating of seating

The construction of the building, the standard of linings and the heating, lighting and ventilation standards provide a level of safety upon which travel distance is based. The standard of seats is also an important consideration.

Seats provided for a closely seated audience should meet the pass criteria for smouldering ignition source 0, flaming ignition source 1 and crib ignition source 5 when tested in accordance with BS 5852:2006, Clause **12**.

D.3.6 Furnishings, fabrics and decorative features

Furnishings, fabrics and decorative features (which include drapes and artificial foliage) need to be of materials which in themselves do not present an unacceptable increase in the combustible materials within the building, and those which would not cause rapid spread of fire or smoke generation if involved in a fire. They should conform to the following specific recommendations.

a) Furnishings, fabrics and decorative features should be non-combustible or should conform to the requirements for classification as type B in accordance with BS 5867-2:2008 after being subjected to the appropriate wetting or cleansing procedure described in BS 5651.

b) Furnishings, fabrics and decorative features should not be provided within enclosed escape routes (other than foyers) unless made from non-combustible materials.

c) Drapes should not be provided in front of exit doors or across escape routes.

d) Textile floor coverings, together with any underlay, should, when tested in accordance with BS 4790, using the test procedure reflecting the method used for securing the floor covering to the floor, either:

   1) not ignite; or

   2) have effects of ignition on both the use-surfaces and under-surfaces not extending beyond a circle of radius 35 mm centred on the central point of application of the nut.

D.4 Ancillary accommodation

Ancillary accommodation for public assembly buildings should be separated from other parts of the building in accordance with **32.5.7**.

D.5 Stage areas

D.5.1 General

The stage area comprises the stage and its ancillary areas, such as property stores and quick-change rooms.

There might be a high fire loading on the stage, particularly because of the quantities of scenery and curtains involved. The risk of fire can be increased because of temporary and flimsy properties and furniture and temporary lighting equipment, and sprinklers might be advisable. The stage area, however, is likely to have close supervision whenever the public is present.

NOTE 1 Where the stage does not have a safety curtain, the responsible authority can limit the amount and type of scenery used. If there is no safety curtain, the need for higher standards of flame retarding can limit the materials used for the construction of scenery and can materially increase running costs whilst limiting the types of use, e.g. touring productions intended for separated stages might not be permitted. A detailed discussion of these matters is beyond the scope of this British Standard and the licensing conditions of the relevant authority should be consulted.

A proscenium wall, safety curtain and stage ventilation can protect the audience from the effects of fire on stage for sufficient time to allow them to evacuate the premises.

Other stage forms in which the audience is more closely associated with the performance cannot easily be separated from the audience, and escape routes for the players on the stage may include audience gangways. Such stages include the open or end stage (where the proscenium wall is omitted), theatre-in-the-round or arena stage (where the audience sits on all sides of the stage) and the thrust stage (where the audience sits on three sides of the stage).

Where an arena stage is the permanent stage arrangement, there need to be separate access routes for the players from the dressing rooms. Where practicable, additional escape routes separated from audience escape routes also need to be provided. Such provisions are generally impracticable where the arrangements are temporary, e.g. in a multi-purpose hall with a flat floor and temporary seating.

Grid and fly galleries provide facilities for flown scenery. These involve working above the stage and are particularly hazardous situations in the event of fire on the stage. Working access has been traditionally by fixed ladders. In a fire situation it is essential that there is access to alternative means of escape.

Stage areas should conform to the following specific recommendations.

a) Escape routes from the stage and stage basement should conform to **D.1**, **D.2** and **D.3** and travel distances should conform to those listed in Table D.2 for open floor areas.

b) Protected lobbies should be provided between:

   1) the stage and the dressing room corridor(s);

   2) the stage and a final exit to the open air;

   3) the stage and the auditorium when a "pass" door is provided in a proscenium wall;

   4) the stage basement and the orchestra pit.

NOTE 2 The stage basement is considered to be part of the stage and hence there is no need for fire-resisting separation between it and the stage.

c) A proscenium wall, where provided, should be of non-combustible construction having a standard of fire resistance equivalent to that required for the elements of construction of the building and in no case less than 60 min. The wall should be carried up from the lowest level of the stage basement to the under-side of the roof.

d) Where a safety curtain is provided:

   1) it should be of robust and rigid construction;

   2) it should consist entirely of non-combustible materials;

   3) it should be able to withstand damage by scenery, properties or falling debris, and be of such strength and stiffness as to resist the pressure of air likely to be caused by fire in the stage area without such distortion as would cause its withdrawal from its retaining guides;

   4) an adequate seal against the passage of smoke between the moveable curtain and the fixed structure should be provided;

5) it should be able to withstand the effect of fire for a sufficient period to allow the complete evacuation of the building;

6) it should be so designed (with any necessary counterweight) that, notwithstanding the air pressure on the face of the curtain which could result from a fire, it will close the proscenium opening completely within 30 s from the operation of the release mechanism;

7) the stage should be ventilated (further information on separated stage ventilation is given in **D.5.4**);

8) where necessary to maintain the integrity of the safety curtain, the curtain and the curtain guides should be protected by a hand-operated drencher system which should be fitted with suitable heads adequate to spray the whole of the stage face of the curtain and to keep the curtain and guides cool in the event of fire whilst the curtain is descending;

9) hand release gear, to cause the descent of the curtain and the operation of the curtain drencher system, should be provided in duplicate and be clearly indicated. One such release should be on the working side of the stage and the other in a position outside the stage, e.g. by the stage door office, readily accessible to fire-fighters or authorized staff;

10) means should be provided for testing the operation of the curtain drencher system.

e) The grid and galleries, including lighting galleries and perches, should be of non-combustible construction, except that superimposed walkways to galleries may be of other material acceptable to the responsible authority.

f) The working fly gallery(ies) and the grid should each be provided with an escape route independent of the stage by way of:

1) a storey exit to an external route; or

2) a doorway to another part of the building leading to a storey exit.

D.5.2 Dressing rooms

Theatre dressing rooms are areas of intense activity during a stage presentation. There might be flimsy and flowing dresses, and hot electrical equipment. For these reasons, dressing rooms should be enclosed with fire-resisting construction.

Means of escape from dressing rooms should be in accordance with the recommendations in **D.2**; seating in dressing rooms should be in accordance with the appropriate recommendations in **D.3**.

At least one escape route should be independent of the stage, but the recommendations for travel distance may be met by an escape route via the stage.

D.5.3 Scene docks

Scene docks are high fire risk areas because they might contain large quantities of combustible materials, and the fire-resisting separation from the stage might be open during a performance to allow the movement of scenery.

Any opening between a scene dock and the stage should be protected by a fire door.

Scene docks should be ventilated in accordance with **D.5.4** other than item b). A manual operating device should be sited in a readily accessible position outside the scene dock.

D.5.4 Separated stage ventilation

Ventilation above the stage grid is essential if the safety curtain is to be effective in a fire. This ventilation may be provided by openable vents or by a powered system.

The use of a safety curtain imposes a severe restriction on the flow of replacement (inlet) air to the stage area, causing the neutral pressure plane in the stage area to rise above the proscenium arch. This ensures that the pressure differential established across the leakage paths between the stage area and the auditorium prevents smoke from being forced into the auditorium, although the stage area is likely to become totally smoke-logged.

Separated stage ventilation should conform to the following recommendations.

NOTE Very large stages with separated side or rear stages may have separate ventilators for each stage area.

a) A separated stage should be provided with ventilation at high level above the stage grid by either:
   1) natural exhaust ventilators or haystack lantern light ventilators, providing an aerodynamic free area of 10% of the area of the stage; or
   2) two or more powered exhaust ventilators designed to provide a total exhaust airflow equivalent to that recommended in item a1).
b) Stage ventilators should open automatically:
   1) on operation of a fusible device designed to operate at a temperature not exceeding 74 °C and so sited below the base of the ventilator as to be clear of the water spray from any sprinkler or drencher system provided;
   2) on operation of the sprinkler system protecting the stage;
   3) on operation of a manual release [see item c)].
c) There should be means for manually operating the stage ventilators; such devices should be provided in duplicate and should be clearly indicated. One such device should be on the working side of the stage and the other in a position outside the stage, e.g. by the stage door office, readily accessible to fire-fighters or authorized staff.
d) The stage ventilation system should be designed to be effective in all wind directions.
e) Means should be provided to enable the ventilators and their mechanisms to be regularly maintained. In addition, means should be provided whereby the ventilators can be closed following a test without recourse to the roof.
f) Powered ventilation systems operating within the stage area should cease functioning on the operation of the stage ventilation system.
g) Haystack lantern light ventilators should conform to **D.5.6**.
h) Natural and powered smoke and heat exhaust ventilators should conform to BS EN 12101-2 and BS EN 12101-3 respectively.

D.5.5 Ventilation for open stages

Exhaust ventilation, preferably mechanical, should be provided over any open stage. The extract system over an open stage should be sized to keep the auditorium relatively clear of smoke during the period of evacuation in the event of a fire on stage. The size and minimum fire resistance of the system will depend upon the size of the stage. Unless determined otherwise, exhaust ventilators over an open stage should have a combined total aerodynamic free area at least 10% of the area of the stage.

D.5.6 Haystack lantern light ventilators

NOTE Safety chains or shock absorbers may be fitted to the sashes provided that they allow the sashes to open to the full extent needed to meet this recommendation.

Where haystack lantern light ventilators are installed, sashes on each side of any lantern light should be bottom-hung so as to open outwards under the force of gravity and should be glazed with either thin sheet glass, or a thin alloy or plastics sheet that would rupture or melt when subject to uncontrolled fire conditions.

Provision should be made for all sashes in any lantern light to be opened simultaneously.

Annex E (normative) Recommendations for shopping complexes

NOTE Whilst the recommendations set out in this annex are generally capable of being applied to most new shopping complexes, some variation is acceptable in small developments where full compliance with the recommendations could be difficult, and in uncovered shopping complexes where some recommendations might be inappropriate. It is also necessary to consider problems associated with refurbishment of existing complexes of all sizes. Constraints imposed by the existing building can necessitate considerable flexibility in applying the recommendations. These forms of development are dealt with in ***E.5****.*

E.1 Planning in relation to fire

E.1.1 General

Many early pedestrianized shopping centres were designed with single-level shop unit access and with the public circulation spaces open to the elements. However, with a few exceptions the trend is now for multilevel covered malls with a variety of sizes of unit, and much free space between them so that barriers are not created for shoppers. Early centres tended to be planned on simple straight axial lines, whereas current developments are often designed with a more complex circulation pattern, to achieve interest and encourage pedestrian flow. Lightness in structure and atmosphere is now the norm. Large open spaces and features such as atria and multilevel shop access are common. Aids to easy circulation, such as lifts and escalators, are emphasized in the overall design concept. Fountains and displays are included to add interest. Entertainment facilities and other uses can be included to add variety and attract custom in new developments and to improve existing ones.

The modern shopping complex offers a different set of fire safety problems from those that are common to a single shop, and this annex considers these problems and how to mitigate possible fire hazards.

E.1.2 Site planning

The siting of shopping complexes that form part of the redevelopment of town centre sites is likely to be restricted by existing development. These restrictions might introduce additional fire safety problems, such as access arrangements for fire-fighters, servicing and car parking arrangements. It is also necessary to ensure that the interface between the complex and any surrounding development is satisfactory. Existing shops and other buildings on the periphery of a complex can be incorporated to their benefit into the new complex, and it is then necessary to ensure that their fire safety standards do not prejudice the fire safety of the new complex, and that any necessary fire separation is provided.

Such problems are unlikely with out-of-town shopping complexes, and a large and relatively unrestricted site can offer the opportunity for large-scale leisure facilities and a wide range of other uses to be incorporated in the overall development. The impact of these activities on the commercial part of the complex should be taken into account when developing a fire safety strategy for the whole complex.

E.1.3 Common public areas

A shopping complex is characterized by pedestrian malls that provide public access to the individual units. These malls are the principal common public areas in a complex. Where malls are uncovered, fire safety problems are largely those of any conventional shopping development except that the malls need to be wide enough for means of escape purposes, and to restrict the likelihood of a fire in one unit affecting the one opposite. With covered malls, however, a number of fire safety problems arise and this annex considers the means to overcome these problems.

First, a covered shopping complex aims to provide an atmosphere, independent of weather conditions, that is comfortable and attractive to shoppers. There might be a higher than typical occupancy of people more at risk in the event of fire due to the ease of accessibility of these premises. In a conventional high street situation, persons escaping from a fire in a shop are considered to be safe once they have left the shop and moved into the open air. However, by enclosing these pedestrian routes a different set of fire safety conditions pertains. People exit into the mall from the affected unit and this additional stage in their escape needs to be effected with relative safety as the malls are a substitute for the public highway, where occupants escaping would expect to find freedom of movement and ultimate safety.

Motivation to escape is important. Research of several major fatal fires and evacuations suggests that in large internal spaces people in a crowd have difficulty in recognizing any immediate threat from a fire elsewhere in the building. People are also likely to underestimate how quickly a fire can spread. In a fire disaster, the uncertainty of the situation in its early stages is usually compounded by a serious delay in warning the public in time for them to start to evacuate and reach safety. To overcome these problems it is necessary to provide a package of related fire precautions measures, complementary staff training and evacuation management procedures, and to introduce appropriate means of escape criteria, aimed at achieving an acceptable level of means of escape conditions in these areas, taking into account the potential risk profile. These aspects are dealt with in **E.3** and **E.4**.

E.1.4 Atria

Multilevel malls pose fire safety problems similar to those in atria as in both cases there is a problem of ensuring that a fire at a lower level does not prejudice the safety of persons on an upper level, and hence some form of smoke control is needed.

Annex B gives recommendations for buildings containing atria, and should be referred to in appropriate cases.

E.1.5 Servicing and car parking

As complexes increase in size, so decisions about servicing arrangements become more critical. Servicing at ground level from surrounding open areas poses least fire safety problems. Whilst such an arrangement might be possible in some out-of-town complexes, where site space is not at a premium, it is rarely an option in more urban forms of development, where basement, roof top, or even intermediate level servicing might be the only possibilities. Whatever the arrangements made for servicing, it is essential to ensure strict segregation of vehicular and pedestrian areas, and to provide adequate standards of fire separation between the shopping part of the development (including public common areas such as the malls) and any servicing areas.

Site considerations and local needs will generally determine the form and extent of car parking arrangements, but the relationship between the car parking areas and the rest of the development is important. In the event of an emergency evacuation, many people who arrived at the development by car will endeavour to leave via the car park in order to retrieve their cars. This might be particularly likely for people with a mobility impairment, who might feel more able to escape in their vehicle, or via the ramped access provided for cars, rather than by emergency stairs. Whether or not this is acceptable will depend on the location and separation between the car parking areas and the rest of the complex, but it is a situation that needs to be taken into account in planning for means of escape. A design that leads to a contraflow between people leaving the complex by the normal escape routes, and people seeking to leave via the car park, should be avoided.

Similarly, the locations of vehicular exits from the car park areas and fire and rescue service access points to the complex need consideration. Depending on the size of the complex, several fire and rescue service access points might be needed, and car park exits should not cause conflict with fire and rescue service access at these points.

E.2 Facilities for the fire and rescue service

E.2.1 Access and water supplies

E.2.1.1 Single-storey shopping complexes

NOTE 1 The dimensional recommendations given in this subclause are generally applicable for single-storey complexes up to about 30 000 m² and/or having one dimension not greater than 190 m. Where the overall floor area of a complex is particularly extensive, it might be necessary to increase the recommended dimensions.

The distance between the fire appliance and the fire should be kept to a minimum, to reduce the time taken for laying out hose. The provision of a wet fire main system can enable an increased distance between the fire appliance parking position and the wet main outlet valves. The route within the complex taken by fire-fighters to reach the outlet valve should be protected by fire-resisting construction.

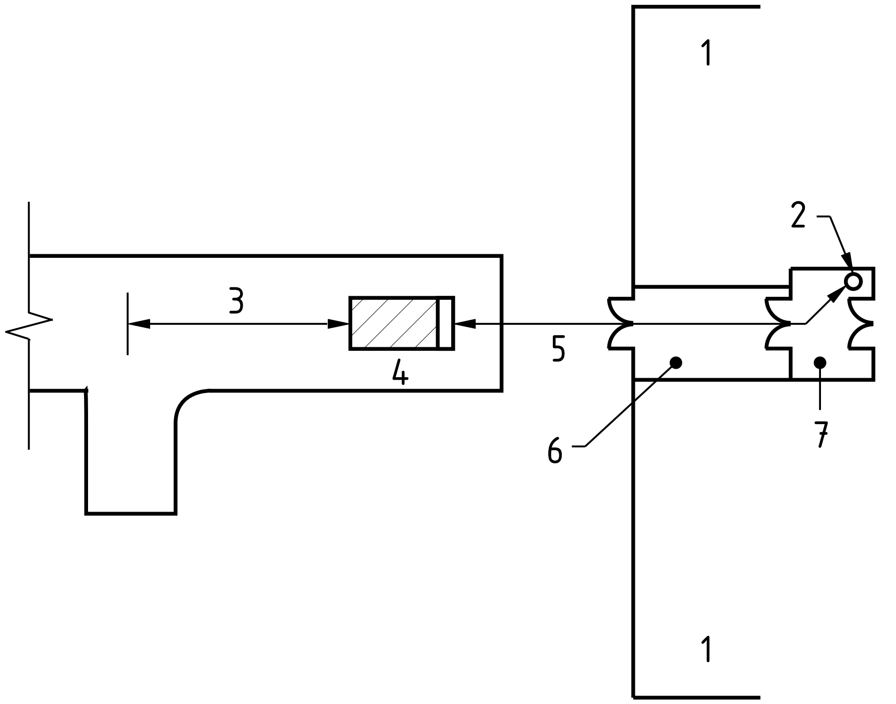
If a wet fire main system is installed, it should conform to BS 9990 and fire appliance access should be provided to within 45 m of each of a sufficient number of outlet valves such that no point in the building is more than 60 m from an outlet valve, measured along a route suitable for laying hose (see Figure E.1).

NOTE 2 If the internal layout is not known at the planning stage, a direct line measurement of 40 m may be used for design purposes, provided that the building when occupied meets the 60 m criterion.

If a wet fire main system is not installed, fire appliance access should be provided within 18 m of each of a sufficient number of entry points so that no point in the building is more than 60 m from an entry point, measured along a route suitable for laying hose (see Figure E.2).

Turnaround facilities should be provided so that fire appliances do not have to reverse more than 20 m.

Figure E.1 **Access to floor areas in single-storey complexes with wet fire mains**

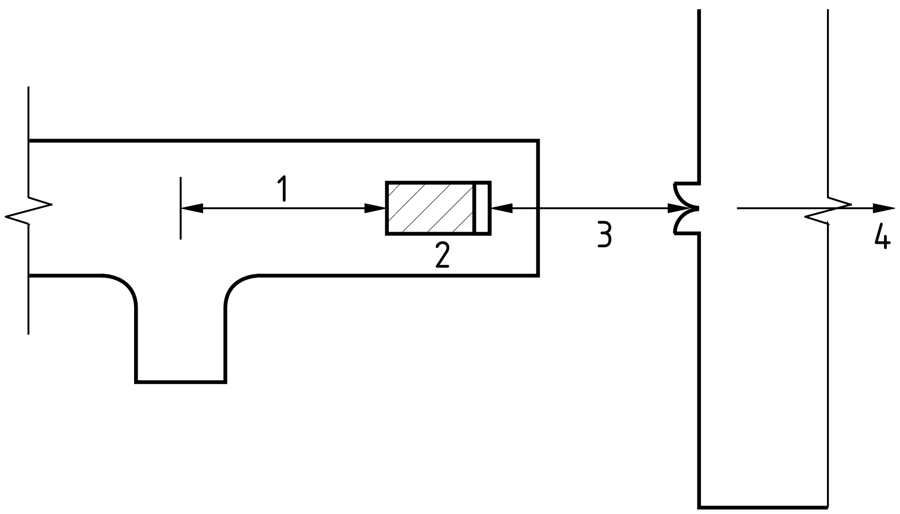


Key

1 Floor area [A)]
2 Wet fire main
3 Reversing distance ⩽20 m
4 Appliance
5 Appliance to outlet distance ⩽45 m
6 Protected corridor
7 Protected lobby

A) No point on the floor area should be more than 60 m from the outlet valve (measured along the hose line) or, for design purposes, more than 40 m in a direct line.

Figure E.2 **Access to floor areas in single-storey complexes with no fire main**



Key

1 Reversing distance ⩽20 m
2 Appliance
3 Appliance to building entrance ⩽18 m
4 Floor area [A)]

A) No point on the floor area should be more than 60 m from the outlet valve (measured along the hose line) or, for design purposes, more than 40 m in a direct line.

E.2.1.2 Multi-storey shopping complexes

Roadways used for fire and rescue service access may be public highways or, if within the boundaries of a large complex, service roadways used by vehicles delivering goods. These access roads can be covered and at any level. If they are covered or are at low level then special provisions might be needed to make it possible to use them for fire and rescue service access. If they are above ground level, access into a building from the roadway may be both upward and downward.

Any floors over an access roadway should be such as to minimize any possibility of collapse onto fire appliances at work during a fire.

Where ramps are used to gain access to upper levels or podium decks where there might be access across the open or top deck to other structures within the complex, they should be of suitable gradient, load-bearing capacity and width for fire appliance use.

NOTE Attention is also drawn to the approving authority's construction requirements for access roadways.

Access roadways for multi-storey shopping complexes should:

a) be positioned such as to allow pumping appliances to proceed to within either:

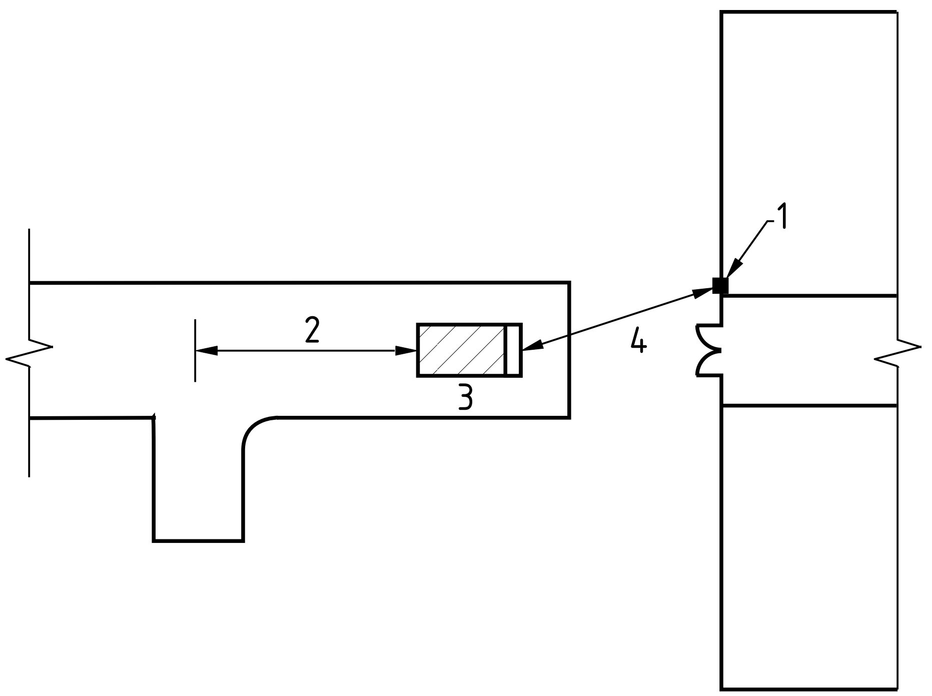
   1) 18 m of, and in sight of, each dry fire main inlet connection point; or

   2) 45 m of each outlet if a wet fire main system is installed;

b) be positioned such as to allow pumping appliances to proceed within 18 m of, and in sight of, any other inlet points, e.g. foam inlet, or infill points to sprinkler or wet main storage tanks;

c) be provided with turnaround facilities so that fire appliances do not have to reverse more than 20 m (see Figure E.3).

Figure E.3 **Access to fire main inlets in multi-storey complexes**



Key

1 Dry main inlet

2 Reversing distance ⩽20 m

3 Appliance

4 Appliance to inlet distance ⩽18 m

Hard-standings should preferably be level or should not exceed a gradient of 1 in 12.

If access roads are enclosed at any level, they should:

1) have a fire resistance of not less than 120 min;
2) be provided with:
    i) ventilation to remove exhaust fumes from a pumping appliance in operation;
    ii) emergency communication systems;
    iii) primary lighting;
    iv) 3 h emergency lighting in accordance with BS 5266-1;
    v) appropriate water supplies.

E.2.2 Communications for fire and rescue service use

Communications systems should be provided within the complex in accordance with the recommendations of Clause **24**.

E.2.3 Fire control centre

A fire control centre should be provided within the complex to enable the fire and rescue service to assume control of an incident immediately on arrival. The fire control centre should conform to the recommendations given in Clause **25**.

E.2.4 Occupancies (other than units) associated with shopping complexes

Where accommodation for other uses, e.g. office blocks, places of entertainment, is sited above or within a shopping complex, it is generally necessary to provide fire and rescue service access to these occupancies that is completely independent of the shopping complex. Any fire-fighting shafts required for these other occupancies should always be independent of the shopping complex.

Where the shopping complex perimeter access roadways are used to reach other occupancies, the roadways should be available for emergency use at all times.

E.3 Planning of escape

E.3.1 Escape routes serving units and other occupancies

E.3.1.1 Number of escape routes from units

The amount of smoke that is likely to be produced from a fire in a shop or other unit in a covered shopping complex could be so great as to put at risk people in other units facing onto the same mall. Alternative means of escape therefore need to be provided from these units, either at a different level or at the same level but leading to a different final exit, even if alternative means of escape are not recommended in Section **5**. Except for large units, this alternative exit may lead through a service corridor (see **E.3.1.4**).

NOTE Escape routes from units are illustrated in Figure E.4.

The means of escape in units should be designed in accordance with the recommendations contained in Section **5**. Small units and kiosks with a single exit do not need to be provided with alternative means of escape unless they exceed 25 m^2 in total area and 5 m in depth (i.e. the distance from the mall frontage to the back of the unit, including any non-retail space).

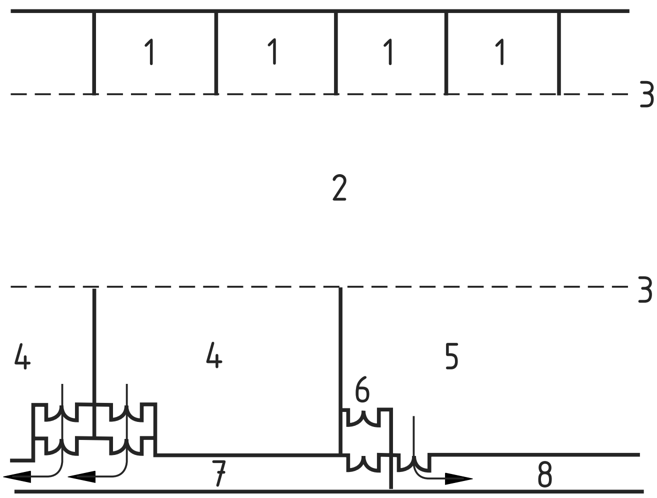
At least one alternative means of escape from any unit (other than a small unit or kiosk) should discharge either:

a) at a different level from that at which the entrance to the unit is situated; or

b) at the same level, but leading to a different final exit(s).

Any exit from a unit that has an occupant capacity exceeding 300 persons should not discharge into a service corridor.

Figure E.4 **Alternative escape routes from units**



Key

1 Small units and kiosks, with a depth not greater than 5 m and a total area not greater than 25 m^2
2 Mall, serving as main escape route
3 Shop fronts, which may be fully open
4 Units with a population not exceeding 300
5 Units with a population exceeding 300
6 Service use only – not to be used as an escape route
7 Service corridor
8 Non-service corridor
→ Alternative escape route

NOTE Lobbies need not be provided if the service corridor is provided with smoke control.

E.3.1.2 Distances of travel and number of escape routes in malls

Travel distance within units is determined by the relevant guidance on that type of occupancy. This annex considers the escape route(s) from unit exits to the final exit(s) to a place of ultimate safety. The mall is likely to be a major element of this escape route.

The distance to the nearest mall exit should be limited. This mall exit need not be a final exit, but may be an exit into a protected corridor that itself leads to a final exit. Malls and walkways should have escape routes of such number and so situated that the travel distance from any point does not exceed the limitations given in Table 12 when minimum fire protection measures are provided, or Table 17 when additional fire protection measures are provided.

Escape routes from the mall should be so sited that a person confronted by fire on entering the mall from a unit can make a safe escape through an alternative mall exit. To achieve this, two exits should be available in substantially different directions.

For reasons such as differences in hours of trading and insufficient staff to supervise evacuation of customers from other parts of the complex, units should not be used as an escape route from a mall or walkway.

E.3.1.3 Width of malls and mall exits

In many complexes units face each other across a pedestrian mall, footpath or walkway. In such cases there is a risk of early fire spread across the mall from one unit to that facing it. This risk is related to the width of the mall and whether the mall is uncovered or covered. The danger of rapid fire spread across a covered mall is greater than in an uncovered mall, and the effect upon the means of escape is more serious in a covered mall because its roof can prevent smoke and hot gases from escaping unless provision is made for smoke venting.

The minimum width of a mall is determined by the need to avoid fire spread across the mall by radiation and flame impingement, and the need to provide enough space for people to escape along the mall to a mall exit.

In some ways, malls are more akin to a public thoroughfare than a space within a building and the safety of people in a mall from fire is provided by a combination of features not normally found in other buildings, i.e. the limitation of fire spread by partial compartmentation and the provision of sprinklers, coupled with smoke control, as well as the provision of multiple exits.

These features make it possible to use malls as a means of escape. The width of the mall and of its exits needs to allow evacuation of the complex without delay, even though the smoke control system is designed to maintain the means of escape for an extended period. People at the back of a slow-moving crowd might feel threatened by smoke overhead and this could lead to problems if those people have to wait too long. It is not possible to set a precise time limit.

Because evacuation is progressive, with people in the mall(s) tending to precede those in the units (who are not in immediate danger unless they are in the unit on fire), it is normally sufficient to size the mall exits on the basis of the number of people the mall is assessed to be capable of holding, and not on the combined population of the malls and units. Although the mall population will normally exceed the aggregate population of the units served by the mall, if this is not the case it is essential that the mall exit capacity is adequate for the occupants of those units.

Large units facing each other across a mall of minimum width, or onto upper-level walkways, can pose difficulties if the number of persons within these units exceeds the capacity of the mall. However, if a fire occurred in a large store, the full width of the mall onto which the units front constitutes an initial buffer zone (which may be of several hundred square metres) from which the people escaping from the store can move to one or more mall exits. Large units also have other exits, independent of the mall, by which a proportion of the occupants escape. This arrangement is acceptable, but in these cases, consideration needs to be given to fire alarm and evacuation procedures within the complex to ensure that occupants are guided to alternative exits.

NOTE 1 Capacities of exits from malls are based on the assumption that a unit width of 500 mm permits a flow of 40 persons/min. The exit width calculation has an implicit time of 2.5 min but this should not be regarded as the actual evacuation time. An adequate discharge rate through a mall exit can be achieved by providing 5 mm of exit width per person to be evacuated, subject to a satisfactory minimum.

The minimum aggregate width of escape routes serving a mall section, in millimetres (mm), may be calculated using the following equation:

$$W = 5\left(\frac{xy}{0.75}\right)$$

where:

- W is the required aggregate mall exit width, in millimetres (mm);
- x is the width of mall section, in metres (m);
- y is the length of mall section, in metres (m);
- 5 is the exit width per person, in millimetres (mm);
- 0.75 is the space occupied per person, in square metres (m^2).

In certain circumstances the width of malls can be affected by obstructions such as escalators, stairs, kiosks and features and these need to be taken into account in calculating the effective width of the mall.

Wider malls are often provided to reduce crowding, and it is unreasonable to assume that very wide malls will be occupied to a high density throughout. Therefore it is reasonable to modify the floor space factor in malls greater than 8 m in width, as it is not expected that malls exceeding this dimension will be occupied to the same density as narrower malls.

NOTE 2 Mall widths are illustrated in Figure E.5.

Malls and mall exits should conform to the following specific recommendations.

a) To provide adequate separation against fire spread, a mall should be not less than 6 m wide measured between the demise line or fascia of the units (whichever is the lesser) if covered, and not less than 5 m wide if uncovered.

NOTE 3 Effective width is that part which is unobstructed by planters, seating, kiosks, etc., and void openings. This effective width should be capable of sustaining the designed flow rate from the mall and units.

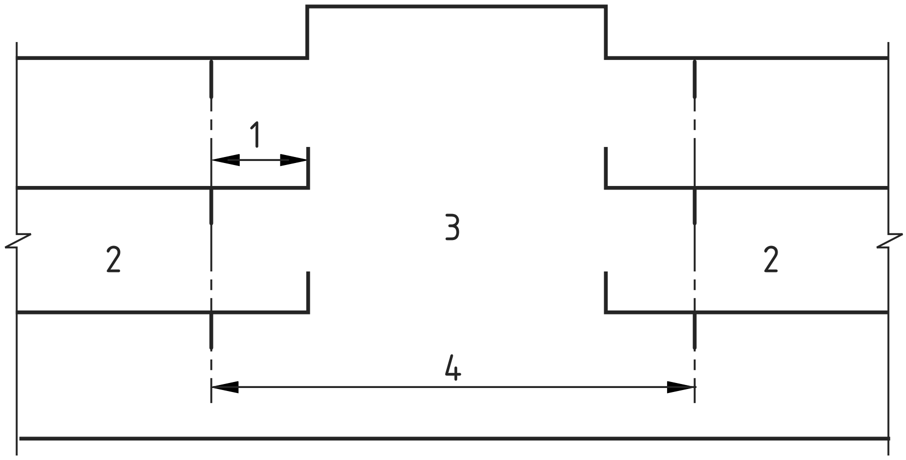
b) To provide adequate capacity for escape, a covered mall with units on both sides should have an effective width of not less than 6 m.

NOTE 4 Effective widths for galleried upper malls may be reduced, providing the unobstructed width is not less than 1.8 m, where it can be shown that the number of people using the mall for escape at that point can be safely accommodated. A similar approach should be adopted where the width of mall or galleried upper mall is reduced by an obstruction.

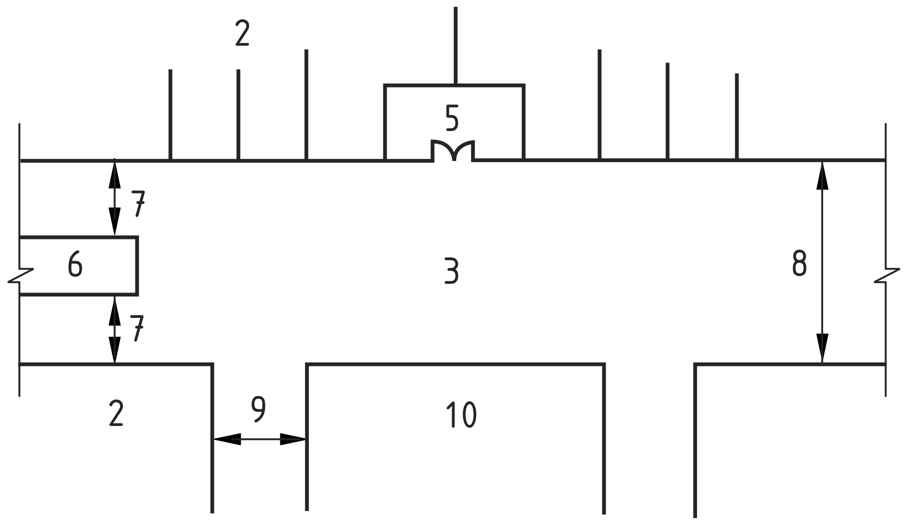
   A mall with a void on one side, such as a galleried upper mall overlooking the level(s) below, or a mall with units on one side and an imperforate fire-resisting wall on the other, should have an effective width of not less than 3 m.

c) If doors are placed across a mall, their aggregate width should not be substantially less than that of the mall itself.

Figure E.5 **Mall widths**



a) Section



b) Plan

Key

1 Walkway
2 Unit
3 Mall
4 Mall width ⩾6 m [A)]
5 Stair
6 Where the mall width is restricted, the reduced width should be substantiated by calculation
7 Obstruction of mall width
8 Mall width
9 Walkway ⩾3 m [B)]
10 Void

[A)] This width may be reduced to 5 m for open malls.
[B)] A lesser width might be acceptable if shown by calculation to be sufficient but in no case should the effective width be less than 1.8 m.

d) The minimum aggregate capacity of escape routes from any mall section should be adequate for the total occupant capacity of the mall section, obtained by dividing the area of the mall section (in square metres) by a floor space factor of 0.75, unless:

1) an area of the mall section has fixed tables and associated seating, in which case a floor space factor of 1.0 should be used for that area; or
2) the width of the mall section exceeds 8 m, in which case a floor space factor of 2.0 should be used for that part of the mall section in excess of 8 m; or
3) the capacity of the unit exits served by the mall section exceeds the population calculated for the mall section, in which case the capacity of the mall exits should be not less than the capacity of the unit exits served by the mall section.

NOTE 5 For calculation purposes, display areas and mall furniture (other than fixed seating for food courts) should not be deducted from the area of the mall; permanent display features (such as fountains) may be deducted.

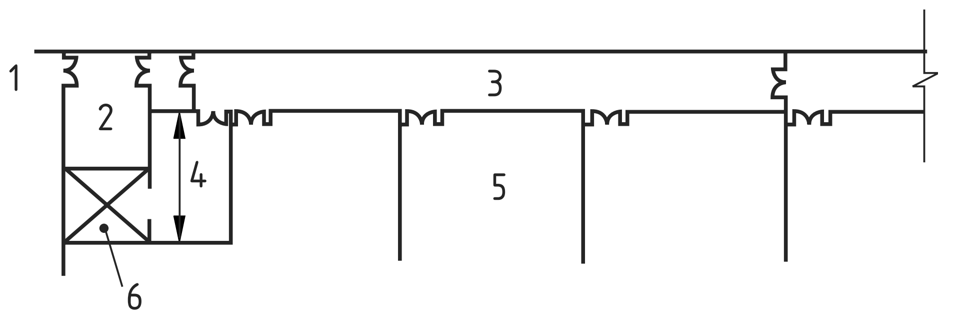
e) The width of any particular escape route from a mall should be not less than the calculated minimum aggregate width divided by the number of escape routes, and in no case less than 1.8 m.

E.3.1.4 Escape routes using service corridors

NOTE 1 Escape routes using service corridors and goods lifts are illustrated in Figure E.6. See also Figure E.4.

As outlined in **E.3.1.1**, most units need alternative means of escape. In some cases it will be difficult to provide alternative means of escape (other than via the mall) which lead directly to a storey exit or to a different level and therefore it might be necessary to use service corridors.

Figure E.6 **Service corridors and goods lifts**



Key
1 Mall
2 Stair
3 Corridor
4 Maximum 12 m if dead end
5 Unit
6 Goods lift

NOTE 2 Units with an occupancy greater than 300 persons should not have any fire exits onto a service corridor.

Although service corridors are normally regarded as unsuitable for means of escape, they may be used (other than from units with an occupant capacity exceeding 300, see **E.3.1.1**) if restrictions are imposed regarding their use. Measures need to be incorporated to minimize smoke spread into and along the corridors, and there need to be restrictions on their length and width (which need to be able to accommodate the total number of persons escaping from the largest unit, after allowing 500 mm of clear width for any goods that may be in transit). Where a service corridor is to be used to provide alternative means of escape from units:

a) each unit served by the corridor should not have more than one exit onto the corridor;
b) any such corridor should lead directly to a storey exit, and if the corridor exceeds 45 m in length it should have a storey exit at each end;

c) the corridor should be at least 2 m, but not more than 3 m, wide;

d) all such corridors should be regularly inspected and centrally monitored by colour closed-circuit television (see Clause **25**);

e) to maintain the integrity of the corridor, it should be separated from any ancillary accommodation and any goods lifts by a protected lobby;

f) any such lobby serving a goods lift should have a depth not exceeding 12 m, unless the lobby is provided with alternative means of escape;

g) to ensure that the corridor remains relatively free of smoke:

   1) each unit should be separated from the corridor by a protected lobby, arranged so that the doors do not obstruct the corridor (see Figure E.4); or

   2) if the corridor links two or more storey exits, it should be subdivided with self-closing fire door(s) in accordance with **E.3.3**; or

   3) a smoke control system design acceptable to the fire authority should be provided;

h) to reduce the danger of fire in a service corridor affecting any stair that serves it, any stair providing a means of escape from a service corridor should be constructed as a protected stairway.

It is not necessary for doors to subdivide the corridor if access to the units is via protected lobbies or the service corridor is provided with smoke control.

E.3.1.5 Escape routes using unloading areas, service roads, vehicular roadways and car parks

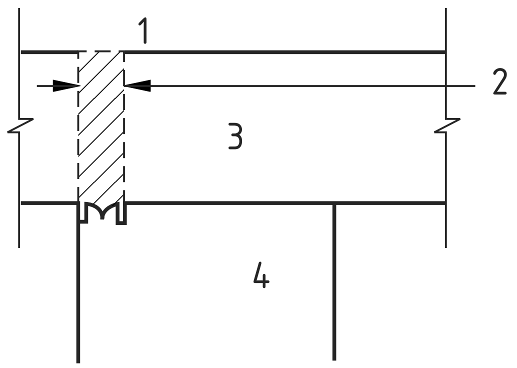
NOTE Escape routes across service areas are illustrated in Figure E.7.

It is undesirable to use the unloading areas, service roads and vehicular roadways of a complex as escape routes from other parts of the complex. If this is necessary in any particular case, suitable routes designated for pedestrians need to be provided and these routes need to be segregated from such areas to ensure that the pedestrian routes remain unobstructed and are available for people who may need to use them. Any escape route to an adjoining car park, or which passes through an unloading area, service road, or is situated in a vehicular roadway, should:

a) be clearly defined and, if necessary, guarded with protective barriers in accordance with BS 6180; and

b) be continuous and not less than 2 m in width.

Figure E.7 **Escape routes across service areas**



Key

1 Final exit

2 Width of defined escape route not less than 2 m

3 Service facility

4 Unit

In many schemes, car parks are provided and positioned so that persons can escape into them without having to negotiate stairs. To be suitable for escape purposes, any adjoining car park should:

1) be separated from the main complex by fire-resisting construction; or
2) be in the open air; or
3) be a separate building/block reached by bridge(s) open to the air.

Mall exits should not discharge into car parks, service roads or basement areas.

E.3.1.6 Escape from occupancies other than units

Complexes or developments can contain office blocks, hotels, residential accommodation and places of entertainment such as theatres and cinemas, dance halls, concert halls and assembly halls. Each of these other occupancies needs to have its own internal means of escape arrangements set out in accordance with accepted principles.

Alternative exits from these other occupancies should not discharge onto a mall even where they have an entry from a mall.

Means of escape from these other occupancies should be separate from protected stairways serving the malls or units.

E.3.2 Escape routes serving other facilities available to the public (other than car parks and public transport facilities)

Facilities which are available to the public should be dealt with as a unit in respect of all fire safety provisions.

Facilities intended for the convenience of shoppers (including child minding facilities) should be positioned near to main exits from the complex.

E.3.3 Escape routes serving non-public common areas and ancillary accommodation

Many forms of ancillary accommodation are necessary in shopping complexes and it is desirable that, wherever possible, these are located in the non-public areas in order that public areas are effectively isolated from any hazard which the ancillary accommodation may impose. In addition to rooms associated with common engineering services, ancillary accommodation includes stores and servicing areas. Other accommodation, not normally available to the public but for which access from public common areas might be necessary, is that associated with the management of the complex for administrative purposes and may include offices, staff rooms and telephone exchanges. Whilst a management suite may be considered as a unit, any management areas remote from this suite are considered as ancillary accommodation.

Non-public common areas and ancillary accommodation (including service installation rooms) should have escape routes of such number and be so situated that the travel distance from any point does not exceed the limitations given in Table 12 when minimum fire protection measures are provided, or Table 17 when additional fire protection measures are provided.

Alternative means of escape which do not involve entry into units should be provided from all common delivery and servicing areas.

Glazed areas separating escape routes from ancillary accommodation and from service installation rooms should be in accordance with **31.3**.

Ancillary accommodation (including service installation rooms) should be separated from any protected stairway by a protected lobby or protected corridor (see **E.3.4.4**) at the storey in which the accommodation is situated, and should be separated from any corridor available to the public by a protected lobby.

NOTE Recommendations for corridors are given in ***17.3.11****.*

Corridors are commonly formed to provide access to ancillary accommodation. In view of the special risks associated with ancillary accommodation, such corridors need to be protected. To prevent a corridor that connects alternative exits from becoming smoke-logged along its length, it is necessary to divide that corridor by a smoke control door and associated screen. Corridors serving ancillary accommodation (including service installation rooms) should be enclosed by construction with a fire resistance of not less than 30 min and all doors within the enclosures should be fire-resisting and self-closing.

Similarly, connecting corridors and dead-end corridors need to be separated so as to restrict the movement of smoke. Corridors connecting alternative exits (other than corridors not exceeding 12 m in length) and corridors that comprise dead ends should be subdivided and separated.

Ancillary accommodation for shopping complexes should be separated from other parts of the building in accordance with **32.5.7**.

E.3.4 Stairs and final exits

E.3.4.1 Number of protected stairways

Accommodation stairs and escalators are provided in multi-level shopping complexes to connect the upper and lower malls. They should be disregarded for the purpose of planning means of escape, even though in practice they are likely to be used if free from smoke and heat. Covered shopping complexes should be provided with smoke control systems designed to ensure that all sections of the malls are usable for means of escape, so all protected stairways serving malls can be expected to remain usable until any necessary evacuation is complete.

The safety of stairs serving other parts of the complex, e.g. car parks, cannot be ensured for an unlimited period of time. In these cases, all but the one nearest the fire can be expected to remain usable until any necessary evacuation is complete.

There should be not less than two protected stairways available from each storey and each car parking level.

E.3.4.2 Siting of protected stairways

Access to protected stairways should, so far as is reasonably practicable, be sited away from open connections between mall levels.

E.3.4.3 Basement stairs

It is preferable that all stairs to basements be entered at ground floor level from the open air, and only from such positions that smoke from any basement fire will not obstruct any exit serving the ground and upper storeys of the complex.

However, if stairs are adequately protected from the ingress of smoke, e.g. by a system using pressure differentials or by the provision of ventilated lobbies at basement storeys, stairs serving upper storeys may be continued down to serve basement storeys. Some shopping complexes are constructed on sloping sites such that a lower mall level can constitute a basement storey even though there may be a final exit from the complex at that level. If any lower mall level is provided with a smoke control system compatible with that provided at other levels, protected stairways may continue down to the lower level without any special precautions being taken.

A protected stairway connecting the basement storey(s) with the ground and upper storeys should be separated from each basement level by a protected lobby in accordance with **E.3.4.4**, unless:

a) the stairway is provided with a smoke control system conforming to BS EN 12101-6; or

b) the basement comprises a lower mall level which is provided with smoke ventilation arrangements in accordance with **E.4.5**.

E.3.4.4 Access lobbies and corridors to protected stairways

It is acceptable to provide direct access from malls into protected stairways without the need for lobby protection, as smoke control is provided in mall areas. Service corridors at the rear of units, however, are not generally provided with smoke control and therefore need to be protected corridors. Still greater protection is necessary in connection with any corridor connecting a mall exit with a storey exit, and with any fire-fighting stairs (see **21.3.2**).

If a protected stairway, other than an external stair, serves a storey or storeys in any of the following circumstances, it should be approached only by way of a protected lobby or protected corridor at the levels indicated.

a) If the stair connects the ground or upper storeys with a basement storey or storeys, or serves only basement storeys, there should be a ventilated protected lobby or ventilated protected corridor at every basement level, unless the stair is provided with a smoke control system using pressure differentials or the basement comprises a lower mall level which is provided with smoke ventilation arrangements (see **18.5**).

b) If the stair provides access to an enclosed car park, there should be a ventilated protected lobby or ventilated protected corridor at every car park access level.

c) If the stair serves a mall or walkway and a service corridor, the service corridor should be separated from the stair by a protected lobby.

Any corridor connecting an exit from a covered mall or walkway with a protected stairway or final exit should be a protected corridor which has no openings or doors to any adjacent accommodation.

E.3.4.5 External escape stairs

Escape routes for the public in shopping complexes should not normally be by way of an external stair. However, exits may be by way of a raised walkway or podium which acts as a street. Occasionally, the planning of the complex is such that it is necessary to consider access onto an external stair leading to a final exit.

External escape stairs provided for means of escape purposes (i.e. to meet the recommendations of **E.3.4.1** and **E.3.4.2**) are deemed to be protected stairways, and hence need to meet the recommendations given in **E.3.4.3**, **E.3.4.4** and **E.3.4.6** as well as those given in **E.3.4.5**.

E.3.4.6 Discharge from stairs and final exits

The safest arrangement is for stairs or final exits to discharge directly to the street at ground level. However, in large complexes this might not be possible and consideration should be given to routes to final exits other than by way of the mall, e.g. via service yards, car parks or basement areas, where adequate provision is made for people to reach safety away from the complex (see **E.3.1.5**). Any external portion of an escape route between a final exit and street level, e.g. across a concourse, service yard or pedestrian walkway, should be clearly defined and if necessary guarded with protective barriers in accordance with BS 6180.

Transformer chambers, boiler rooms, refuse storage areas and similar risks should not have any openings that would prejudice the means of escape from the complex.

In some circumstances, escape upwards rather than downwards, e.g. to service decks above the general level of the shopping malls, might be acceptable. The relationship between any upward escape routes and smoke reservoirs needs to be examined, to avoid leading people into a place where smoke might accumulate.

Any final exit needs to be immediately apparent to people using a stair that serves storeys both above and below the point of final exit. In order to prevent people who are escaping from passing the point of discharge, it might be necessary to divide the landing at that level, although a door may be provided in the dividing structure for normal circulation between the upper and lower storeys.

E.4 Fire protection facilities

E.4.1 Fire detection and alarm systems

Each unit within the complex should have a fire alarm system that conforms to BS 5839-1. The control and indicating equipment of each such system should be capable of stand-alone operation and should be suitably equipped to interface with the central fire alarm system as follows:

a) to transmit to the central control room a signal that an alarm has been initiated within that unit;

b) to transmit to the central control room a signal that a fault has occurred in the fire alarm system of that unit;

c) to receive from the central fire alarm system a signal for the operation of the audible/visual alarm warning devices within that unit in accordance with the fire routine (see **44.2**).

The central fire alarm system should conform to BS 5839-1 in respect of all common areas of the complex. It should be capable of interfacing with the fire alarm system in each unit for the transmission of signals as recommended in item a), so as to comprise an integrated system governing the operation and monitoring of all fire alarm equipment within the complex.

NOTE It is acceptable for signals related to the operation of, or faults within, fire extinguishing equipment in units (e.g. sprinklers, gaseous systems) to be transmitted via the same interface as is used for fire alarm signals from that unit.

The interface between the central fire alarm system and the fire alarm systems within units should be by means of equipment designated to prevent any incompatible voltage or other fault within the fire equipment in a manner that could damage or adversely affect the operation of the central fire alarm system. The relays and other equipment associated with each individual unit interface should be housed in a separate box (or a separate compartment of a panel) controlled and maintained by the owner of the complex. All wiring connections within the interface box/panel should be carried out by the installer of the central fire alarm system.

Manual call points should be provided throughout the complex, other than in the mall(s). In addition, automatic detectors should be provided to detect the occurrence of fire in non-public common areas, in relevant locations and elsewhere as required for the operation of other automatic fire protection equipment, e.g. smoke ventilators.

The complex should be divided into fire alarm zones for the purpose of identifying the location of the origin of a fire alarm signal. Each unit should be designated as one or more zones at the central fire alarm indicating equipment (larger units may comprise several zones). The central fire alarm indicating equipment should be located in the central control room from which the emergency procedure will be supervised. In the event that the control room is of necessity located remote from the initial point of arrival of the fire and rescue service, or there are two or more fire and rescue service access points, repeater panels should be provided at the fire and rescue service access points.

In spaces where smoke control arrangements are used, the fire alarm system should be zoned in accordance with the smoke control system zoning arrangements.

Fire alarm systems in covered non-public common areas which are totally fire and smoke separated (including fire shutters operated only by automatic smoke detection) may be zoned independently from units and public common areas.

The complex should be divided into fire alarm sectors for the purpose of giving audible/visual warning simultaneously in all parts of the complex that would be similarly threatened by a fire in any one location. The divisions between sectors should be determined in relation to fire compartmentation, smoke reservoirs, designated escape routes, common access from units to malls, service corridors, etc., and the fire routine (see **44.2**). A sector should comprise one or more of the fire alarm zones which may need to be evacuated simultaneously. It might be necessary to give audible/visual warning in two or more sectors simultaneously, depending on the location of the fire.

The operation of the fire alarm system in any fire alarm zone should be indicated at the central control room of the shopping complex.

Provision should be made for the operation of the evacuation signal throughout all fire alarm zones in any fire alarm sector or the complete complex from the central control room.

The installation, servicing, testing and maintenance of all fire alarm systems should be in accordance with the provisions of BS 5839-1.

The central fire alarm control and indicating equipment, including power supplies and monitoring facilities, should be under the immediate control of the management of the shopping complex.

E.4.2 Fire detection systems

All covered non-public common areas and stockrooms of shopping complexes should be protected by an automatic fire detection system, in addition to whatever provision is made in those areas for automatic fire control.

Where automatic fire control systems are designed to be actuated by automatic fire detectors, the systems will be combined and should therefore be commissioned and tested together.

Public common areas/malls provided with a smoke control system should be protected by an automatic fire detection system using smoke-sensitive detectors on each level (e.g. ground floor malls will require automatic smoke detectors to be fitted to the underside of the balconies above). Where the fronts of units extend to the edges of any balcony/walkway above, automatic smoke detectors should be provided in these units.

Units (or parts thereof) employing a self-contained independent smoke control system should be provided with a type L3 automatic fire detection system in accordance with BS 5839-1:2002+A2:2008.

In spaces where smoke control and/or other automatic fire protection devices are employed, the automatic fire detection system(s) should be zoned in accordance with the zoning arrangements for those facilities.

NOTE Covered non-public common areas which are totally fire and smoke separated (including fire shutters only operated by smoke detectors) may be zoned independently from units and public common areas.

Where automatic fire detection systems are employed to initiate other active fire protection measures, care should be taken to ensure that the accidental operation of a detector other than in the fire zone cannot prejudice the operation of the active fire protection devices.

Where active fire protection measures can (or need to) be activated from one or more zones, e.g. from a unit or a mall, care should be taken to ensure that the activation signals from each system are compatible and complementary.

The performance of all automatic fire detection equipment in shopping complexes designed for life safety or property protection should conform at least to the recommendations of BS 5839-1 for that purpose.

The installation, servicing, testing and maintenance of all automatic fire detection equipment in a shopping complex should conform to the relevant recommendations of BS 5839-1.

E.4.3 Control of evacuation in a fire – Communications with public common areas

A public address system conforming to BS 5839-1 should be provided in all covered malls of a shopping complex.

Emergency announcements should be preceded by a distinctive and accessible method of raising an alarm that is unique to all emergency conditions.

The facilities for public address in the central control room should include arrangements for making separate announcements in each covered mall area if required, or for addressing certain preselected areas simultaneously.

NOTE If a powered smoke ventilation system is provided in a shopping complex, the ambient background noise level needs to include any noise generated by that ventilation system.

The volume of emergency announcements made from the central control room to all covered malls should be at least 5 dB(A) above the ambient background noise level in an emergency in every part of the complex.

E.4.4 Sprinkler systems

Sprinkler protection should normally be provided throughout any covered shopping complex, except that it may be omitted in:

a) any part provided with a suitable alternative fixed fire suppression system;

b) any part that comprises a separate occupancy and is used for a purpose for which an automatic sprinkler system is inappropriate (in which case it should be provided with an alternative fixed fire protection system);

c) other occupancies/main uses which are part of the complex as a whole but which are totally fire separated, do not share the means of escape, and are subject to their own standards and codes of practice (see also **E.3.1.6**, Clause **31** and Clause **32**).

The design, installation, maintenance and user responsibilities of sprinkler systems, and the operating temperatures of the sprinkler heads, should be in accordance with BS EN 12845 (new systems) or BS 5306-2 (existing systems).

Sprinkler systems should be connected to duplicate water supplies conforming to BS EN 12845 (new systems) or BS 5306-2 (existing systems).

E.4.5 Smoke control provisions

E.4.5.1 General

*NOTE Smoke control arrangements to assist fire-fighting are covered in Clause **28**.*

In an open-air street, a fire in a shop will usually only threaten the occupants of that shop, and once they have escaped onto the street, they would generally be safe. However, a covered shopping complex has individual units opening onto a covered mall and smoke from a fire in any unit would spread rapidly via the mall system, leading to the malls becoming smoke logged in a very short time, perhaps just one or two minutes. Therefore a fire in a unit does not just threaten the occupants of that unit, but also the occupants of the entire complex.

At peak times a shopping complex can be very densely populated and in practice the time needed for evacuation can be considerably longer than the time taken for hazardous conditions to develop in the malls. Statistics of fire deaths show that most fire fatalities are due to the effects of smoke, and hence it is essential that covered shopping complexes have adequate automatic smoke control to ensure that escape is unhindered by smoke.

Although the role of a smoke ventilation system is principally one of life safety, it should also be remembered that fire-fighting becomes both difficult and dangerous in a smoke-logged building.

The provisions for automatic smoke control in this annex are for public common areas, individual units, other occupancies and non-public common areas. The methods of smoke control used are smoke ventilation (both natural and powered) and pressurization.

Any variations on this guidance should be agreed with the enforcement authorities.

Smoke control is an integral part of shopping centre design. It should be designed in accordance with BS 7346-4, BRE Report BR 186 and BRE Report BR 368.

E.4.5.2 Control of automatic smoke ventilation

It is important for life safety purposes that the arrangements for the control of smoke in shopping complexes come into effect without delay once the presence of smoke is detected. The automatic detection of smoke and the automatic operation of the smoke ventilation equipment should take precedence over the provision of any manual controls that might appear to be desirable. A fire and rescue service override should be provided at a location to be agreed with the fire authority.

Such arrangements include the automatic shutting down of mechanical ventilation and air-conditioning plant, including air curtain systems at unit doorways and circulatory systems connected with refrigerated display cabinets in shop units, the opening of smoke ventilators, the release of smoke curtains and the energizing of powered smoke ventilation plant. The sequencing and extent of the replacement air arrangements for the smoke ventilation system are very important, depend on the location at which smoke is detected, and require detailed consultation with the fire authority.

Where the removal of smoke from the common areas is the objective, arrangements should be made for the automatic detection of smoke within the relevant smoke control zone. Automatic detection facilities should always be provided at the mall ceiling and, additionally, below an upper-level balcony/canopy where this is appropriate.

All arrangements for the control of smoke in covered shopping complexes should be either permanently fixed in position or automatic in operation and, where possible, fail-safe. Automatic electrical connections by means of relays or similar devices to shut down or operate circuitry for the purpose of the control of smoke should be initiated immediately a fire is detected.

Automatic fire detection equipment used in connection with the control of smoke should operate on the principle of smoke detection and should be installed in accordance with BS 5839-1. Where the removal of smoke from within a unit is the chosen objective of smoke control, a type L1 smoke detection system, as described in BS 5839-1:2002+A2:2008, should be provided within the unit.

E.4.5.3 Smoke control arrangements in common areas (other than in malls)

E.4.5.3.1 General

*NOTE Smoke control for fire-fighting shafts is covered in **28.2**.*

Non-public areas incorporating servicing facilities are often shared by many different units and can comprise accommodation at all levels, including basement levels and roof areas. Stair traffic between these areas will invariably involve upward movement when the stairs are used as escape routes, necessitating their enclosure and their protection by ventilated lobbies.

If public stairs are to be safely used by occupants of a shopping complex to escape from fire, it is essential that they remain free from smoke and heat for sufficient time for evacuation of the building. This need is deemed to be met under normal circumstances by the provision of fire-resisting enclosures and fire-resisting self-closing doors. However, additional precautions are necessary in the case of stairs serving basements or areas of high fire risk.

E.4.5.3.2 Smoke control in enclosed car parks

Enclosed car parks should be provided with one of the following means of venting smoke:

a) permanent vents with an area not less than 2.5% of the floor area, uniformly distributed on at least three sides of the car park;

b) a powered smoke ventilation system conforming to BS 7346-4 or BS 7346-7 as appropriate.

E.4.5.3.3 Smoke shafts

If smoke shafts are led up through the building to discharge direct to open air, the outlets should be maintained unobstructed, or be covered only with:

a) non-combustible grilles and/or louvres; or

b) smoke outlet terminals conforming to BS EN 12101-2 or BS EN 12101-3.

Shafts serving smoke outlets should:

1) be provided separately from different basement levels and from such accommodation as boiler rooms, rooms containing oil-filled switchgear, storage spaces and car parks;

2) for natural (buoyancy driven) systems, have throughout their length a cross-sectional area not less than that of the smoke outlets they serve, or have their size (area) supported by appropriate hydraulic calculations;

3) be enclosed with solid non-combustible material having a fire resistance not less than that needed for the storey served, or through which they pass, whichever is the higher.

E.5 Uncovered shopping complexes, small shopping developments, refurbished and existing premises incorporated into shopping complexes

E.5.1 General

The recommendations in this annex are, in the main, made in the context of new medium to large shopping complexes with fully or partially covered malls.

Although these recommendations can be applied to complexes of all forms and sizes, it might nevertheless be appropriate to consider some variation in the case of uncovered complexes, small shopping developments, refurbishment of existing shopping complexes and covering existing streets. However, except where otherwise set out in this annex, it is not possible to give firm recommendations for these forms of development because of the wide variation in form and other factors. Much will depend on the particular circumstances and a flexible application of the recommendations is therefore needed. Such an approach is particularly relevant where developments constitute, or are to be incorporated in, a building of architectural/historical interest. A sensitive handling of the fire protection facilities is necessary if the architectural/historic features are not to be prejudiced.

Any variations made in accordance with this subclause should be agreed with the enforcing authorities.

Any extensions to an existing complex should conform to the appropriate recommendations in this annex.

E.5.2 Uncovered shopping complexes

Some of the recommendations of this annex are specially directed at those parts of new complexes having uncovered malls, e.g. those on escape distances in **E.3.1**. Others might not be relevant, e.g. those on smoke ventilation in **E.4.5**. However, although most of the recommendations could be applied whether or not the malls are covered, uncovered shopping complexes tend to display fewer fire safety problems than covered ones. Some uncovered developments might be little different, in fire safety terms, to a conventional group of high street shops. In general, uncovered shopping complexes do not need to be sprinklered. However, an uncovered complex might still have features that lead to the need to consider the provision of sprinklers. For example, there might be communal features that could affect the overall safety of the development, such as communal basement servicing arrangements.

When designing uncovered shopping complexes, consideration should be given to the possibility of the development becoming covered at a later date, possibly as part of a refurbishment scheme. In particular, malls with an effective width of less than 6 m, and unsprinklered units, will pose problems (see also **E.5.4**).

E.5.3 Small shopping developments

At their simplest these developments are typified by the traditional shopping arcade. These often grew out of existing narrow lanes where the space between opposing buildings was subsequently glazed over to provide weather protection and a more pleasant environment. These small developments, whether in a new building or formed by the subdivision of an existing building, should be of no greater size overall than would be acceptable for a single uncompartmented shop. Owing to the smallness of the development it might be difficult to provide the minimum width of mall recommended for complexes generally. Similarly it might only be possible to service the units from the mall, and it might not always be possible to obtain secondary escape from units. Particular consideration needs to be given to providing accessible means of escape in these situations.

In assessing the fire safety standards of these small developments it can sometimes be appropriate to consider cases by comparison with the fire safety needs of a single shop of similar size taking into account the multi-occupancy factor. Where there is simple and direct means of escape, short distances of travel, a good standard of automatic fire detection and alarm, and arrangements for total evacuation in an emergency, then a lesser standard of provision in some other areas might be appropriate but each case would need to be considered on its merits.

E.5.4 Refurbishment of existing shopping complexes

The demands of the public in respect of their shopping environment have changed dramatically in recent years. High standards in respect of weather protection and comfort are expected. Many early shopping complexes were often no more than pedestrianized precincts with the public common areas largely open to the elements. Commercial competition from newer and more environmentally pleasing developments has led to widespread refurbishment of older complexes.

Particular problems arise in the refurbishment and/or enclosure of uncovered shopping complexes to meet, as far as practicable, current standards. Where existing open malls are to be covered a number of problems arise. Malls that are of a width that was satisfactory when they were substantially open might be less satisfactory when covered, and it might be difficult to widen them without severe disruption to trading.

Fire separation between adjoining units will not necessarily be a significant problem, and with sufficient roof height it is not generally difficult to provide smoke venting in the new roof structure.

Any refurbishment offers an opportunity to upgrade fire safety standards, and the starting point should be the recommendations in this British Standard.

E.5.5 Existing premises incorporated into shopping complexes

When existing premises are incorporated into shopping complexes, often as part of a town centre development, similar problems to those discussed in **E.5.3** and **E.5.4** will arise and therefore similar flexible solutions will be appropriate.

Annex F (normative) Process plant and outdoor structures

F.1 General

As a general principle the recommendations of this British Standard are to be applied to all buildings. However, in respect of certain buildings and structures, in particular those purpose-designed to house process and storage plant, these recommendations might be either inappropriate or unreasonably restrictive.

The design of these buildings and structures can range from fully enclosed buildings to open structures, such as external plant, and, whilst they can be large, internal divisions can be absent or largely incomplete. In addition, they characteristically have a low occupancy relative to conventional buildings of comparable size, typically not more than 10 persons, who by nature of their work will be familiar with the premises and the nature of the processes therein.

NOTE Attention is drawn to the Regulatory Reform (Fire Safety) Order 2005 [2], the Fire (Scotland) Act 2005 [3] as amended, and the Fire Safety (Scotland) Regulations 2006 [4]. (Northern Ireland has its own legislation, on which work is ongoing at the time of publication of BS 9999.)

In such cases the recommendations given in this annex are applicable. However, because of the specific nature of these buildings and structures and the wide variety of possible designs, the recommendations can only provide general design considerations, and consultation at an early stage with the relevant authorities is advisable. In particular, the package of fire safety measures provided, including any additional fire protection measures, such as automatic fire detection, extinguishing and smoke control systems (see Clause **19**) and any localized suppression system (see Clause **39**) should be taken into account in determining the adequacy of the design.

F.2 Process plant buildings

Buildings containing process plant are often distinguished from conventional buildings by greater ceiling heights and the presence of a larger number of openings in floors around plant, pipes and services. In consequence, there is an increased chance of a person becoming aware of a fire in the early stages of its development, independent of the alarm being raised by others.

Whilst it is essential that the magnitude of smoke production during a fire is not underestimated; due to the nature of processes carried out in buildings of this type, the main threat to the means of escape is the potential for rapid escalation of the fire and the resultant thermal radiation as a consequence of this. The travel distances given in Section **5** remain applicable to these buildings, however departures from the recommendations for conventional buildings in respect of escape route widths (see **17.6.2**) and vertical means of escape (see Clause **18**) might be acceptable.

Process plant buildings which, by virtue of their design and the nature of the process, pose a reduced threat of rapid smoke logging and also have a low occupancy, may be provided with a single protected stair or external escape stair, with alternative means of escape incorporating stairs and/or ladders, that may be internal and/or external.

For all other process plant buildings the recommendations of Section **5** should be followed.

F.3 Weather housed plant buildings

The purpose of these buildings is solely to provide enclosure of the process plant to control the environment for operator comfort and/or to protect the plant from the effects of the weather. They are typically large hangar or shed-like buildings, often without discernible floors, but rather galleries, walkways and connecting stairs associated with the process plant itself.

In consequence, increased travel distances and unenclosed vertical components of escape can be accepted provided that sufficient escape routes remain unaffected during the early period of a fire to enable persons to evacuate the building safely. In these circumstances, the vertical components of the escape routes form part of the overall travel distance to a final exit. Where there is a danger of smoke logging of the unenclosed vertical components of escape within the building, external escape routes with a reduced level of fire resistance can offer a satisfactory solution provided that the external wall in the vicinity of these provides sufficient resistance to prevent the passage of smoke and heat. The egress from this point to a place of ultimate safety should be substantially unrestricted.

However, equally the absence of enclosure means that alternative routes can be rapidly affected by the same incident. Therefore unless otherwise separated to provide at least a reduced level of fire resistance, the horizontal component of alternative escape routes should be not less than 90° apart and the vertical components should either be a minimum of 20 m apart, or descend at opposite extremities of the structure.

The travel distances for weather housed plant buildings should conform to Table F.1. Where exact travel distances are not known, direct distances should be taken as two thirds of the travel distance.

Table F.1 **Maximum travel distances for weather housed plant buildings, weather protected plant and external plant**

Situation	**Travel distance**, in metres (m)	
	Two-way travel	**One-way travel**
Weather housed plant		
Risk profile A1	100	20 [A)]
Risk profile A2	100	18 [A)]
Risk profile A3	60	13 [A)]
Risk profile A4 [B)]	Not applicable [B)]	Not applicable [B)]
External plant/weather protected plant		
Normal fire hazard outdoor zone	200 [C)]	25 [D)]
High fire hazard outdoor zone [E)]		
Frequently visited	100 [C)]	13
Not frequently visited	200 [C)]	25

A) This is the maximum travel distance that is allowable when the minimum level of fire protection measures is provided (see Clause **16**). If additional fire protection measures are provided then the travel distance may be increased (see Clause **19**), for example in respect of increased ceiling height (see **19.3**).

B) See Table 4.

C) Plus an additional 50 m at ground level where the direction of travel is substantially unrestricted.

D) 100 m from the top of a storage tank or silo, provided that a person is not required to cross the top of more than one other tank to reach a route leading to ground level.

E) Such areas are outside the scope of this British Standard unless a sprinkler system or another appropriate fire suppression system is installed to reduce the risk profile. See **F.5**b), Table 4 and **6.5**.

F.4 Weather protected plant

These buildings serve a similar function to that for weather housed plant (**F.3**), but are distinguished from these by large areas of openings that breach the enclosure. These can be for process reasons, including ventilation; e.g. ridge vents at high level, and louvres or open sides at low level. As a consequence, the potential for smoke logging is mitigated. Where the hazard from fire on weather protected plant is determined to be more akin to that for external plant (**F.5**), it is appropriate to use the travel distances for this (see Table F.1).

F.5 External plant

Whilst the potential for smoke logging is largely absent in external plant, there still remains a danger to persons from the fire itself and the effects of radiated heat. Adequate means of escape to enable persons to quickly move away from a fire is, therefore, essential. Generally a minimum of two escape routes should be provided from any part of the plant, so sited that they are clear alternatives, i.e. not likely to be involved in the same initial fire. The horizontal component of alternative escape routes should be not less than 90° and the vertical components should either be a minimum of 20 m apart, or descend at opposite extremities of the structure.

The overall travel distance should be measured to a point at ground level, outside the confines of the plant or structure housing it, such as an access roadway or open ground, which provides unrestricted egress to an assembly point in a safe location, where persons are no longer in danger from the effects of fire or smoke. The planning of escape routes need not necessarily be designed to require a person to come down to ground level straight away. Indeed, in some cases it will be safer to walk away from the fire at high level before descending to the ground. For example, where means are provided to contain an incident such as by a bund or sloping of the ground to a suitable collecting point, an alternative vertical escape route should be provided remote from this.

Some plant, such as distillation columns, is tall and often isolated and free-standing. They are therefore deemed dead ends for means of escape purposes. Even though the dead end travel distance can considerably exceed that normally allowed (see Table F.1), it might be unreasonable and/or impracticable to require alternative escape routes. In such circumstances, it is therefore appropriate for other risk reduction measures to be taken to reduce the need for the upper parts of the plant to be visited, especially when it is operating and therefore poses the greatest risk; for example by the provision of remote sampling and monitoring.

For the purposes of determining adequate travel distances, external plant is classified as follows.

a) *Normal fire hazard outdoor zones*. Units of plant where there is not an extremely high fire danger (nominally risk profile A3 or less; see **6.4**). These generally include all tank farms, silos, pipe-rack areas and storage locations. The travel distances for normal fire hazard outdoor zones should conform to Table F.1.

b) *High fire hazard outdoor zones*. Units of plant which present an extremely high fire danger (nominally risk profile A4; see Note 1); i.e. in the event of fire, extremely rapid escalation and spread of flames, smoke and fumes to affect the unit can be reasonably expected to occur. For example: where extremely or highly flammable liquids {as classified under the Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 [26]} are being processed under pressure and above their flashpoint; where flammable gases are being processed; or where materials are processed above their auto-ignition temperature. If a sprinkler system or another appropriate fire suppression system is fitted, the travel distances for high fire hazard outdoor zones should conform to Table F.1 (see Note 1).

*NOTE 1 Risk profile A4 is unacceptable within the scope of BS 9999 (see Table 4). If a sprinkler system or another appropriate fire suppression system is installed, the risk profile will be reduced to A3 (see **6.5**) and the travel distances in Table F.1 will apply. If such a system is not installed, a fire engineering solution would be required for which BS 9999 goes not give guidance.*

NOTE 2 The processing of toxic materials will not lead to "high fire hazard outdoor zone" status unless their substantial release is probable in the early stages of a fire, or the material itself is flammable or flammable materials are involved in the process in a manner to present an extremely high fire danger.

It is also appropriate to take account of the occupancy levels and their duration. Although units of external plant are typically very large, the number of personnel operating them is usually small, where parts might only be periodically visited. Therefore, in determining adequate means of escape in high hazard outdoor zones, two frequencies of visit are distinguished, i.e. "frequently visited" and "not frequently visited". "Frequently visited" means:

1) visited once a day or more;

2) visited once a week or more by a group of three or more persons; or

3) visited for the purposes of taking samples of flammable gas or liquid at a temperature above its flashpoint.

Annex G (normative) Recommendations for refuges and evacuation lifts

G.1 Refuges

A refuge is a location where people whose abilities or impairments might cause their evacuation to be delayed can, if necessary, await assistance with the next part of their movement to a place of ultimate safety (be it management assistance or the activation of an engineered fire safety system). This movement may be vertical (up or down stairs or via lifts), horizontal (if the building is large in plan) or a combination (up or down ramped walkways). Whilst awaiting this assistance, they need to be protected so that they are reasonably safe from the effects of a fire. A refuge should therefore be a place of relative safety. It should be protected from a fire for a period of time sufficient to enable the evacuation sequence to be completed without placing the person(s) needing assistance, or those rendering that assistance, at unacceptable risk from a fire within the premises. Refuges should only ever be considered as temporary waiting areas, where disabled people can wait until they can complete their evacuation to a place of ultimate safety. Refuges should not be used as a place to leave disabled people to await rescue by the fire service.

NOTE 1 These provisions do not apply to:
- *storeys providing level access directly to a final exit;*
- *storeys consisting exclusively of plant rooms.*

Refuges are commonly located within fire protected stairwells, and where they are so located they should be accessed in the same direction as the escape flow. Whilst they might be of use to persons other than wheelchair users, each refuge should provide an area accessible to a wheelchair and in which the user can await assistance. Refuges should be provided on all storeys of a building for:

NOTE 2 "Storey" includes any open areas to which the public or staff have access, such as a roof garden.

a) each protected stairway affording egress from each storey; and

b) each final exit leading onto a flight of stairs external to the building.

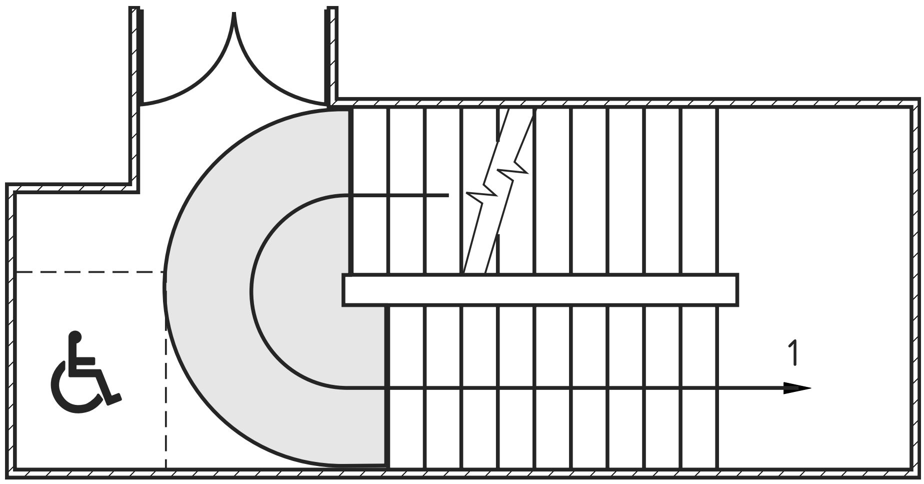
A refuge needs to be of sufficient size both to accommodate a wheelchair and to allow the user to manoeuvre into the wheelchair space without undue difficulty. To accommodate the wide variety of wheelchairs in use, including powered wheelchairs, the space provided for a wheelchair in a refuge should be not less than 900 mm × 1 400 mm allowing for manoeuvring. To enable wheelchair users to manoeuvre themselves into the refuge, the door width should have a clear opening of not less than 850 mm, and the corridor width should be not less than 900 mm.

NOTE 3 Managers of sporting or other venues where a number of disabled people might be present are advised not to restrict the number of disabled people who can be admitted to that venue on the grounds of the size of refuges, since some disabled people who use mobility aids such as a wheelchair will be able to self-evacuate in the case of a real fire. Specific guidance on sports facilities is given in the Sport England publication Access for disabled people *[79].*

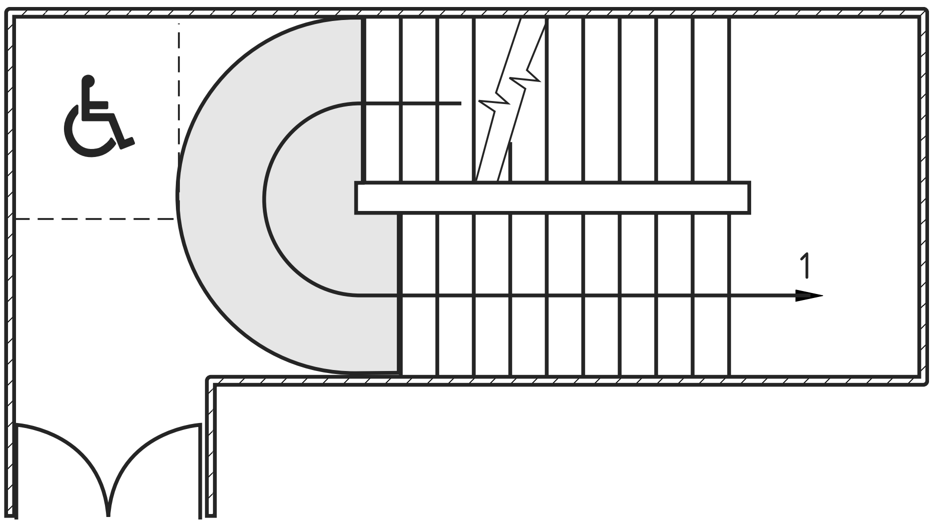
In most premises it is considered reasonable to have refuges of a size where each one is able to accommodate one wheelchair user. Where it is reasonably foreseeable that the proportion of disabled users in a building will be relatively high, or where the use of the premises is likely to result in groups of wheelchair users being present (e.g. some types of sporting, entertainment, transport or public assembly buildings), consideration should be given to increasing the size and/or number of refuges accordingly.

It is not always possible to provide a refuge at the head of a stair, but it might be possible to provide a satisfactory refuge within a protected lobby, corridor or protected room adjacent to the stairway. Where a refuge is a protected stairway or protected lobby or protected corridor, the wheelchair space should not reduce the width of the escape route, and where the wheelchair space is within a protected stairway, access to the wheelchair space should not obstruct the flow of persons escaping. The principles for the provision of wheelchair spaces within protected stairways are shown in Figure G.1.

Figure G.1 **Wheelchair spaces in protected stairways**



a) Provision where access to the wheelchair space is in the same direction as the escape flow within the stairway



NOTE In this example the landing is larger to allow access to the wheelchair space without disrupting the flow of persons escaping.

b) Provision where access to the wheelchair space is counter to the access flow within the stairway

Key

1 Escape flow

Wheelchair space

Occupied by escape flow

Figure G.2 and Figure G.3 illustrate examples of refuges and routes of escape from a fire. In a building where there is fire-resisting separation across the storey, this creates two compartments, each of which constitutes a refuge from a fire in the other. An example of such an arrangement is shown in Figure G.2c) for buildings without evacuation lifts, and in Figure G.3c) for buildings with evacuation lifts. In Figure G.2a) and Figure G.2b), the protected stairways or lobbies serve as refuges. In many buildings such spaces are formed as part of the design and construction process.

NOTE 4 It is acceptable to have a refuge in a staircase requiring only single-door protection for means of escape purposes, provided that the refuge space meets minimum dimensions.

Where an evacuation lift is provided (see also **G.2**) it should normally be located close to a protected stairway, as in Figure G.3b), but this is not always necessary provided that there is safe access from the refuge to a stairway. Figure G.3a) and Figure G.3c) show examples of arrangements where the lobby has separate access to two compartments and provides a refuge from each. If the lobby becomes untenable before the lift arrives, safe access to the stairway remote from the fire is possible. If the position of the fire is such that it is not possible to enter the lift lobby, then either the other compartment [Figure G.3c)] or the stairway [Figure G.3a)] provides a refuge.

Whilst most refuges will be bounded by and protected by fire-resisting construction, other means of smoke control may also be used to protect refuges, such as smoke extraction systems incorporating down stands and/or smoke reservoirs. An area in open air such as a flat roof, balcony, podium, platform or similar place sufficiently protected (or remote) from any fire risk and provided with its own means of escape can also be used as a refuge.

It is essential that the location of refuges and of wheelchair spaces within refuges does not have any adverse effect on the means of escape provided in the building.

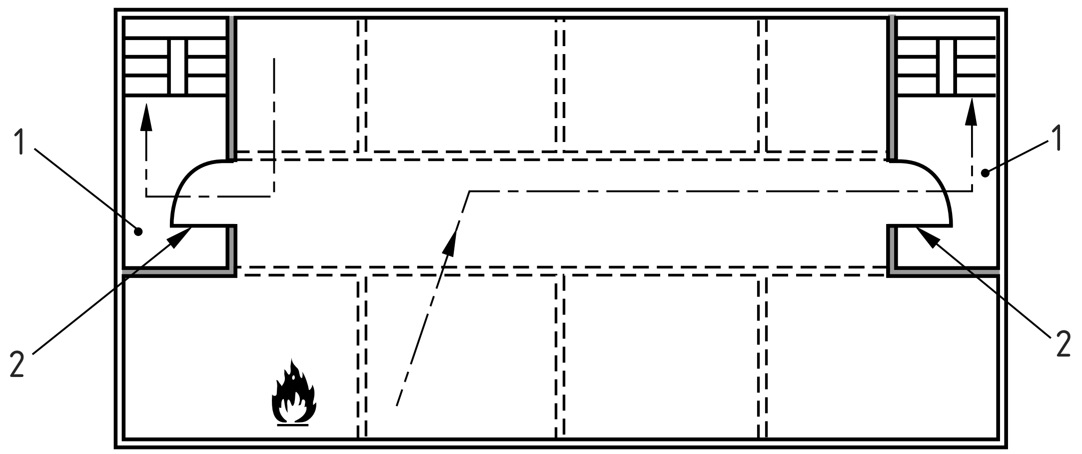
When the number and locations of refuges have been decided, procedures should be established in accordance with **46.8** for independent communication between the occupants and evacuation management personnel.

Where a refuge is within a pressurized stair it should conform to BS EN 10201-6.

To facilitate the effective evacuation of people from refuges, an emergency voice communication (EVC) system should be provided. It is essential that the occupants of each refuge are able to alert other people that they are in need of assistance and for them to be reassured that this assistance will be forthcoming.

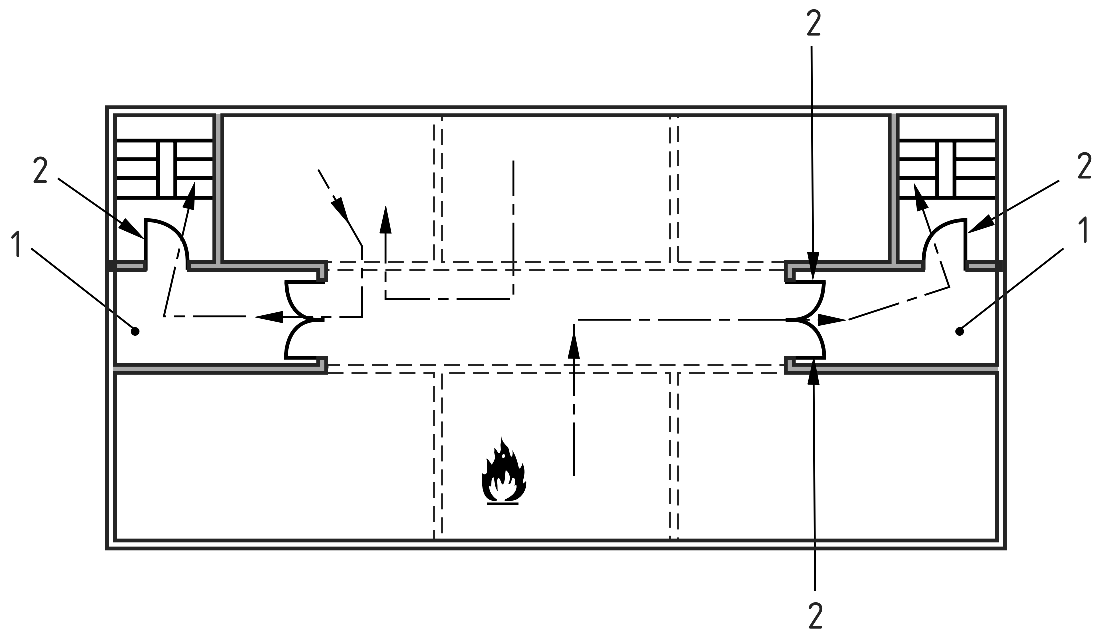
The EVC system should conform to BS 5839-9:2003 and consist of Type B outstations which communicate with a master station located in the building control room (where one exists) or some other suitable control point at fire and rescue service access level.

Figure G.2 **Examples of refuges in buildings not provided with evacuation lifts**



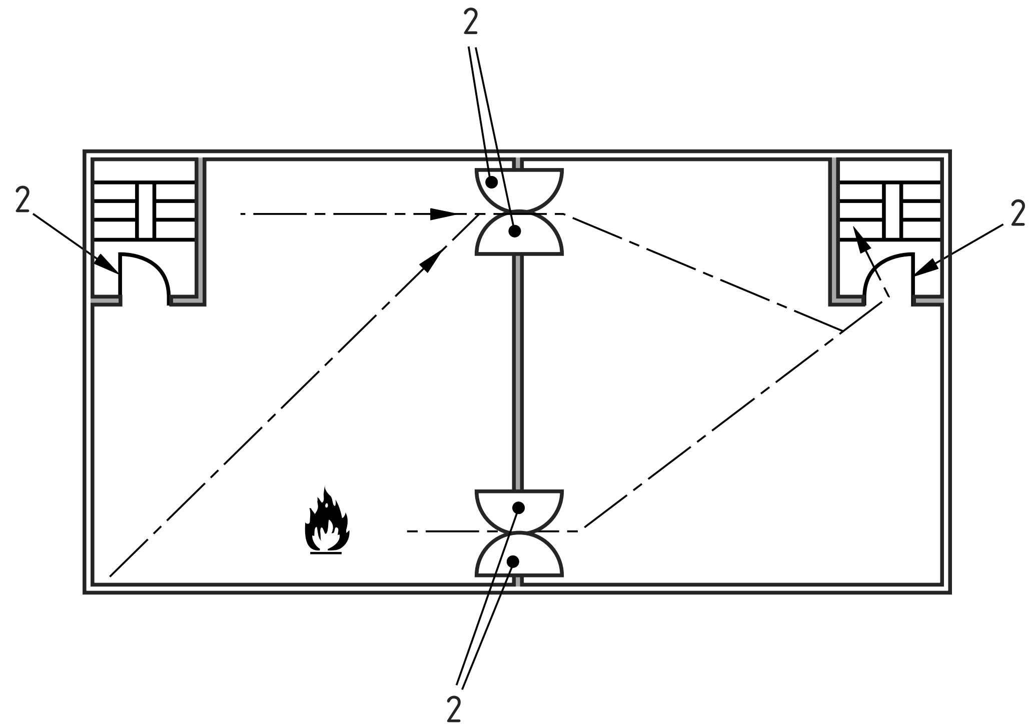
NOTE 1 Protected stairways should be approached by way of a protected lobby in certain situations, e.g. in high buildings.

a) Protected stairways used as refuges



b) Protected lobbies used as refuges

Figure G.2 **Examples of refuges in buildings not provided with evacuation lifts** *(continued)*



NOTE 2 Persons occupying the left-hand compartment would not reach a refuge until they had entered the right-hand compartment. Two doorsets in the partition are necessary in case access to one of the doorsets is blocked by fire.

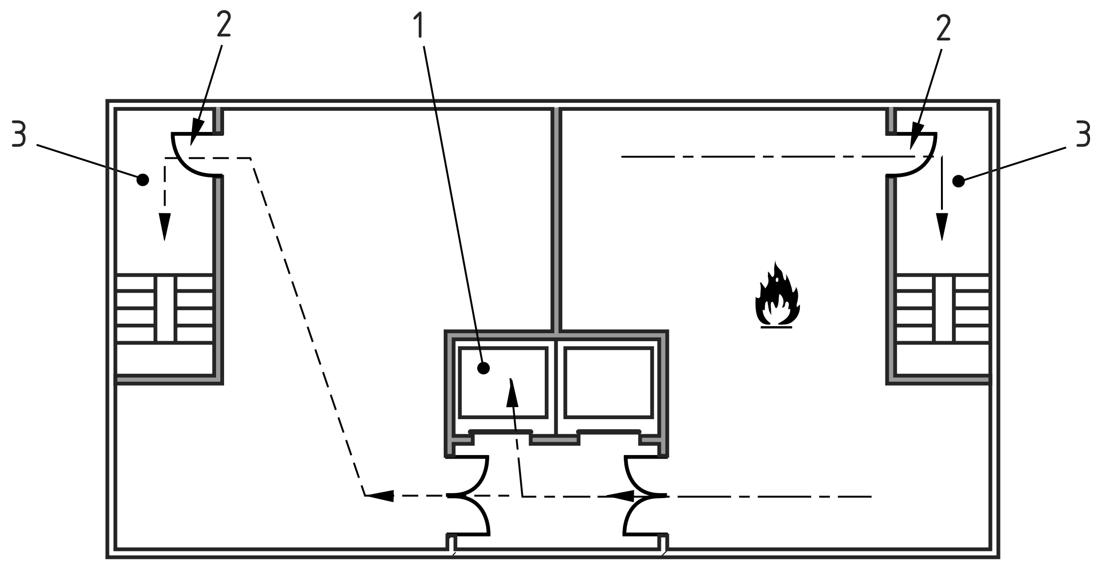
c) Storey divided into two refuges (stairway not provided with wheelchair space)

Key

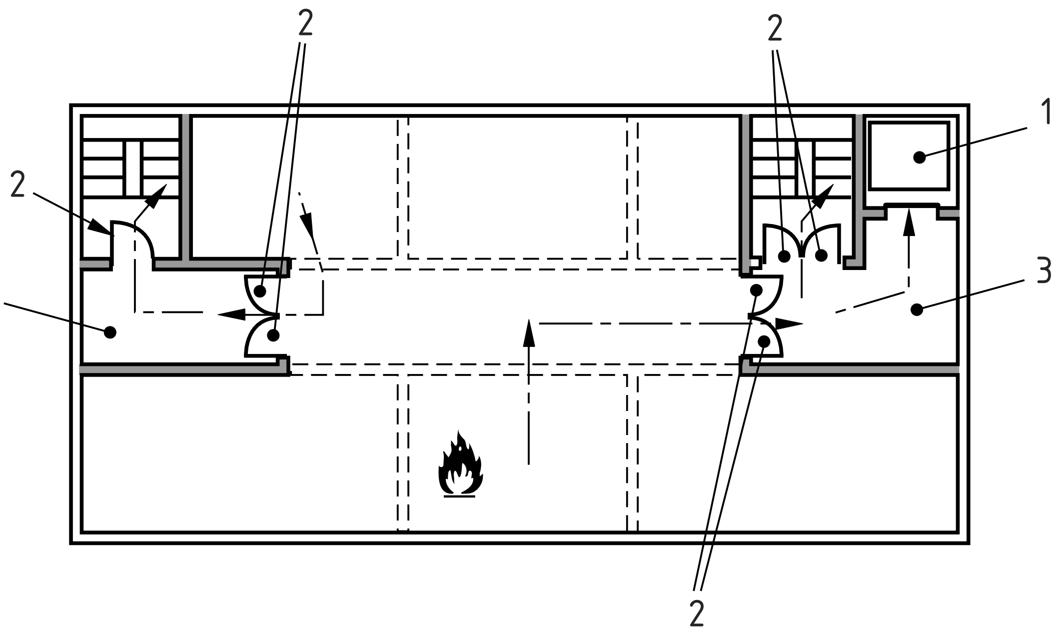
1	Refuge
2	FD 30S fire door [A)]
(grey box)	30 min (minimum) fire-resisting construction
= = = =	Partitioning for cellular planning
— — ►	Possible escape route

A) The doorset may have one or two leaves and, dependent on its location, may be single or double action (swing).

Figure G.3 **Examples of refuges in buildings provided with evacuation lifts**



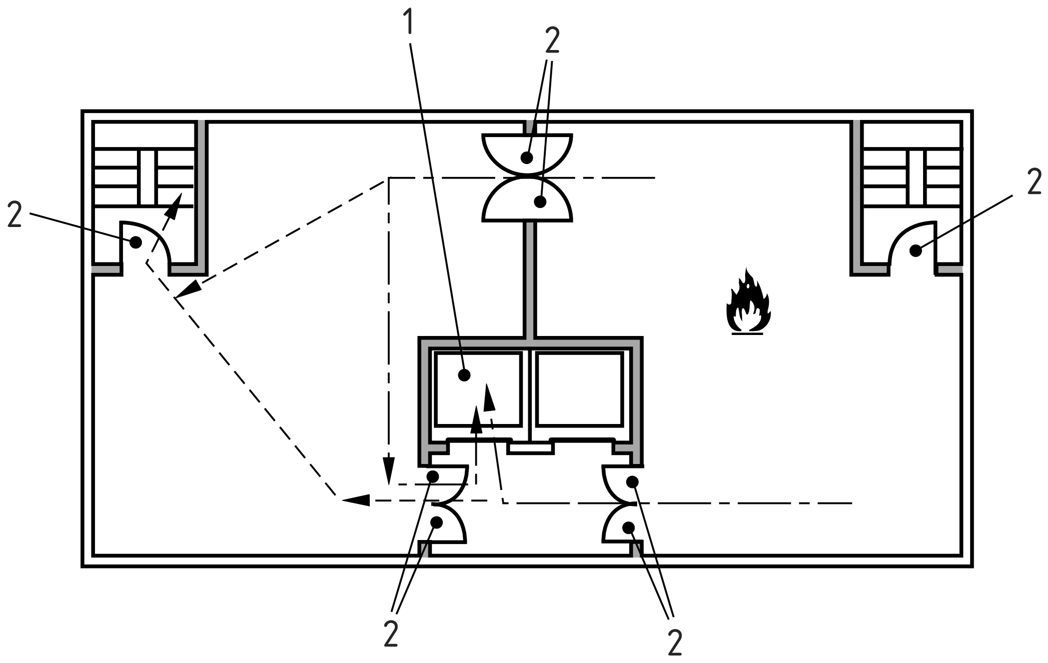
a) Protected stairways used as refuges



NOTE 1 A fire-fighting lift may be used for evacuation.

b) Protected lobbies used as refuges

Figure G.3 **Examples of refuges in buildings provided with evacuation lifts** *(continued)*



NOTE 2 The doorset in the partition separating the two parts of the accommodation is required in case access to the lift lobby is blocked by fire.

c) Storey divided into two refuges

Key

1	Evacuation lift [A)]
2	FD 30S fire door [B)]
3	Refuge
[grey box]	30 min (minimum) fire-resisting construction
= = = =	Partitioning for cellular planning
— — ►	Immediate escape route
——-►	Extended or alternative escape route

A) The lift landing doors should be FD 30 fire doors.

B) The doorset may have one or two leaves and, dependent on its location, may be single or double action (swing).

G.2 Evacuation lifts

G.2.1 General

Where a lift is part of the evacuation sequence for people requiring assistance, it should be an evacuation lift. Where an evacuation lift is used, it is expected that the evacuation will be assisted by an authorized person(s) (see also **G.2.3**).

An evacuation lift, where provided, should always be available for evacuation purposes. Wherever practicable it needs to be a lift used routinely as a passenger lift and not one used solely for evacuation or occasionally as a lift for transporting goods. It should be designed and installed in accordance with the relevant provisions in BS 8300, BS EN 81-1 or BS EN 81-2, and BS EN 81-70.

An evacuation lift should be situated within a protected enclosure consisting of the lift well itself and a protected lobby at each storey served by the lift, and should be provided with a protected route from the evacuation lift lobby at the final exit level to a final exit. It should be associated with a refuge (see **G.1**) and should be clearly identified. No part of an escape route should be served only via a lift.

An evacuation lift should be provided with a switch clearly marked "Evacuation Lift" and situated adjacent to the lift landing door at the final exit storey. Operation of this switch should cause the evacuation lift to return to the final exit storey and should isolate the lift landing call controls. The evacuation lift should then operate only in response to the lift car control panel and the communication system provided should be in operation. Unauthorized operation of the switch may be prevented by the use of a key operated switch or by placing the switch in a glass-fronted box.

Where evacuation lifts are provided, their use to evacuate people requiring assistance should be a matter of priority. Once under staff control, the lift will therefore only normally be used to evacuate those persons in need of assistance. Alternative power supplies, etc., might only be specified to accommodate the evacuation of people requiring assistance, and might not have sufficient capacity to allow their use by others. Other building occupants should be directed to escape via the routes provided for that purpose.

A fire-fighting lift (which is provided principally for the use of the fire and rescue service in fighting fires) may be used for the evacuation of disabled people prior to the arrival of the fire and rescue service. Where this is planned, the relevant local fire authority should be consulted before implementation.

G.2.2 Power supplies

The primary electrical supply should be obtained from a sub-main circuit exclusive to the lift and independent of any other main or sub-main circuit. Other lifts in the same well may be fed from the same primary supply, provided that the supply is adequate for the purpose and that arrangements are such that a fault occurring in any other lift in that well or the power supplies thereto does not affect in any way the operation of the evacuation lift.

Except for hydraulic lifts serving two storeys only, the lower of which contains a final exit to a place of ultimate safety, an alternative power supply should be provided such as an automatically started generator, a privately owned distribution system that would not be affected by a fire in the building (either by being disconnected for fire-fighting purposes or by failure of the main switchboard providing the normal power supply to the building) or a separately fused protected circuit fed directly from the main incoming electrical supply to the building located in a fire protected enclosure. The cables transmitting the alternative power supply should be separated from those of the primary supply and routed through areas of low fire risk, or should be physically protected so that a breakdown, or any cause of a breakdown, on one cable cannot lead to simultaneous failure of the other supply. Any power switches or isolators should be clearly identified and labels should be provided at the main switchboard and at the alternative power supply indicating the presence and location of the other supply.

Battery inverters are not normally acceptable as alternative power supplies, unless it can be demonstrated that:

a) this power supply is capable of operating the lift at normal speed; and

b) it has sufficient capacity to enable the lift to operate enough complete cycles to serve and evacuate every refuge associated with the shaft, at one refuge per cycle (movement from final exit level to a refuge and back to the final exit level being considered as one cycle). Movement to the level from which the authorized person will take control of the lift should also be included. The capacity should be calculated with allowance for the batteries' supply capacity at the end of their design life.

Where it is reasonably foreseeable that the refuges will be used by more than one user (e.g. some types of sporting, entertainment, transport or public assembly buildings), and the size of the evacuation lift is such that more than one cycle would be required to evacuate each refuge, the battery capacity should be increased accordingly.

Any electrical substation, distribution board, generator, hydraulic pump or other apparatus should be protected from the action of fire in the building for a period not less than that specified for the enclosing structure of the evacuation lift installation and in accordance with the general principles of structural fire protection for a lift machine room or machinery space.

G.2.3 Control and operation of evacuation lifts

In all lifts to be used for evacuation, the lift car control should be switched on so that the lift car is under operator control, and the lift car should be taken only to those levels where a person is in need of assistance, as delays could arise were the lift to remain on normal service with calls registered at many landings. Where the premises has a fire detection and alarm system installed, operation of the alarm will normally cause the lifts to descend or ascend to final exit level and remain in that position. Whilst it is appropriate that an evacuation lift is controlled in this way, the lift car control should be configured to override this signal, when activated.

To manage this system adequately, a number of senior staff (and deputies) should be designated and they should be capable of carrying out the necessary duties quickly and efficiently at all times during which the building is occupied.

The evacuation procedure for people requiring assistance should begin at the first warning of fire. In premises where there is a two-stage fire warning system, this should be on the sounding of the "alert" or "first-stage" alarm.

*NOTE Communication systems recommended for fire-fighting lifts (see **21.3**) are not sufficient for an evacuation lift.*

Except in two-storey buildings, some form of communication system should be provided to enable the rapid and unambiguous identification of those storeys with people requiring assistance with evacuation, and the relaying of this information to the person operating the evacuation or fire-fighting lift car. Such a system may consist of a control sited at each lift landing and linked to the lift car call indicators. Requests may be made to the person controlling the evacuation, either by using visual indicators or a telephone and then relaying to the lift operator by telephone, or by a communications system using personal radio transceivers.

Staff immediately available at the final exit level (possibly security or reception staff) should be designated and trained as evacuation lift operators. The duties to be undertaken by a designated member of staff, immediately on receipt of a fire alert signal, should include the following.

a) An operator designated to take control of the lift should operate the evacuation lift switch, and should:

    1) determine the storey and part of the building indicated as the location of the fire;

    2) determine the storeys at which people are awaiting assistance; and

    3) take control of the lift and proceed to move people requiring assistance to the final exit level.

b) A designated person should ensure that:

    1) any people requiring assistance in the storey for which that person is responsible move to the nearest refuge (lift lobby, etc.) to await the lift; and that

    2) the person controlling the evacuation lift is aware that a person or persons is/are waiting for the lift.

Unless a different order has been agreed with the fire authority, evacuation should normally be in the following order:

1) the fire floor;

2) the floor immediately above the fire floor;

3) other floors above the fire floor starting at the top storey;

4) all remaining floors.

It needs to be appreciated, however, that the actual fire conditions might necessitate changes in the planned sequence.

At final exit level, help should be available to assist passengers from the lift thus permitting a rapid vacation of the car and avoiding congestion near final exits.

If an evacuation lift fails to arrive at a landing, or access to it at any level is obstructed by the fire, it will be necessary to use a stairway. If the lift itself remains safe to use it might only be necessary to descend to the storey below using the stairway and from there continue the descent by lift. It is necessary therefore to determine the best method of negotiating stairs and some practice might be necessary.

When the fire and rescue service arrives, the officer in charge should be briefed by the designated senior member of staff co-ordinating the evacuation on both the position and circumstances of the fire and of the progress of the evacuation. Subsequent priorities for the use of evacuation lifts and fire-fighting lifts will then be decided by the fire and rescue service.

G.3 Construction of refuges and evacuation lift enclosures

NOTE The construction of enclosures to fire-fighting lifts is covered in ***21.3****.*

G.3.1 Fire resistance

Where fire resistance is recommended in this annex, the period of resistance should be taken (in the absence of any recommendation to the contrary) as being not less than 30 min. Elements of construction forming refuges, evacuation lift enclosures and lobbies should have the following fire resistance.

a) Load-bearing walls should have equal fire resistance with respect to load-bearing capacity (and integrity and insulation where appropriate) from either side and should only have uninsulated glazed elements as permitted in **31.3**.

b) Non-load-bearing walls and partitions should have equal fire resistance with respect to integrity and insulation from either side and should only have uninsulated glazed elements as permitted in **31.3**.

c) Doors should have equal fire resistance with respect to integrity from either side, except in the case of doors to:

   1) lift wells where fire resistance is with respect to exposure of the landing side only;

   2) external escape routes where fire resistance should be from the inside.

G.3.2 Glazed elements

Glazed elements that are fire-resisting in terms of integrity and insulation to a level of fire resistance equivalent to that for the structure into which they are installed may be used without restriction.

Glazed elements that are fire-resisting in terms of integrity may be used only where there is a requirement to provide vision panels in order to comply with legislation.

G.3.3 Fire doors

Fire doors, including self-closing devices, should be in accordance with **33.1**.

Doors (except lift landing doors) protecting openings in refuges or enclosures to evacuation lifts should be FD 30S fire doors. Lift landing doors to evacuation lifts should be FD 30 fire doors.

G.3.4 Hold-open systems

Hold-open devices for refuges and evacuation lift enclosures should be in accordance with **33.1.6.2**.

Annex H (normative) Fire safety manual

H.1 General

NOTE Depending on circumstances, the fire safety manual might need to be separate from the safety plan required by the Construction (Design and Management) Regulations 2007 [18], in which case the information from this should be duplicated in the fire safety manual. The actual form of the fire safety manual will depend on the type of occupancy involved.

A fire safety manual should contain design information and operational records. The design information forms the basis of an ongoing history document to which additional material is added when the building is occupied and at regular intervals thereafter. The designer is largely responsible for those parts of the fire safety manual that contain design information; further information is given in **H.4.1**. The fire safety manager is responsible for those parts of the fire safety manual that contain operational records, the fire safety policy statement and the fire safety documentation; further information is given in **H.4.2**, **H.4.3** and **H.4.4**.

The fire safety manual should:

a) provide a full description of the assumptions and philosophies that led to the fire safety design, including explicit assumptions regarding the management of the building, housekeeping and other management functions;

b) explain the nature of the fire safety planning, construction and systems designed into the building, and their relationship to overall safety and evacuation management;

c) draw on the documentation produced at the design stage to describe the use of the various protection systems in each type of potential incident;

d) set out the responsibilities of management and staff with regard to fire safety;

e) provide a continuously updated record of all aspects of the building and the building users that affect its fire safety.

H.2 Actions to be taken by the designer

It is the responsibility of the designer, in the first instance, to initiate and create the fire safety manual for a project.

Designers should inform their clients of the nature, function and capabilities of the fire precautions that have been designed into the building, especially those of which the nature might be less evident.

H.3 Actions to be taken by the fire safety management team

The fire safety manager and/or designated representatives should be responsible for the upkeep of the manual. The initial occupants of the building need to develop the manual provided by the designers at hand-over.

Provision needs to be made for recording the results of monitored test evacuations, the results of tests of the fire safety systems, and any other relevant information.

The fire safety manual should be made available for inspection or tests by auditors and regulators and for operational purposes by the fire and rescue service.

H.4 Contents of the fire safety manual

H.4.1 Design information

NOTE Attention is also drawn to the information required by the Construction (Design and Management) Regulations 2007 [18], to Regulation 16B of the Building Regulations 2000 [19], and to currently applicable fire safety legislation.

Where and as appropriate, the fire safety manual should contain full details of the following items or details of where the information is located:

a) fire safety policy statement (see **H.4.3**);

b) fire safety documentation for the building (see **H.4.4**);

c) any identified fire risks, and particular hazards for fire-fighters (e.g. some types of sandwich panels);

d) control systems utilized throughout the building;

e) critical transportation routes for building services;

f) site plans, including the location of fire safety signs;

g) escape routes;

h) assembly points and/or muster stations;

i) access (exterior and interior) for the fire and rescue service and pre-planned procedures agreed with the fire and rescue service;

j) fire-fighting equipment;

k) communication systems, including details of alternative formats provided;

l) a full description of the active and passive protection systems in the building;

m) a full description of all the other design aspects which have a direct bearing on the fire safety management, including the management level (see Clause **8**);

n) an operator's manual for the fire safety systems;

o) an inspection, maintenance and repair manual for the fire safety systems, including details of routine inspection, maintenance and testing activities, with schedules, frequencies and routine test measures;

p) fire prevention and security measures (including measures for the prevention of arson);

q) details of interactions with security, building management, other safety systems, etc.;

r) drawings of the building identifying any smoke control zones, fire detection zones, colour closed-circuit television (CCTV) cameras, public address or voice alarm zones and any other key equipment locations;

s) description of the basic fire precaution measures;

t) documentation from contractors and manufacturers (including any instructions, guarantees and test certificates) and spare parts;

u) as-built drawings, specifications, equipment-operating parameters and record drawings in accordance with BS 1635 for all fire protection measures, both active and passive, incorporated into the building;

v) the results of any acceptance tests of all installed safety systems (which might have involved the regulatory authorities and insurance company representatives);

w) any IT system used to manage the fire safety manual (e.g. maintenance schedules, record keeping);

x) information relating to approvals, certification and licensing, with copies of all certificates and licences;

y) pre-planned procedures for salvage;

z) other information, etc., relating to other reasons for protecting the building – property, contents, fabric, heritage, environment;

aa) any other information needed so that building fire safety managers can manage the building safely and carry out any necessary fire safety risk assessments.

H.4.2 Operational records

NOTE 1 Attention is also drawn to the need for information relating to regulatory requirements (e.g. building regulations/standards and licensing approvals).

NOTE 2 The 2004 edition of the Building Regulations 2000, Approved Document M [30] refers to the advisability of preparing an access statement and indicates that if kept updated during construction, this might be of value to the end user of the building, who might have ongoing obligations under the Disability Discrimination Act 1995 [1].

Where and as appropriate, the fire safety manual should contain full details of the following items or details of where the information is located:

a) safety management structure;

b) changes to management structure;

c) access statements;

d) continuing control and audit plans, including the findings of the annual audit (see **41.8**);

e) a log detailing inspection of fire prevention measures (see **42.1**);

f) a log detailing inspection of escape routes (see **43.2**);

g) maintenance records of all heat-dissipating equipment and fire safety equipment (see **43.3** and Annex V);

h) changes to building systems and safety plans (see **44.1**);

i) the fire routine (see **44.2**);

j) testing of fire safety systems;

k) results of monitored test evacuations (see **44.6**), including:

- assessment of the pattern of response during different stages of the alarm sequence in different parts of the complex;
- timing and content of public address announcements (see **I.2**);
- specific problems for disabled people, including the audibility of alarms and messages, the visibility of signs and the usability of equipment, such as ramps and refuges;
- apparent interpretation of the announcements by public and staff;
- numbers of people using the different escape routes;
- timing of the stages of evacuation;
- faults identified and remedies implemented;

l) staff training records, including:
   - date of the instruction or exercise;
   - duration;
   - the name of the person giving the instruction;
   - names of the persons receiving the instruction;
   - the nature of the instruction, training or drill;

m) planned maintenance procedures;

n) system failure and fault recording procedures;

o) contingency plans, including plans for salvage and damage control and business continuity;

p) housekeeping routines (including key boards and chain panels in theatres and similar premises);

q) documentation in the management plans of the complex detailing the roles of tenants;

r) safe system of work procedures for non-routine activities where these could increase the risk from fire, including hot work permits (see **48.2**);

s) a log of contractors' and/or workmen's attendance;

t) changes to building structure;

u) information relating to any fire certificates or licensing;

v) information relating to fire risk assessments required by legislation, and a copy of any such assessments;

w) a log book of all events that occur over the life of the building that relate to fire safety;

x) any fire incidents or "near miss" events and any lessons learned from them (see **45.10**);

y) false alarms and evacuations;

z) feedback from staff, occupants or other users of the building (see **H.5**);

aa) results and changes following reviews and testing of the manual (see **H.5**).

H.4.3 Fire safety policy statement

When the fire safety manual is first created, only a proposed policy statement is likely to be available. It should be replaced by the full policy statement as soon as possible.

In order to develop and maintain the safety of the building, the building management team should formulate a policy statement appropriate to the building configuration, location, occupation, and if relevant, to the building users. The policy statement should include:

a) general safety issues related to the use of the building;

b) possible fire scenarios;

c) aims and objectives of the proposed management system and its methodology.

This policy should be endorsed by the highest level of management.

H.4.4 Fire safety documentation

The fire safety provisions within the building should be documented and should include the following details:

a) a summary of the risk assessment, fire safety analysis and strategy. The emphasis of this analysis should be related to the performance requirements of the building;

b) a description of the philosophy, method of calculation, design and analysis software used, assumptions, inputs and outputs;

c) plans and layout drawings, including services;

d) identification of means of escape routes complete with recommended flow pathways for safe evacuation;

e) for complex buildings with phased evacuation, details of the appropriate escape flow/sequence;

f) a full description of the levels of passive fire protection provided throughout the building, including provisions for structural protection, compartmentation, protected shafts, fire-fighting shafts, cavities/voids and their respective protective barriers, fire doors, etc.;

g) a full description of all the active fire safety measures, including detection, alarm, suppression, and smoke control systems, fans, dampers, and curtains;

h) integration of active and passive fire safety measures, the linkage between active and passive fire safety measures employed throughout the building and the extent to which this linkage applies;

i) identification of areas of high fire load, together with details of their provided protection and procedures for safe operation in those areas;

j) a concise description with performance ratings of the active systems employed, specified and identified on appropriate drawings, including:

   - automatic fire detection controls;
   - smoke controls;
   - sprinklers;
   - emergency lighting;
   - way-guidance;
   - communications;

k) clear identification of zoned areas of a building (e.g. fire alarm zones, hazardous area zones) supported by plans/drawings;

l) location of control panels and prime movers;

m) which, if any, computer models, virtual reality or CFD (Computational Fluid Dynamics) have been used in the design;

n) any assumptions made in the computer models from which the safety design was derived, the input data and output results, together with any changes to the design as the result of reanalysis using different or improved software;

o) any quantitative or qualitative risk assessments and sensitivity analyses.

Control systems utilized throughout the building should be clearly documented. Identification of controls should be made with respect to activation/sequencing of plant, including the procedures for start-up/shut-down and manual overriding of plant controls in a fail-safe manner.

Critical transportation routes for building services should be identified on the site plans. This includes air/smoke duct routes, electrical cable runways and other fluid/gas pipelines utilized in the building. Associated with these service routes should be the results of the risk assessment undertaken, complete with any fire protection provided.

The site plans should illustrate fully the fire and rescue service access facilities incorporated in the building design (see also Annex M). There are two important aspects to this.

1) *Outside the building.*
   The plans should show details of entry/exit points complete with clear routes for gaining access to the building from public roads. Specifications should show how access is achieved for the full range of emergency service vehicles. All other facilities provided for the fire and rescue service on the outer extremities of the building should be clearly identified and shown on the plans, e.g. fire main inlets (see BS 9990), water storage tanks and access points to fire-fighting shafts.
2) *Inside the building.*
   The plans should show fire-fighting shafts,
   fire mains and details of access and facilities, including control rooms/systems, provided to assist the fire and rescue service.

H.5 Maintenance, review and testing of the fire safety manual

The fire safety manual should be kept up to date on a routine and regular basis by the fire safety manager or a competent person nominated for the task, so that the information described in **H.4.2** is included within one working week of any event. It should be updated as appropriate to record feedback from staff and other users of the building. If any fire safety equipment is found to be unreliable, records should be kept of the problems experienced. If deemed necessary, this information should be provided to the particular manufacturer.

The fire safety manual should be reviewed and its procedures tested annually, or whenever alterations are made to the building, in accordance with a documented procedure. The review should include:

a) all plant and equipment interface controls, to ensure that equipment is all in working order and that maintenance procedures are being followed;
b) all staff duties and training procedures;
c) records, as-built drawings and specifications of the fire protection measures;
d) responses to any false alarms, “near miss” events or real fires that have occurred since the previous review.

Most of the testing should be a matter of routine activity for the management to ensure that prescribed activities are being properly carried out. Testing should where possible be monitored by senior management.

Records of reviews should be kept and of the changes made. If an IT system is used to manage the manual then it is particularly important to carry out regular checks that the requirements are being met.

Inspection routines should make provision for all systems installed in the building, such as fire alarms and smoke control equipment. They should include systems installed in units and other occupancies, as well as those that are the direct responsibility of the management of the overall building.

There should be a major building test evacuation at least once a year to test all of the systems and procedures in the fire safety manual (see **44.6**).

H.6 Location and access

The fire safety manual should be kept on the premises and should be made available for inspection by the fire enforcement authority or other relevant enforcing authority on request. At least one duplicate maintained identical copy should be retained in a separate location away from the premises.

Annex I (normative) Fire control centre and evacuation management

*NOTE See also **10.4.2.1, 44.4, 44.5, 45.5** and Clause **46**.*

I.1 Fire control centre management

The fire control centre in a building is where any centralized detection, alarm, communication and/or control functions are located. The fire control centre may be a panel (e.g. located at the building reception area), a dedicated fire control room, part of a central building control room, or be located remotely. Depending on the characteristics, including the extent, of a complex, certain functions of the control room are inevitably closely associated with its day-to-day safety management. This includes monitoring situations and providing verbal guidance to occupants. In extensive complexes it can be advisable to computerize the functions of the control room.

If a fire is discovered or suspected in a unit or other occupancy in a complex, there are certain actions that should be carried out by the people managing the fire control centre of the unit or other occupancy in question, and certain actions that should be carried out by the people managing the fire control centre of the complex.

a) The management of units and other occupancies should take the following actions.

NOTE The management of the complex are responsible for contacting the fire and rescue service [see b2)].

   1) Alert the central control room to the possible emergency.
   2) Alert employees (or selected employees) to the emergency.
   3) Establish the location and apparent extent of the fire and assess the situation.
   4) Shut down non-essential equipment.
   5) Organize and effect the movement and/or evacuation of the public and employees as determined by item a3).
   6) Take steps consistent with the safety of individuals to fight the fire or contain it.
   7) Ensure that, on arrival of the fire and rescue service, every assistance is given to enable them to attack the fire effectively, and in particular inform the fire and rescue service of the situation as regards the safety and whereabouts of the occupants of the unit or other occupancy.

b) The management of the complex should take the following actions.

   1) Establish the location of the alarm of fire.
   2) Send an alarm call to the fire and rescue service immediately with whatever detail has been prearranged as being necessary.
   3) Alert appropriate staff to the occurrence and location of the potential emergency.

4) Organize and effect (as dictated by a responsible assessment of the situation and other information available) procedures prearranged with the fire authority, the movement of the public and employees in the areas affected, and the direction of the public in appropriate common areas.
5) Take steps to localize the effects of the fire and, if possible, contain it to the area or unit affected.
6) Ensure that, on arrival of the fire and rescue service, information is immediately available and every assistance is given, in accordance with previously agreed procedures.

The following actions should be taken in order for the fire control centre to carry out effective evacuation (see also **I.2**).

1) Control centre staff should have the training necessary in the delivery of emergency messages including giving instruction and assistance with authority, so as to ensure prompt compliance with public address announcements.
2) Where appropriate, back-up automatic message units should be provided from which a range of stored or pre-recorded messages can be selected.
3) Where public address announcements are to be given by control centre staff, special training and explicit guidance should be given to them on the delivery of emergency messages.
4) Announcements, both pre-recorded and live, should be worded and delivered in such a way as to provide reassurance and relevant information, but also to convey the sense of urgency necessary to motivate people to move promptly in the safest direction.
5) Not all people will be able to hear or understand public address announcements. Control room staff should ensure that other staff are directed to give assistance to people needing extra assistance.

I.2 Evacuation management

In large and complex buildings (particularly those where members of the public are present), evacuation is best managed by the combined use of public address announcements and staff. Pre-recorded messages should not take precedence over live "directive" messages delivered by trained control centre announcers.

When establishing evacuation procedures in large or complex buildings, major features that needs to be taken into account are the sophistication of the fire detection and alarm system and of the public address and/or voice alarm system.

Directive messages provide the occupants with the clear, prompt and accurate information they will need to move safely without delay. The use of public address systems should not be restricted to coded staff messages.

Recommended procedures for phased evacuation are given in Annex X.

Public address and voice alarm systems should be zoned where appropriate so that messages can be given in specific parts of the building. This permits evacuation to be conducted in stages. The design of the public address and/or voice alarm system should take account of the level of background noise, e.g. when any smoke control plant is running. If an automatic public address and/or voice alarm system is provided, it should be possible to override it.

Public address and/or voice alarm messages (live directive and pre-recorded non-directive) should be set out in the fire safety manual (see Clause **9** and Annex H) (and possibly a more detailed communications and training manual), and should be validated and updated on the basis of training and monitoring exercises.

All background sound systems, including temporary ones, should be silenced in the event of fire.

Annex J (informative) Fire safety equipment, facilities and systems

J.1 General

This annex contains examples of fire safety equipment, facilities and systems requiring inspection, maintenance, testing and repair. The list is not exhaustive but conversely, not every building will need every item listed, and the designer therefore needs to take into account the particular circumstances of each building individually.

J.2 Detection

Examples of detection equipment, facilities and systems include:

- fire detection and alarm systems;
- smoke detection and alarm systems;
- intruder detection;
- integrated security and fire systems.

J.3 Alarms and communications

Examples of alarm and communication equipment, facilities and systems include:

- fire alarms and warning systems;
- call points, break-glass alarms, voice call-points;
- analogue addressable alarm systems;
- alarm sounders;
- voice alarms;
- two-stage alarms/communications;
- the location of alarm indicator panels;
- the arrangements for calling the fire and rescue service;
- siting of exit signs;
- signage, illuminated signs;
- means of communication between storeys or zones;
- public address systems;
- voice alarm systems;
- links to emergency power;
- any fire control centre;
- closed-circuit television (CCTV).

J.4 Suppression

Examples of suppression equipment, facilities and systems include:

- automatic sprinkler systems;
- portable fire extinguishers and hose reels;
- gaseous, foam and powder extinguishing systems;
- other fixed extinguishing systems (e.g. CO_2);
- water mist and directed water deluge systems;
- plant, pumps and plumbing;
- water tanks;
- bunds and run-off tanks;
- links to emergency power (see also **J.10**).

J.5 Smoke control

Examples of smoke control equipment, facilities and systems include:

- smoke control systems for means of escape and/or fire-fighting;
- smoke and heat exhaust ventilation systems;
- pressure differential systems;
- smoke seals on doors;
- standby fans and motors;
- links to emergency power (see also **J.10**);
- make-up air systems;
- smoke barriers.

J.6 Means of escape

Examples of equipment, facilities and systems for means of escape include:

- evacuation lifts and their associated equipment;
- evacuation chairs and similar equipment for disabled people;
- safety, emergency and escape lighting systems (including self-contained luminaires with sealed batteries);
- way-guidance systems;
- suitable (e.g. non-slip) floor surfaces within escape routes;
- openable windows on escape routes;
- door closing devices, door retaining devices, hinges and latches;
- protection measures provided for escape routes, especially those not in regular use;
- refuges, including protected lobbies used as refuges, and other nominated places of temporary safety;
- stairs, escalators and ramps.

J.7 Built-in fire protection

Examples of structural features that can aid fire protection include:

- compartmentation systems, including fire doors, automatic release mechanisms and closing mechanisms;
- structural fire protection measures;
- penetration seals;
- intumescent seals;
- void or cavity barriers;
- other fire stopping and seals;
- protected means of escape;
- structural protection;
- protection measures provided for lifts and stairways protected from fire;
- fire-resisting glazing.

J.8 Fire-fighting

Examples of fire-fighting equipment, facilities and systems include:

- fire hydrants and fire mains, and associated valves, etc.;
- wet or dry rising fire mains and the inlet and/or outlet boxes;
- foam inlets to oil-fired boilers;
- outlet straps to fire mains;
- fire-fighting lift installations.

J.9 Control systems

Examples of control systems that can aid fire protection include:

- central controls to release any doors held open by automatic release mechanisms;
- the fire-fighting lift switch;
- any mechanical ventilation or pressurization systems;
- lift controls;
- escalator controls;
- door control mechanisms;
- evacuation and fire-fighting lifts;
- openings that are automatically opened by smoke detectors at the time of a fire;
- automatically operated air input fans which maintain a positive air pressure so that smoke is restricted from entering escape routes.
- connections to the fire and rescue service that are automatically and continuously monitored;
- fire control centres;
- "swipe card" and similar systems for access.

J.10 Power

Examples of power equipment, facilities and systems include:

- protected power supplies and cables;
- generators and batteries;
- diesel generator for the standby power supply;
- emergency lighting, standby power systems;
- lightning protection systems.

J.11 Access to the building and its surroundings

Examples of access facilities that can aid fire protection include:

- access roads;
- car parking;
- service roadways also used for fire and rescue service access;
- assembly point or points;
- access for the fire and rescue service to any fire main, foam or other inlet;
- fire appliance access to required positions within the building;
- automatic barriers;
- "swipe card" and similar security barriers.

Annex K (informative) Signs and signage

Fire safety signs are divided into a number of categories, each category supporting and complementing an individual part of the fire safety management strategy.

a) *Means of escape signs and signing systems* are used to assist in an effective and efficient evacuation to a designated place of relative or ultimate safety, e.g. exit, fire exit, exit for emergency use only.

b) *Way-guidance signs and signing systems* are used to assist in identifying escape routes by using a comprehensive arrangement of visual components, signs and markings in special circumstances or for specific categories of people, and are additional to the standard means of escape signs.

c) *Fire safety notices* are used:

- to inform and instruct building occupants of measures to be taken to maintain the integrity of passive fire protection, e.g. "fire door keep shut";
- to instruct and inform building occupants of the actions to be taken in conjunction with fire alarms, evacuation procedures and/or emergency planning.

d) *First aid fire-fighting equipment signs*, incorporating the appropriate classification information, are used to identify the equipment type.

e) *Emergency equipment identification signs* are used for alarms, emergency telephone and other essential equipment.

f) *Emergency egress equipment signs* are used to identify devices and panic hardware provided specifically to ensure efficient and effective evacuation and to override security on an escape route.

NOTE 1 Site identification signs might be needed for multi-hazardous chemical storage at the perimeter and entrance to the site. This is usually determined in consultation with the enforcement authority.

g) *Fire-fighter facilities signs* are used to identify and locate equipment provided for fire-fighters, e.g. dry riser, gas shut off, sprinkler valve location, hydrant and fire plan.

h) *Hazard warning signs* are used to identify locations where there are specific risks associated with actions or procedures deemed to be hazardous.

NOTE 2 Prohibition signs are normally displayed in conjunction with hazard warning signs, e.g. "no smoking", "no naked flame", "no access for unauthorized persons".

i) *Prohibition signs* are used to prohibit behaviour likely to increase or cause danger.

j) *Assembly point and safe area signs* are used to assist in the accountability of personnel in the event of evacuation.

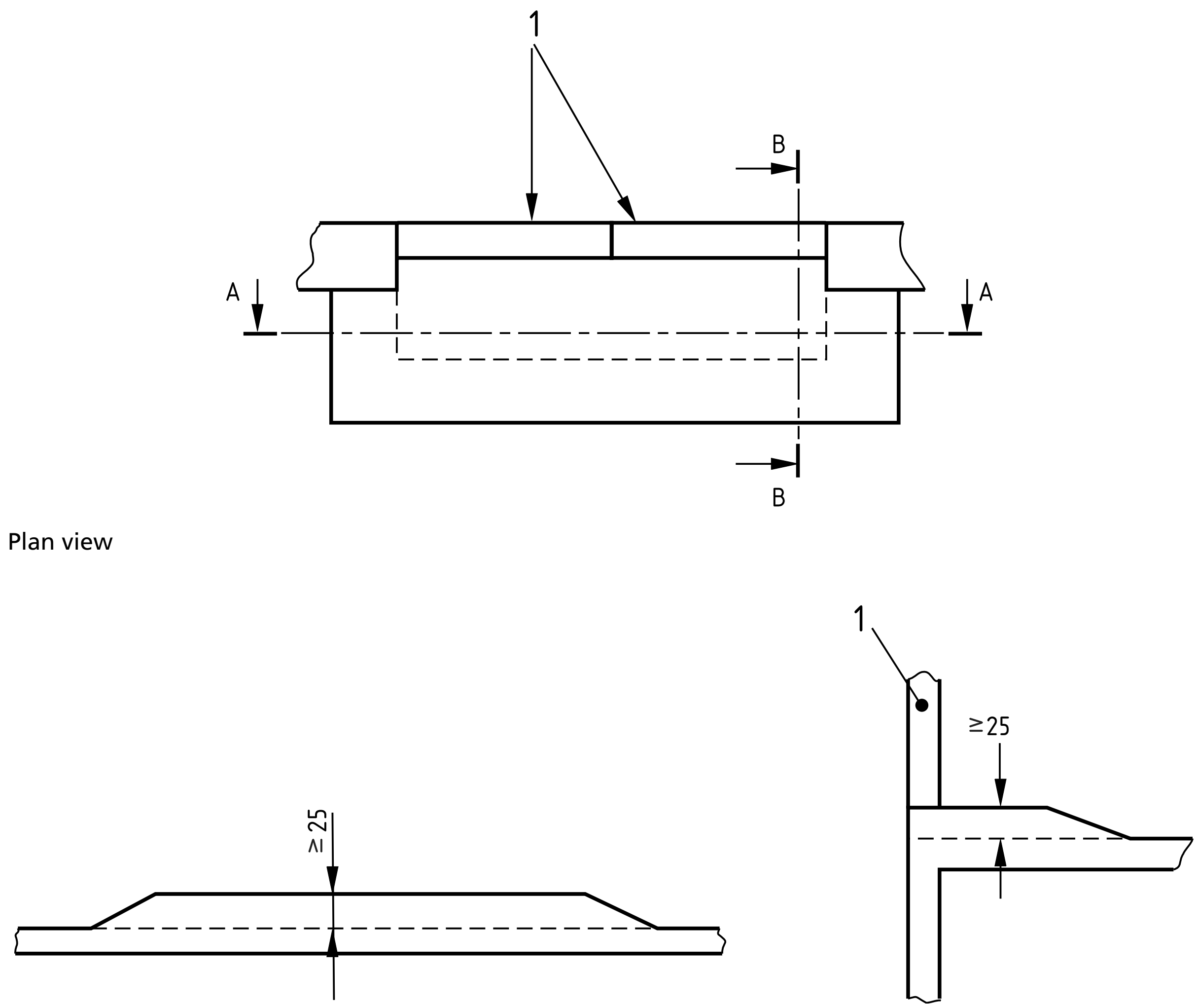
Annex L (informative) Typical arrangements to keep fire-fighting lift wells free from water

Examples of typical arrangements to keep fire-fighting lift wells free from water include:

- the use of a raised threshold to the lift entrance (see Figure L.1);
- the use of a drainage grid to the lift entrance (see Figure L.2);
- the use of a floor sloped away from the lift entrance (see Figure L.3).

Figure L.1 **Raised threshold to lift entrance**

Dimensions in millimetres



a) Plan view

b) Section A–A

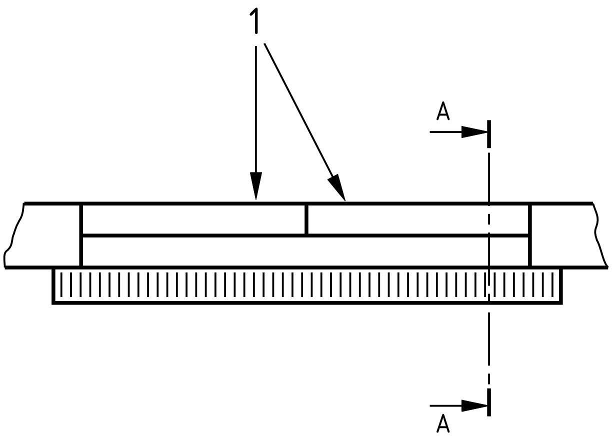
c) Section B–B

Key

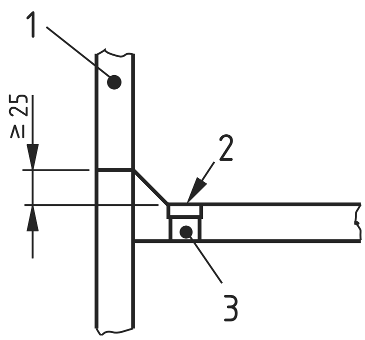
1 Lift landing door

Figure L.2 **Drainage grid to lift entrance**

Dimensions in millimetres



a) Plan view



b) Section A–A

Key

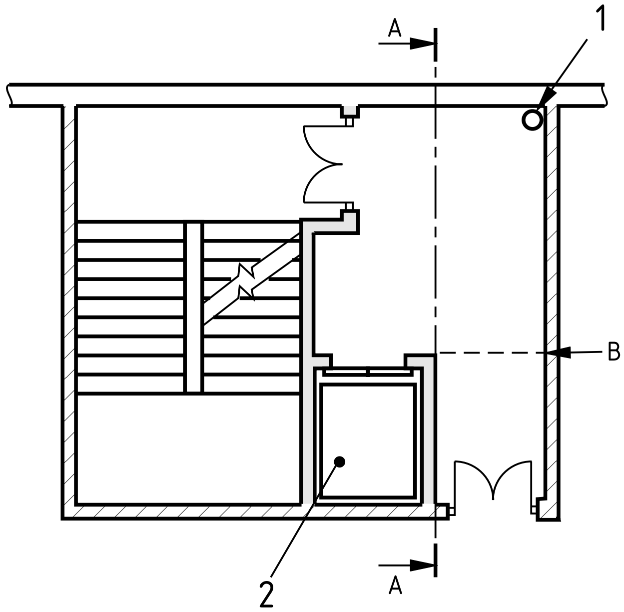
1 Lift landing door

2 Drainage grid

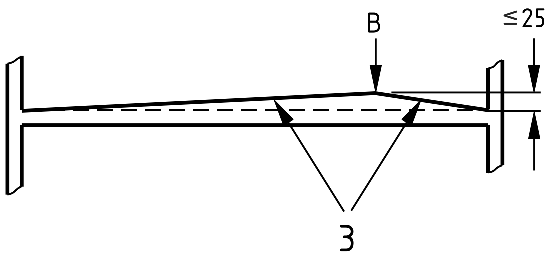
3 Gully leading to drainpipe

Figure L.3 **Floor sloped away from lift entrance**

Dimensions in millimetres



a) Plan view



b) Section A–A

Key

1 Landing valve of fire main

2 Fire-fighting lift

3 Minimum fall 1:100

Annex M (normative) Operational information (emergency packs) for the fire and rescue service

Emergency packs should provide operational information needed by fire crews at the time of an incident, in a simple and useable format. Where appropriate they should include the following information:

a) fire and rescue service contingency plan for the building (this is usually provided by the fire and rescue service);

b) simple floor plan layouts, indicating any relevant fire resistance provisions, internal access provisions, fire-fighting facilities, building services and any specific hazards;

c) any relevant information (including operating instructions) relating to equipment/fixed installations provided for means of escape or fire-fighting;

d) the implications of any fire-engineering strategy on the performance of the building during a fire, e.g. reduced fire resistance of elements of structure or areas of the building with additional fire protection measures;

e) information relevant to preventing environmental damage;

f) information relevant to mitigating loss and assisting salvage operations.

Depending on the complexity of the building, schematic fire system plans might also be necessary. An isometric or cut-away view might be appropriate as the best means of illustrating the building. Fire protection facilities shown on any of these plans should be labelled, and where plan symbols are used, a key to the symbols should be provided.

Additional information may also be placed in the emergency pack, e.g. CD-ROMs containing the full fire safety plan, business recovery plans or business continuity plans, but it is essential to ensure that it is clearly distinguished from the basic operational information.

Emergency packs kept on the premises should be sited such that they are readily accessible to attending fire crews. Emergency packs are often sited on the outside of the building in plans boxes, but if site security is an issue, the boxes may be sited internally on the predetermined fire and rescue service access route into the building. For a large site and/or where a 24 h site presence is maintained, it can be acceptable for the emergency packs to be sited within a security office or fire control room. Where plans boxes are sited externally, they should be in a prominent position, preferably protected against all weather conditions.

Where a plans box is used, a photo-luminescent identification sign should be provided on the outer face of the box door. This should remain prominent so that if the building's lighting fails, the sign will clearly indicate the location of the box. Where a plans box is not used, the emergency pack should be clearly identified by an appropriate method.

Annex N (normative) Commissioning and hand-over of smoke control systems

N.1 General

The procedures recommended in this annex should be carried out in addition to the general procedures for commissioning and hand-over recommended in Clause **40**.

N.2 Smoke ventilation systems

N.2.1 General

The volume flow of inlets for mechanical systems, and quantities, size and location of inlets for natural systems, should be checked and should meet the design criteria. If security doors are opened to provide inlets, or if security is maintained by means of an open mesh shutter, the inlet area could be reduced. In such circumstances, an assessment of the free area should be made and a correction factor applied in respect of any such door.

N.2.2 Powered smoke exhaust systems

The volume extract rate should be measured at ambient conditions. The measurements should be carried out to ensure that the extract rate at each location is in line with the required extract rate for the design fire.

If standby generators are installed to provide emergency electrical power, these should be checked for correct operation. If standby generators are common to other emergency systems, these other systems should be powered by the generators to ensure that a reliable power supply is provided that can handle the full emergency load.

NOTE 1 The volume extract (or supply) airflow readings should be taken either by using a vane anemometer at each extract grille, then totalling the readings, or by taking a Pitot traverse in an appropriate straight section of ductwork (approximately 4 m from any obstruction or outlet, etc.) for each fan, then totalling the results.

NOTE 2 Further information can be found in the CIBSE Commissioning Code A *[80].*

N.2.3 Natural smoke ventilation systems

The areas of the ventilators should be measured, and along with test certificates for ventilator aerodynamic coefficients, these should be compared with the figures required by the approved design.

NOTE This can be done by measuring a sample of each ventilator size and calculating the measured area by totalling the numbers of vents.

N.3 Smoke control systems employing pressure differentials

The commissioning and hand-over procedures for smoke control systems employing pressure differentials should be in accordance with BS EN 12101-6.

Annex O (normative) Fire safety training

O.1 General

Fire safety training should form part of the planning, training and monitoring activity defined in the fire safety manual (see Clause **9** and Annex H).

All training should be given by a person who is competent both in the subject and in training.

Fire safety training should be continuous, commencing with induction training on the first day of appointment of new staff and continuing in the form of regular refresher training.

Thereafter, staff should receive sufficient training at regular intervals (at least once a year) to make sure that they remain familiar with the fire precautions for the workplace and are reminded of the action to be taken in an emergency. Training should be more frequent where there is a high turnover of staff or where there is a high risk of fire.

In so far as the responsibilities are applicable to their role, all staff, including part-time staff, security staff, cleaning staff and contractors should be trained and instructed in:

- basic fire prevention;
- good housekeeping;
- risk awareness;
- smoking policy;
- the fire routine;
- the terms, conditions and restrictions of any licence;
- actions to be taken upon discovering a fire or upon hearing the fire alarm;
- knowledge of the escape routes, refuges and exits, especially those not in regular use;
- raising the alarm, including the location of alarm indicator panels;
- action to be taken upon hearing the fire alarm;
- arrangements for calling the fire and rescue service;
- special provisions for assisting disabled people;
- location of fire-fighting equipment;
- selection and use of fire-fighting equipment, including hand fire-fighting equipment (in larger premises it might be appropriate to train specific staff in this respect, rather than all staff);
- the importance of fire doors and the need to close all doors at the time of a fire and on hearing the fire alarm;
- process shutdown and shutting down non-essential equipment, stopping machines and processes and isolating power supplies, where appropriate;
- evacuation procedures (this includes reassuring any members of the public, escorting them to exits, and encouraging them to get well clear of the building);
- incident reporting procedures, including for "near miss" events and false alarms.

Any members of staff who have particular responsibilities in respect of fire safety, including supervisory roles, should receive detailed instruction in their own duties and appropriate refresher training at least once, and preferably twice, in each period of twelve months. Persons with particular responsibilities are likely to include:

- department heads;
- fire marshals or fire wardens;
- fire-fighting teams in large workplaces;
- floor supervisors;
- central control room staff;
- security staff (including night security patrols);
- attendants;
- stewards;
- kitchen staff;
- engineering and maintenance staff;
- receptionists and telephonists.

O.2 Additional training for staff in large buildings

In larger premises it can be appropriate to train specific persons to ensure that all staff and members of the public are safely evacuated and that everyone is accounted for. Special arrangements might be needed in premises where there are only occasional visitors and where formal procedures to deal with such visitors are not practicable.

A person or persons should be delegated to liaise with the fire and rescue service on arrival, to confirm whether everyone has been accounted for, to determine the location of the fire and any special risks (e.g. the location of hazardous substances), and, where necessary, to make arrangements for the fire and rescue service vehicles to enter the site.

Security personnel should be fully briefed as to the extent of their duties concerning precautions against fire during and outside working/opening hours. This brief should include:

- the timing of patrols of all parts of the building;
- how and where to call the fire and rescue service in every case of fire or suspected fire;
- which telephone lines are connected to an exchange line (there should be at least one per floor, or more if the floor area is large);
- the action to be taken on finding a fire, including the use of fire-fighting equipment;
- the operation of automatic fire alarms, sprinklers, etc.;
- the safe operation of self-closing doors and shutters;
- the position of all main services controls;
- actions to receive and direct the fire and rescue service on arrival.

Contractors should be given at least the minimum instruction as recommended for new employees. They should also be trained in the fire safety precautions relating to their special tasks. If they do not have such training, they should be allowed to work only with supervision or after suitable training has been given. Particular attention should be paid to the fire safety training and education of persons carrying out welding or cutting, using blow lamps or other open flames, and other types of hot work, whether by employees or contractors (see also **42.6** and **48.2**).

The training should be based on written instructions provided by management and appropriate to the specific responsibilities of the members of staff.

NOTE It is a matter for local agreement whether a tenant's staff are trained by the management of the complex or by the tenant's management.

The education of the tenants of every unit and other occupancy in the complex needs to form part of the planning and training activity defined in the fire safety manual (see Clause **9** and Annex H).

The entire fire routine, including evacuation procedures, should be tested regularly by simulated emergencies without involving the public, or by staff carrying out a walk-through so that each stage of the procedures is examined. This should include a physical examination of the escape routes and emergency equipment and critical review of recommended fire instruction notices. See **44.6** for further information on test evacuations.

It should be noted that disabled people are likely to expend more effort in the case of a real fire (e.g. leaving their wheelchair to escape using walking aids or other means) than in a practice walk-through, so it is important that there is a chance for disabled people to practice their personal evacuation plan but in a way that does not cause them unnecessary discomfort (see **46.7** and **46.11**).

Details of all training and instruction given/received should be recorded in the fire safety manual (see Clause **9** and Annex H).

Annex P (normative) Control of conditions in public areas

P.1 Combustibles in covered shopping complexes

Any fire in a public area, given the opportunity for growth, can present a greater risk to safety than one that starts in a unit. Additional fire risks are sometimes created in public areas by persons introducing combustibles into common spaces, e.g. by extending a sales display beyond the line of the front of a unit in a shopping mall.

As a general rule, the fire safety manager should ensure as far as possible that combustible materials are not introduced into public areas. To this end, a management permit system for the use of public common areas should be introduced, so that strict control can be exercised over any activity or use of the areas other than those related to access and egress by the public.

Combustible materials in a static form should not be permitted on upper walkways, or in any mall section that is less than 5 m in height or which incorporates any form of canopy.

Where combustible items and/or materials are used in displays, demonstrations or sales promotions, the fire safety manager should ensure that such items:

- are restricted wholly to ground level;
- present no surface more than 1 m in height;
- are entirely uncovered;
- are positioned not less than 3 m from openings to units or other occupancies;
- do not reduce the escape width of the public area.

Separately covered shops, kiosks, stalls, etc., should be compatible with the agreed fire safety strategy for the complex and should not reduce the escape width of the public area.

P.2 Food courts, catering and demonstrations

In many complexes it is common to group together small catering outlets with shared customer seating (food courts). The fire safety manager of the complex should limit any combustible furniture or other materials in these areas and ensure the frequent clearance of food and litter, etc.

Public common areas are also frequently used for demonstrations and sales promotions. The fire safety manager should not allow such events to take place if there is a chance that they might introduce a fire risk into public common areas, or if they might negate the functions of, or reduce the sensitivity of, fire safety systems. For example, in common public areas, demonstrations and sales promotions should be avoided if they involve:

- the production of fumes or flammable aerosol suspensions;
- the use of flammable liquids in excess of 0.5 l; or
- the use of liquefied petroleum gas.

Any part of the complex which is devoted to the preparation and serving of refreshments should comprise a separated unit of the complex.

Where two or more organizations share the same area, management responsibilities should be formally allocated by the management of the complex.

P.3 Assembly and performance functions

Certain areas, particularly any that are generously proportioned or have upper-level walkway balconies, offer the potential for assembly and performance functions. Apart from any licensing arrangements, decisions whether to use the public common areas for such purposes depends largely on the exit facilities from each of the relevant sections of the levels involved.

Consultation with the appropriate licensing authority and the fire authority is necessary before permissions for this type of use are granted.

When a public area is used for assembly or performance functions:

a) all exit routes should be returned to their full effective width before the normal business of the complex is resumed;

b) the public common areas should not be used for the temporary storage of combustible items;

c) stewarding staff should be in attendance during the function, in numbers appropriate to the nature and location of the function and the number of people attending.

P.4 Leisure facilities

NOTE Guidance on safety provisions for fairground rides is given in the HSE publication HSG 175 [81].

Apart from facilities intended for exclusive use by small children (e.g. crèches, play areas, individual machines for giving rides to children, roundabouts and funfairs), leisure and entertainment facilities should not be installed in the public common areas of a complex, but should occupy a separate unit.

All leisure facilities in a complex should be under the control of the management of the complex, and fire precautions should be put in place that are appropriate to the nature of the activity.

P.5 General fire safety controls

In a complex, regular checks of the premises, which could be by closed-circuit television (CCTV), should be carried out during opening hours, and after the complex is closed at night.

The premises should be inspected at the beginning of each working day to ensure that:

a) access for the fire and rescue service to any fire main, foam or other inlet is not obstructed;

b) fire appliance access to required positions within the building is not obstructed;

c) the fire alarm system is operative.

All parts of the complex should be inspected regularly throughout the day with particular attention being paid to cloakrooms, medical rooms, etc., and to those parts not normally visited by staff.

Whenever members of the public are present in the complex, every part of the common public areas should be checked at 30 min intervals and every part of the non-public areas at 60 min intervals. In addition, inspections should be made of the common servicing areas following deliveries to units.

A daily inspection should be carried out after closing to ensure that the premises are left in a condition where the risk of fire is minimal.

Daily visual checks should be carried out in respect of the fire warning system, fire-fighting equipment and safety lighting, so that any obvious defects are discovered without delay.

When premises are to be left unattended, all non-essential electrical services should be turned off at the mains and any gas-fired equipment not fitted with flame supervision devices should be turned off.

Annex Q (normative) Recommendations for owners of multi-occupancy residential buildings

Q.1 General

The recommendations given in this annex are intended for the guidance of owners or their agents in the day-to-day control of a multi-occupancy residential building (e.g. containing flats).

NOTE The recommendations given in this annex only refer to the responsibility of the owner for fire safety in this type of premises. The effectiveness of fire safety precautions depends on the cooperation of the people living in the individual flats or dwellings. In order for the fire precautions to be effective, residents need to follow the instructions given on fire instruction notices in the building. Annex R contains information that can be given to owners and occupiers of dwelling, including flats. Examples of suitable fire instruction notices are given in Annex S.

If it is necessary for flats to be occupied before building works are completed it is essential that all escape routes from occupied dwellings are finished before occupation and are kept free from any building materials or equipment.

Q.2 Fire doors and escape routes

Escape routes which consist of stairs, corridors, balconies, etc., are safe routes for the occupants to move to a recognized safe place outdoors. To keep these routes safe it is essential that the fire doors are not wedged open and the self-closing mechanisms are well maintained. Nothing should be stored along the escape routes as this can stop people from using them and can itself be a source of fire.

Unless provided with a hold-open system, in which case they should be returned to the closed position each night, fire doors which subdivide corridors should continue to have a "fire door keep closed" warning notice on them reminding people to keep the fire doors closed.

The maintenance of fire doors should be carried out in accordance with the manufacturer's recommendations.

Q.3 Provision of smoke control

NOTE Openable windows on the escape routes allow the fire and rescue service to release smoke from a building and are not intended to be opened by people escaping from the building.

Smoke control is essential to allow people to escape from a building. Smoke control restricts the spread of smoke, and thereby fire, and stops it from endangering escape routes. At least one of the following smoke control arrangements should be used:

a) corridors or circulation spaces subdivided by fire doors to restrict smoke filling an entire escape route;

b) openings that are automatically operated by smoke detectors at the time of a fire;

c) smoke extraction systems, either natural or mechanical;

d) automatically operated systems designed to create a pressure differential so that smoke is restricted from entering escape routes.

Mechanical devices such as those in items a) and b) should be inspected and tested in accordance with a planned maintenance programme in order that any failures can be identified and corrected as soon as possible (see Annex V).

Ancillary accommodation may be provided with permanent ventilation to allow smoke to escape without affecting dwellings or escape routes from dwellings.

Q.4 Engineering services and fire and rescue service facilities

Any alterations, additions, repairs, or modifications to services and equipment should be carried out only by competent persons.

Services that assist escape (in addition to those described in **Q.2** and **Q.3**) include stairway and corridor lighting with independent or secondary sources of electricity supply, and duplicate lighting systems. These should be periodically inspected to make sure that they are working effectively and that switches are adequately labelled to indicate which circuits they control.

Fire detection and alarm systems together with any associated door control mechanisms which they control should be regularly inspected and tested (see Annex V).

One or more of the passenger lifts in the building may be made available for the exclusive use of fire-fighters in an emergency, when a switch at fire and rescue service access level (usually the entrance level) marked "Fire-fighting lift" is operated. Any lift that is designated as a fire-fighting lift should receive early attention when it breaks down. Regular inspections of the fire-fighting lift switch should be made to check for any unauthorized use.

Wet or dry rising fire mains and the inlet and/or outlet boxes that go with them, together with any foam inlets to oil-fired boilers, should be regularly inspected for damage and repaired if necessary. Where provided, outlet straps to fire mains should be checked to see that they are in place and secure.

Fire and rescue service access roads and gates leading to the building can become seriously obstructed by the indiscriminate parking of cars and other vehicles using the site. Control and enforcement of parking restrictions can prove difficult, but the provision and maintenance of notices giving clear instructions regarding parking arrangements can go some way to alleviating this problem.

Q.5 Portable fire-fighting equipment

Where small bore hose reels and portable fire extinguishers are installed they should be maintained and tested in accordance with BS 5306-1 or BS EN 671 for hose reels and BS 5306-3 for portable fire extinguishers.

The introduction of any new building services can present an additional fire risk and suitable additional portable fire equipment should be provided.

As the residents of sheltered housing cannot be expected to use manual fire-fighting equipment, its provision should be restricted to higher fire risk areas such as communal kitchens, and wardens' accommodation.

Q.6 Sheltered housing

Individual dwelling entrance doors should be provided with smoke seals, as this will provide a high degree of protection against the smoke contamination of any dwelling adjacent to one on fire.

An automatic fire detection and alarm system should be installed in order that the fire and rescue service can be alerted at an early stage of the development of a fire. It is preferable for the fire alarm devices to sound only in the zone in which the fire has been detected (as well as at the main control panel, at all repeater panels and at any central receiving station).

A log should be kept of any residents who would require assistance in a fire situation in order to evacuate their dwelling and/or the building, and the fire and rescue service should be made aware of the log and its location. The log might form part of the fire safety manual (see Clause **9** and Annex H).

Occupants of sheltered housing should be instructed that:

a) in the event of discovering a fire, they should not attempt to tackle it, but should activate the nearest manual call point (should a smoke detector not have already activated the automatic fire alarm system) and then proceed to the nearest safe telephone and call the fire and rescue service. They should not look for the warden, nor wait for the warden (or alarm receiving station) to contact them. They should then proceed to the nominated place of ultimate safety;

b) in the event of a fire being discovered by someone else, they should remain in their own dwelling and await instructions from the warden or fire and rescue service, unless otherwise instructed by the warden or a member of the fire and rescue service.

Q.7 Furniture in communal areas in sheltered housing

All furniture in communal areas should conform to the medium hazard resistance to ignition classification specified in BS 7176.

All curtains in communal areas should meet the performance requirements for classification as type B or type C when tested in accordance with BS 5867-2:2008.

Annex R (informative) Advice to occupiers of dwellings in residential buildings

R.1 General

This annex contains information regarding fire safety advice that can be given to occupiers of flats and other dwellings in residential buildings which are not single private dwellings. In general the same information applies to both occupiers of flats and occupiers of other domestic residential buildings. Where the information differs, the difference is highlighted in the text.

The fire and rescue service can generally provide additional advice on fire safety if it is felt to be necessary.

Examples of suitable fire instruction notices (see **44.2**) are given in Annex S.

R.2 Smoke alarms

The longer a fire burns before it is discovered, the more likely it is to cause death or injury. A fire that starts smouldering at night is therefore very dangerous.

People are not always awoken by the smell of smoke. A fire involving certain furnishings can produce poisonous gases that prevent people from recovering consciousness. Even when people do awake, their means of exit can be blocked by thick choking smoke.

Installing smoke alarms in a dwelling does not stop fires starting and does not put a fire out, but if properly installed and looked after they can give an early warning of fire and increase the chances of escape.

Guidance on the selection and installation of smoke alarms can be obtained from local fire and rescue services.

R.3 Ways in which fires can start

Fires in domestic buildings can start in many ways, including:

- careless use of matches, candles, cigarettes and pipes;
- careless use of cookers, especially leaving chip pans without watching them;
- drying and airing of clothes and other items that could burn near heaters such as gas fires and electric radiant, storage and convector heaters;
- no fire guards to prevent objects from falling into an open fire;
- children playing with matches and cigarette lighters;
- old or faulty domestic appliances, including electric blankets;
- putting portable heaters close to furniture and curtains;
- not taking out the plugs from electrical appliances at night or when away from home, unless they are designed for continuous operation, e.g. refrigerators, video recorders, clocks, etc.;
- use of paraffin heaters;
- covering of storage and convector heaters thus preventing air from getting to them;
- irregular or poor servicing of heating appliances.

R.4 General fire safety advice

Figure R.1 shows an example of general fire safety advice that can be given to occupiers of dwellings in residential buildings.

Figure R.1 **General fire safety advice for occupiers of dwellings in residential buildings**

Small fires are common, causing serious injuries and extensive damage to property and possessions. By following a few simple steps and maintaining a basic level of awareness you can considerably reduce the chances of fire in your home. The easiest and most effective way of protecting your home is by fitting at least one smoke alarm, and regularly making sure it works.

The following 13 tips will help keep your family and home safe:

1. Fit smoke alarms on each level in your home. Keep them free from dust and test them once a week. Consider buying a 10-year alarm; otherwise change the batteries in your alarm every year.
2. Make a fire action plan so that everyone in your home knows how to escape if there is a fire.
3. Keep the exits from your home clear so that people can escape if there is a fire.
4. Make sure that everyone in your home can easily find the keys for doors and windows.
5. Take extra care in the kitchen – accidents while cooking account for over half of fires in homes. Never leave young children alone in the kitchen.
6. Take extra care when cooking with hot oil. Consider buying a deep-fat fryer which is controlled by a thermostat (if you don't already have one).
7. Never leave lit candles in rooms that nobody is in or in rooms where children are on their own. Make sure candles are in secure holders on a surface that doesn't burn and are away from any materials that could burn.
8. Make sure cigarettes are stubbed out properly and are disposed of carefully, and never smoke in bed.
9. Get into the habit of closing doors at night. If you want to keep a child's bedroom door open, close the doors to the lounge and kitchen; it may well help save their life if there is a fire.
10. Don't overload electrical sockets. Remember, one plug for one socket.
11. Keep matches and lighters where children can't see or reach them.
12. Take special care when you're tired or when you've been drinking.
13. Don't leave the TV or other electrical appliances on standby as this could cause a fire. Always switch it off and unplug when it's not in use.

If you or a member of your household has any difficulty seeing, hearing or moving about the home, you will need to take extra care to deal with the risk of a fire. Your local Fire and Rescue Service will be able to assess how safe your home is and help to fit fire safety equipment such as smoke alarms.

High-rise flats are built to be fire-resisting, and most fires won't spread further than one or two rooms. Walls, ceilings and doors will hold back flames and smoke, so if there's a fire somewhere else in the building, you're usually safest in your flat unless you're affected by heat or smoke.

You should plan how to escape if there is a fire in your home. It is likely that the flat will share common areas with other flats. The owner or occupiers of the flats will have the responsibility to make sure that the necessary fire precaution measures needed in these areas are installed. For example, there may be a fire alarm and the doors and fire resisting features of the common areas will need to be maintained. It is important that occupiers understand the fire precaution measures built into the common areas and that they ask the landlord to explain the safety plans for the premises and make sure that they are familiar with what they should do when a fire happens. If you cannot escape you will need to find a room where you can wait for assistance. This is particularly important if you have difficulty moving around or using stairs. It is advisable for your safe room to have a window that opens, and a phone.

R.5 Heating

Most dwellings, including flats, are provided with a fixed heating system. The risk of a fire occurring can be reduced if the fixed heating system is used rather than heaters, as all types of portable heaters can start a fire if they are not properly sited, used correctly and maintained in good working order.

The entrance lobby and corridor of a flat is the normal escape route in the event of a fire, so it is essential that portable radiant heaters are not used in these areas. It is not advisable to use paraffin heaters. Special care needs to be taken with portable bottle gas heaters, particularly when changing cylinders. The manufacturer's instructions for all portable heaters include guidance on where they should be placed, how they should be used and how they can be kept in safe working order.

R.6 Doors

Self-closing doors are provided in flats and other dwellings in residential buildings, to stop the spread of fire and smoke. It is most important that they are not wedged open and that the self-closing mechanism works correctly.

If self-closing doors do not close themselves, it is the responsibility of the occupants to ensure that the defect is reported to the porter, caretaker or landlord, or to the local housing authority.

It can help to prevent the spread of fire if occupants close tightly as many doors as possible before going to bed or when leaving the premises empty.

R.7 Abuse of fire-fighting equipment

Fire-fighting equipment (in the form of fire extinguishers, fire mains and outlets) and fire safety signs are installed in flats and other residential buildings. It is the responsibility of all occupants to ensure that such equipment is not interfered with, and if any item of equipment is found apparently damaged, to report it immediately.

R.8 Access roads

It is important that fire and rescue service access roads to blocks of flats and other residential buildings are kept clear and unobstructed, to allow access by the fire and rescue service and other emergency vehicles at all times. It is the responsibility of all occupants to ensure that they do not park their cars in these roads or allow their visitors to do so, and if they see any vehicles parked there, to report it.

R.9 Sprinkler systems

Sprinkler systems are activated by heat from the fire, and release water onto it. They are designed to prevent the fire growing, so that much less smoke and heat are produced and people have more time to escape. In many cases a sprinkler system will put the fire out. Where a sprinkler system is installed it is important that the sprinklers are not painted over, since this can slow their response to a fire. Concealed sprinklers hide the sprinkler using a cover plate, which falls away when the solder holding it in place melts. It is particularly important that this cover plate is not painted over.

Annex S (informative) Examples of fire instruction notices

The fire instruction notice provides instructions on fire precautions and actions to take in the event of a fire. This annex gives examples of fire instruction notices for a range of situations.

- An example of a suitable fire instruction notice for flats is shown in Figure S.1.
- An example of a suitable fire instruction notice for other residential buildings is shown in Figure S.2.
- An example of a suitable fire instruction notice for shops, offices, industrial, storage and other similar buildings provided with a single-stage alarm system is shown in Figure S.3.
- An example of a suitable fire instruction notice for shops, offices, industrial, storage and other similar buildings provided with a two-stage alarm system is shown in Figure S.4.

Figure S.1 **Example of a fire instruction notice for use in flats**

This building has been built in such a way as to protect the people in it if a fire breaks out. The important thing to remember is that if the fire starts in your home, it is up to you to make sure that you can get out of it.

AT ALL TIMES

— Make sure that the smoke alarms in your home are working.

— Do not store anything in your hall or corridor, especially anything that will burn easily.

— Use the fixed heating system fitted in your home. If this is not possible, only use a convector heater in your hall or corridor. Do not use any form of radiant heater there, especially one with either a flame (gas or paraffin) or a radiant element (electric bar fire).

— Do not store things in the cupboard(s) where your gas and electricity meters are fitted.

— Do not block access roads to the building.

IF A FIRE BREAKS OUT IN YOUR HOME

— If you are in the room where the fire is, leave straight away, together with anybody else, then close the door.

— Do not stay behind to try to put the fire out.

— Tell everybody else in your home about the fire and get everybody to leave. Close the front door and leave the building.

— Do not use the lift (unless it is a designated evacuation lift).

— Do not use a balcony unless it is part of the escape route from the building.

— CALL THE FIRE BRIGADE.

IF YOU SEE OR HEAR OF A FIRE IN ANOTHER PART OF THE BUILDING

— It will usually be safe for you to stay in your own home.

— You must leave your home if smoke or heat affects it. Close all doors and windows.

CALLING THE FIRE BRIGADE

The fire brigade should always be called to a fire, even if it only seems a small fire. This should be done straight away.

The way to call the fire brigade is by telephone as follows.

1) Dial 999 from a land-line or 112 from a mobile phone.

2) When the operator answers give the telephone number you are ringing from and ask for FIRE.

3) When the fire brigade reply tell them clearly the address where the fire is.

4) Do not end the call until the fire brigade have repeated the address to you and you are sure they have got it right. The fire brigade cannot help if they do not have the full address.

Figure S.2 **Example of a fire instruction notice for use in other residential buildings**

If a fire starts in your home, it is up to you to make sure that you can get out of it.

Do not wait until a fire happens. Read these instructions and find out the best way for you and your family to get out of your home and also out of the building if a fire started somewhere else. There may be more than one way out. If you and all the other people in the building follow these rules you will all be much safer and less likely to start a fire or be injured in one.

AT ALL TIMES

— Make sure that the smoke alarms in your home are working.

— Do not store anything in your hall or corridor, especially anything that will burn easily.

— Use the fixed heating system fitted in your home. If this is not possible, only use a convector heater in your hall or corridor. Do not use any form of radiant heater there, especially one with either a flame (gas or paraffin) or a radiant element (electric bar fire).

— Do not store things in the cupboard(s) where your gas and electricity meters are fitted.

— Do not block access roads to the building.

IF A FIRE BREAKS OUT IN YOUR HOME

— If you are in the room where the fire is, leave straight away, together with anybody else, then close the door.

— Do not stay behind to try to put the fire out.

— Tell everybody else in your home about the fire and get everybody to leave. Close the front door and leave the building.

— Do not use the lift (unless it is a designated evacuation lift).

— Do not use a balcony unless it is part of the escape route from the building.

— CALL THE FIRE BRIGADE.

CALLING THE FIRE BRIGADE

The fire brigade should always be called to a fire, even if it only seems a small fire. This should be done straight away.

The way to call the fire brigade is by telephone as follows.

1) Dial 999 from a land-line or 112 from a mobile phone.

2) When the operator answers give the telephone number you are ringing from and ask for FIRE.

3) When the fire brigade reply tell them clearly the address where the fire is.

4) Do not end the call until the fire brigade have repeated the address to you and you are sure they have got it right. The fire brigade cannot help if they do not have the full address.

Figure S.3 **Example of a fire instruction notice for use in buildings provided with a single-stage alarm system**

IF YOU DISCOVER A FIRE

1) Operate the fire alarm immediately.
2) Call the fire brigade.
3) Attack the fire if possible with the equipment provided, but do not take any personal risks.
4) Leave immediately if the fire cannot be brought quickly under control. Shut doors and windows to slow down the spread of smoke, but only if it will not significantly delay your escape.

ON HEARING THE ALARM

— Leave the building and proceed to the assembly point at ………………
— Use the nearest available exit.
— Do not use the lifts (except for designated evacuation lifts).
— Only collect small valuables and a coat if they are close.
— Do not stop to collect other personal belongings.
— Take your friends or family members with you.
— Do not re-enter the building until instructed that it is safe to do so.

Figure S.4 **Example of a fire instruction notice for use in buildings provided with a two-stage alarm system**

IF YOU DISCOVER A FIRE

1) Operate the fire alarm immediately.
2) Attack the fire if possible with the equipment provided, but do not take any personal risks.
3) Leave immediately if the fire cannot be brought quickly under control. Shut doors and windows to slow down the spread of smoke but only if it will not significantly delay your escape.

ON HEARING THE ALARM

— The “alert” signal is a series of short signals on the alarm which may be interspaced with a voice message.
— Remain at your workplace but be prepared to leave if necessary.
— Await further instructions, either by the public address system or from the floor fire marshal.

NOTE Disabled people and assisting companions should move immediately to the designated location upon hearing the alert signal (and voice message).

— If the “alert” signal sounds outside the normal working hours, leave the building immediately. The normal working hours for this building are ....(e.g. Monday to Friday 0900–1800 hours).
— The “general alarm” is a continuous sounding of the alarm, which may be interspaced with a voice message.
— On hearing this, leave the building and proceed to the assembly point at ....
— Use the nearest available exit.
— Do not use the lifts (except for designated evacuation lifts).
— Only collect small valuables and a coat if they are close.
— Do not stop to collect other personal belongings.
— Take your friends or family members with you.
— Do not re-enter the building until instructed that it is safe to do so.

Annex T (normative) Audience/crowd control

NOTE Attention is drawn to the fact that there is a legal requirement to obtain a licence for the majority of public functions.

T.1 Audience/crowd control at public functions

T.1.1 General

Certain functions, e.g. pop concerts, can present additional risks, largely from the effects of over-excitement and irrational behaviour. These dangers are further exacerbated if overcrowding is permitted. Steps should be taken on such occasions to reduce the dangers and minimize the risk.

At the planning stage, the number and the width of exits should be determined by calculating the number of persons any room or storey is capable of holding. Generally the calculation involves dividing the area, in square metres, by a predetermined occupancy load factor applicable for the use to which the premises are to be put.

The conditions of any licence normally specify the maximum number of persons to be accommodated. This is the number, derived by calculation, for which the exits from the premises are intended to cater in the event of an emergency. Any appreciable increase in this number puts all occupants at risk.

T.1.2 Before admitting the public

NOTE 1 Experiences of fires in places of assembly have highlighted the importance of ensuring that exit doors can be easily and immediately opened, that exit routes are free from obstruction and adequately lit and that combustible waste has been removed.

Before the public are admitted to any performance or function, the fire safety manager should ensure that:

a) all necessary fire safety features are available and in effective working order;

b) all exit doors are unlocked and readily available for use;

c) all chains, wedges or other removable fastenings are removed from exit doors and hung in their storage positions;

d) all emergency fastenings are working effectively;

e) any doors, gates or shutters that are required to be locked in the open position are so locked;

f) all exit routes and exit doors (both internally and externally) are free from obstruction;

g) fire doors are not wedged or propped open;

h) exit routes and exit signs are adequately illuminated and, where two power supplies are provided, e.g. mains and battery, both are operative;

NOTE 2 Particular care should be taken if contractors have been working on the premises.

i) there are no obvious fire hazards, such as accumulated waste;

j) the appropriate number of staff/attendants, including those trained to assist disabled people, are present (see **T.1.3**);

k) any equipment provided to assist the evacuation of disabled people, including evacuation lifts, evacuation chairs and vibrating pagers, is operative.

T.1.3 During and after admitting the public

While members of the public are being admitted:

a) in licensed premises, the fire safety manager should ensure that the number of persons admitted does not exceed that specified by the terms of the licence;

b) in unlicensed premises, the fire safety manager should ensure that the number of persons admitted does not exceed that for which means of escape is provided and for which the premises are designed.

There should be a sufficient number of competent and adequately trained staff available throughout the event to deal with any emergency situation and to assist, where necessary, in evacuation of the premises.

At the start of any function such as a pop concert, either the manager or some other competent person should make a public announcement specifically explaining the fire routine. In particular, the means of raising the alarm and the location of exits should be explained. Not all people will be able to hear or understand public address announcements. The manager should ensure that other staff are available to help people needing extra assistance in a fire.

After all members of the public are believed to have left the building, it should be inspected to ensure that no persons remain and there are no smouldering fires or other potential fire risks.

T.2 Crowd control in complexes

Certain times, such as immediately before and after Christmas in a retail complex, can present additional dangers if overcrowding is permitted. Steps need to be taken on such occasions to reduce the dangers and minimize the risk.

In particular:

a) controls and checks should be in place to ensure that overcrowding does not take place;

b) there should be a sufficient number of competent and adequately trained staff available to deal with any emergency situation and to assist, where necessary, in the evacuation of all people in the complex. This might entail training additional staff;

c) an "active" public address system should be used regularly as a principal means of reducing crowd congestion and coordinating evacuations in shops.

Annex U (normative) Hot work

NOTE 1 Guidance on the control and permission of hot work is given in the Fire Protection Association publication Hot work permit scheme *[82]. Attention is drawn to the Building Regulations 2000 [19], the Building (Scotland) Regulations 2004, as amended [20] and the Building Regulations (Northern Ireland) 2000 [31] in respect of approval for building works.*

NOTE 2 Where dangerous substances, as defined by the Dangerous Substances and Explosive Atmospheres Regulations 2002 [27], are or have been present, particular procedures are required. These are discussed in Health and Safety Executive publication L 137 [83].

The fire safety manager should be satisfied that both the person issuing a hot work permit and the person(s) to whom the permit is being issued understand and are able to carry out their individual responsibilities, which should be detailed in the written hot work procedure. If the work is to be carried out by contractors, they should be made fully aware of pertinent fire and safety rules for the building.

A hot work permit should only be issued:

- if the fire safety manager is satisfied that an adequate fire risk assessment and method statement have been prepared;
- by those competent and authorized to do so;
- when preparation work is complete and necessary precautions are in place; and
- if the hot work is to be carried out by those competent in the particular activity.

The hazards and necessary precautions should be identified through a fire risk assessment, which should include inspection of the work area prior to issue of the permit. Issues that should be taken into account when preparing for, during and after hot work include, but are not limited to, the following:

- whether the item to be worked on can be removed to a safe area;
- consideration of other people, other activities or other hazards, etc., in the work area;
- preparation of the place of work, including removal or protection of combustible or flammable materials to prevent their ignition, which can include those on the other sides of partitions, walls, etc.;
- provision of and training in the operation of suitable fire extinguishers (see BS 5306-8) and other fire precautions as specified on the hot work permit. Ideally a separate “standby person”, who is not involved in carrying out the hot work, should be available to use the fire-fighting equipment;
- availability of a safety officer (if appropriate);
- particular precautions for specific work situations, e.g. overhead or confined space working;
- particular precautions where the premises, plant or equipment present special risks;
- ensuring safety during the work by following the agreed method statement and conditions of the hot work permit;
- leaving the workplace clean and safe, e.g. removal of hot work equipment and ensuring that there is no smouldering, etc.;
- checking the area after the job is completed, including a final check at a later time (at least 60 min) and certainly prior to the premises being vacated.

Annex V (normative) Routine inspection and maintenance of fire safety installations

V.1 General

NOTE Fire safety installations comprise the items and elements of which examples are listed in Annex J.

It is essential for the safety of the occupants of a building that fire safety equipment (including passive fire protection provisions) is inspected frequently. Although much of the inspection can be undertaken by suitably trained personnel, a formal agreement should be made with the installer or the installer's representative to provide the regular inspection and testing described in the relevant British Standards for individual fire safety installations.

Unless temporary alternative fire safety systems can be put in place, it might be appropriate for certain of the inspections carried out at three-monthly or longer intervals to be done outside normal working hours.

V.2 Daily inspections

V.2.1 General

The checks described in **V.2.2** to **V.2.6** should be undertaken daily. For premises with defined opening times such as shops, theatres and cinemas, these checks should be undertaken prior to members of the public entering the building.

V.2.2 Fire detection and alarm systems

All fire detection and alarm systems should be inspected daily. In particular, it should be ensured that:

a) the control panel indicates normal operation or, if any fault is indicated, that it has been logged and the appropriate action(s) taken;

b) any fault recorded the previous day has received attention.

V.2.3 Emergency and escape lighting systems

All emergency and escape lighting systems should be inspected daily. In particular, it should be ensured that:

a) every lamp is lit if the system is maintained;

b) the control panel for any central battery system or generator indicates normal operation;

c) any fault found is logged and the appropriate action(s) taken.

V.2.4 Sprinkler systems

All sprinkler systems should be inspected daily. In particular, it should be ensured that:

a) unless the connection to the fire and rescue service is automatically monitored continuously, there is continuity of the connections between the alarm switch and the control unit and between the control unit and the fire and rescue service (usually via a remote manned centre);

b) unless automatically controlled, the water level and air pressure are correct in any pressure tank that provides a duplicate supply;

c) any necessary corrective action(s) are taken.

V.2.5 Fire door automatic release mechanisms

All doors that are held open by automatic release mechanisms should be released daily.

V.2.6 Portable fire extinguishers and hose reels

All points should be inspected daily at which portable fire extinguishers or hose reels are usually located. Missing fire extinguishers or hose reels should be replaced immediately. Any extinguisher used in a fire or for training, or otherwise discharged, should be recharged immediately. Damaged extinguishers or hose reels should be repaired or replaced.

V.3 Weekly

V.3.1 General

In addition to the checks recommended in **V.2**, the checks described in **V.3.3** to **V.3.7** should be undertaken once a week.

V.3.2 Fire detection and alarm systems

All fire detection and alarm systems should be inspected weekly. In particular, it should be ensured that:

a) the control equipment is able to receive a fire signal and to initiate the evacuation procedure, recording which trigger device has been used, in accordance with BS 5839-1;

b) any standby batteries are in good condition and the fuel, oil and coolant levels of any standby generators are correct, topping up as necessary;

c) the reserves of paper and ink or ribbon for any printer are adequate for two weeks' normal usage.

V.3.3 Sprinkler systems

All sprinkler systems should be inspected weekly. In particular, it should be ensured that:

a) water and air pressure gauge readings on installations, trunk mains and pressure tanks, and water levels in elevated private reservoirs, rivers, canals, lakes, water storage tanks, etc., meet the design criteria and all gauge readings and levels are recorded;

b) each water motor alarm has been sounded for at least 30 s;

c) automatic pumps start when the water pressure is reduced to the specified level;

d) for automatic pumps powered by a diesel engine:

   1) the fuel and oil levels of the engine meet the design and/or manufacturer's specification;

   2) the oil pressure, the flow of cooling water through open-circuit cooling systems or the water level in the primary circuit of closed-circuit cooling systems all meet the design and/or manufacturer's specification;

   3) the engine restarts using the manual start test button;

e) the electrolyte level and density of all lead acid Plante cells meet the design and/or manufacturer's specification. If the density is low the battery charger should be checked for efficient operation and, if the charger is working correctly, the affected cells should be replaced;

f) the mode monitoring system for stop valves in life safety installations is operating correctly;

g) there is continuity of connection between the alarm switch and the control unit and between the control unit and the fire and rescue service (usually via a remote manned centre) for automatically monitored connections;

h) trace heating systems provided to prevent freezing in the sprinkler system are functioning correctly.

V.3.4 Gaseous, foam and powder extinguishing systems

All gaseous, foam and powder extinguishing systems should be inspected weekly. In particular, it should be ensured that:

a) any pressure gauges are functioning correctly;

b) all operating controls are both properly set and accessible;

c) all indicators are functioning correctly;

d) the equipment, particularly pipework and nozzles, is free from dust and dirt, is not physically damaged nor leaking, and remains in its designed position;

e) the fire risk and its enclosure have not changed;

f) the quantity of extinguishing medium is correct and, for foam systems, the water supply is available and at the correct pressure.

V.3.5 Smoke control systems for means of escape

Actuation of the system should be simulated once a week. It should be ensured that any fans and powered exhaust ventilators operate correctly, smoke dampers close (or open in some systems), natural exhaust ventilators open, automatic smoke curtains move into position, etc.

V.3.6 Evacuation lifts and fire-fighting lift installations

The operation of the evacuation and fire-fighting lift switches should be tested once a week and should be repaired or replaced if found to be faulty.

V.3.7 Fire hydrants

All fire hydrants should be inspected once a week. In particular, it should be ensured that there are no obstructions impeding access, that the indicator plates are in position, and that the isolating valves are locked open.

V.4 Monthly

V.4.1 General

In addition to the checks recommended in **V.2** and **V.3**, the checks described in **V.4.2** to **V.4.9** should be undertaken once a month.

V.4.2 Fire detection and alarm systems

Any standby generator should be started up once a month by simulating failure of the normal power supply, and allowed to energize the system for at least 1 h, while the system is monitored for any malfunctioning caused by the use of the generator. After restoring the normal supply, the charging arrangements for the generator starting battery should be tested, and the appropriate action should be taken if they are found not to be functioning correctly. In addition, the oil and coolant levels should be topped up and the fuel tanks filled.

V.4.3 Emergency and escape lighting systems

A failure of the supply to the normal lighting should be simulated once a month, during which all luminaires and exit signs should be inspected to determine whether they are functioning correctly. If the standby supply is from a generator with back-up batteries, a test should be carried out to determine whether all luminaires and exit signs function correctly even if the generator is prevented from starting. Any luminaires or exit signs that do not function correctly should be repaired or replaced.

After restoring the supply to the normal lighting, it should be ensured that:

a) indicator lamps or devices to self-contained luminaires or internally illuminated exit signs show that the normal supply has been restored;

b) indicator lamps or devices to central battery systems show that the normal supply has been restored, and that the charging arrangements are functioning correctly;

c) the charging arrangements for any battery for starting a generator are functioning correctly;

d) the oil and coolant levels are topped up and the fuel tanks filled.

V.4.4 Gaseous, foam and powder extinguishing systems

A monthly check should be carried out to ensure that all personnel who might have to operate the equipment or system(s) are properly trained and authorized to do so, and in particular that new employees have been instructed in their use.

V.4.5 Evacuation lifts and fire-fighting lift installations

A failure of the primary power supply should be simulated once a month. If a generator provides the standby power supply, it should energize the lift(s) for at least 1 h.

V.4.6 Hose reels

Hose reels should be visually inspected once a month. In particular, it should be ensured that there are no leaks and that drum assemblies are free to rotate on their spindles.

V.4.7 Automatic opening doors

The operation of fail-safe mechanisms should be tested once a month, either by "breaking out" the doorset or by simulating failure of the mains power supply, as appropriate. The results of the test should be recorded. Any doors that are found to be faulty should be repaired or replaced.

V.4.8 Doors on hold-open devices

The operation of hold-open devices should be tested once a month by simulating failure of the mains power supply or operation of the fire alarm system. The results of the test should be recorded. Any doors that are found to be faulty should be repaired or replaced.

V.4.9 Emergency and panic escape doors

The operation of all emergency and panic escape devices, especially on external doors not used for other purposes, should be checked once a month for ease of operation and opening of the door. Weather conditions can affect the door and frame relationship, and therefore the ease of operation of escape devices.

V.5 Three-monthly

In addition to the checks recommended in **V.2**, **V.3** and **V.4**, the actuation of all smoke control systems should be simulated once every three months. All zones should be separately tested and it should be ensured that any fans and powered exhaust ventilators operate correctly, smoke dampers close (or open in some systems), etc.

V.6 Six-monthly

V.6.1 General

In addition to the checks recommended in **V.2**, **V.3**, **V.4** and **V.5**, the checks described in **V.6.2** and **V.6.3** should be undertaken once every six months.

Arrangements should be made for six-monthly inspections and tests to be carried out by competent persons on the fire detection and alarm systems, the sprinkler systems, any extinguishing systems, the emergency and escape lighting systems and the fire-fighting lift, for any defects found to be logged and the necessary action taken, and for certificates of testing to be obtained.

V.6.2 Fire doors

All fire doors should be inspected every six months. In particular, it should be ensured that:

a) heat-activated seals and smoke seals are undamaged;

b) door leaves are not structurally damaged or excessively bowed or deformed;

c) gaps between the door leaf and the frame are not so small as to be likely to bind, or so large as to prevent effective fire and smoke-sealing;

d) hanging devices, securing devices, self-closing devices and automatic release mechanisms are operating correctly.

V.6.3 Fire mains

All fire mains should be inspected every six months. In particular, it should be ensured that:

a) inlets, landing valves, drain valves, door hinges and locking arrangements for inlet and landing valve boxes are ready for immediate use, and spindles, glands and washers are in a satisfactory condition;

b) for wet mains:

   1) booster pumps and their associated mechanical and electrical apparatus are functioning correctly;

   2) storage tanks are full of clean water.

V.7 Yearly

NOTE Attention is drawn to the testing and inspection requirements of BS 7671.

In addition to the checks recommended in **V.2**, **V.3**, **V.4**, **V.5** and **V.6**, arrangements should be made for annual inspections and tests of the following to be carried out by competent persons, for any defects to be logged and the necessary action taken, and for certificates of testing to be obtained:

a) fire detection and alarm systems;

b) self-contained luminaires with sealed batteries, if more than 3 years old;

c) sprinkler and drencher systems;

d) smoke ventilators and smoke control systems;

e) evacuation lifts;

f) fire-fighting lift installations;

g) fire hydrants;

h) fire mains;

i) portable fire extinguishers;

j) hose reels.

Stocks of foam concentrate or solution should be checked annually and replenished as necessary.

Annex W (normative) Routine inspection and maintenance of ventilation and air conditioning ductwork

W.1 Inspection and maintenance

Maintenance of air conditioning and ventilating equipment, including air filters, motors, fire dampers and their controls, smoke detectors and alarms, is of paramount importance both in preventing fire and in ensuring that measures taken to mitigate its consequences are effective when needed.

Before any works of maintenance are carried out, the extent of any fire hazards involved, and the potential effect of any fire on the occupants or operation of the building, should be assessed. Appropriate precautionary measures should be taken where necessary, e.g. temporarily relocating occupants who might be put at risk in the event of a fire, and it is essential that fire escape routes are kept unobstructed. All reasonable precautions should be taken to avoid the outbreak of fire. Smoking should be prohibited in ducts, and maintenance workers should be instructed to observe "No Smoking" rules applicable to other areas of the building. Portable fire extinguishers should be readily available.

As filters, etc., become contaminated they become a progressively greater fire hazard, and hence it is essential that they are cleaned and/or replaced as recommended by the manufacturer or supplier. Similarly, it is essential that deposits of combustible material (including any dust) are not allowed to build up within the ductwork itself. Panels forming ceiling voids used for the extraction of air from non-domestic kitchens and from deep fat fryers need frequent cleansing to avoid the build-up of grease deposits. The provision of access panels facilitates such cleansing, other maintenance, and also fire-fighting.

Arrangements should be made for all fire dampers to be tested by a competent person on completion of the installation and at regular intervals not exceeding 2 years, and to be repaired or replaced immediately if found to be faulty. Spring-operated fire dampers should be tested annually and fire dampers situated in dust-laden and similar atmospheres should be tested much more frequently, at periods suited to the degree of pollution.

Arrangements should be made for periodic maintenance of any smoke detector system used to operate fire dampers and for such system(s) to be tested by a competent person after installation to determine whether detection occurs at the appropriate design smoke density. Any smoke detector system that is found to be faulty should be either repaired or replaced immediately.

W.2 Fire and rescue service access to ductwork

Problems have been encountered where fire-fighting personnel have been unable to gain easy access to ductwork at intermediate levels between the input and output ends of the system, and this has lead to extensive cutting and/or dismantling operations to fight a fire within ductwork systems. Routine checks should be made to ensure that access panels for fire-fighting access purposes are provided, that the panels are removable without the need for specialist tools or equipment, and that all such panels can be accessed without difficulty.

W.3 Records

A system of records is an essential part of a successful maintenance policy.

Maintenance should be planned and scheduled, and maintenance procedures should be standardized.

The central system of records should include a complete inventory of the system, giving complete information on all equipment, components, distribution networks, electrical apparatus, controls and wiring. In particular the records should include the specification and location of fire dampers and cavity barriers, and the positions of all fire compartment boundaries and all cavity barriers should be marked on the installation drawings.

A certificate of completion should be obtained.

In buildings with extensive ductwork systems, it can be advisable for plans to be kept on the premises that show the installed system, fire-fighting access panels, firemen's control, siting of fire dampers, and plant room access and layout. The provision of such plans, especially if displayed or readily available, can be of great assistance not only to fire and rescue service personnel but also to maintenance engineers working on the system.

Copies of all records should be added to the fire safety manual (see Clause **9** and Annex H).

W.4 Housekeeping

Metal ductwork can conduct sufficient heat from a fire inside the ductwork, or on the fire side of a fire damper, to ignite adjacent combustible materials. It is therefore essential that a separation of at least 500 mm is maintained between uninsulated ductwork and combustible goods, packaging, partitioning, etc. Signs conforming to BS 5499 should be provided to warn of the need to maintain a clear zone around the ductwork.

Annex X (normative) Phased evacuation

X.1 Fire marshals/fire wardens

A senior fire marshal should be appointed with overall responsibility for fire safety in the building during a phased evacuation. A deputy senior fire marshal/fire warden should also be appointed.

In addition, fully trained fire marshals/fire wardens are needed to be responsible for maintaining calm and discipline in an emergency. Each storey should have one fire marshal for each exit on that storey.

Actions to be taken by fire marshals/fire wardens are detailed in **X.3**.

X.2 Evacuation guidelines

To achieve a safe and orderly evacuation:

a) a prominent notice should be displayed in the fire control centre (see Annex I) indicating that the building incorporates phased evacuation;

b) the fire alarm system should remain in the phased evacuation mode both during and outside normal working hours, but should incorporate a facility to enable total simultaneous evacuation of the building during periods outside normal working hours;

c) a manual system of phased evacuation should be used where more than three phases of evacuation (including the initial phase) are required;

NOTE 1 Either a manual or an automatic system for phased evacuation is satisfactory where not more than three phases of evacuation (including the initial phase) are required.

d) where a manual system of phased evacuation is used:
   - the fire control centre should be permanently staffed during normal working hours by a competent person;
   - the initial phase of the evacuation (i.e. evacuation of the fire floor and floor immediately above) should be carried out automatically;
   - the time periods between evacuation phases should be governed by information received from the fire marshals/fire wardens, but should not exceed the maximum time needed to evacuate two storeys simultaneously;

e) where an automatic system is used for phased evacuation, the time periods between evacuation phases should allow for simultaneous evacuation of two storeys;

NOTE 2 An example of messages for use with phased evacuation and a suggested sequence of tones and messages and time lapse between each element are given in Annex Z.

f) if progressive evacuation is necessary, the normal sequence of evacuation should be:
   - the floor of origin of the fire and the floor immediately above;
   - the next two floors above;
   - the remaining floors in groups of two working up the building;
   - floors in groups of two below the floor of origin working downwards.

NOTE 3 This sequence might need to be changed to reflect the fire situation.

The evacuation of all disabled people in the building should normally commence on the sounding of the initial alert.

All floors below ground level should be treated as one zone for evacuation purposes. Except where a fire occurs below ground level this zone should either be the last one to be evacuated, or be evacuated simultaneously with the ground floor.

X.3 Fire evacuation procedures

X.3.1 Action to be taken by senior fire marshal and deputy senior fire marshal

The following instructions for action in the event of a fire should be issued to the senior fire marshal and deputy senior fire marshal.

a) During normal office hours:

   1) on the actuation of the fire alarm, proceed to the fire control centre;
   2) ensure that the fire and rescue service has been called and someone has been detailed to meet the fire and rescue service on arrival;
   3) confirm that initial evacuation is taking place;
   4) ensure that the management plan for the evacuation of disabled people is proceeding;
   5) await information from floor fire marshals/fire wardens;
   6) by the use of the public address system or fire telephone system, give the building occupants information relating to the alarm;
   7) carry out necessary evacuations using the agreed plan unless information from the fire marshal indicates that the fire is under control and no further evacuation is necessary;
   8) on the arrival of the fire and rescue service, give all available information to the senior fire officer.

b) Outside normal office hours:

   1) on the actuation of the fire alarm, report to the fire control point;
   2) switch the fire alarm system to total evacuation mode;
   3) ensure that the fire and rescue service has been called;
   4) on the arrival of the fire and rescue service, give all available information to the senior fire officer.

X.3.2 Action to be taken by fire marshals/fire wardens

The following instructions for action in the event of a fire should be issued to the fire marshals/fire wardens.

a) During normal hours:

   1) if the "alert" signal sounds on your floor:

      i) evacuate disabled people using the agreed procedure;

      ii) await information by public address system or fire telephone system;

      iii) reassure other staff and discourage them from leaving the floor at the sound of the "alert" signal;

      iv) on instructions from the public address system or fire telephone system, initiate evacuation;

      v) ensure that floor evacuation is complete;

      vi) leave the building and report to the assembly point at...........

   2) if the general alarm sounds on your floor:

      i) ensure that floor evacuation is complete and report this to the fire control centre via the fire telephone;

      ii) if the fire is located on your floor, attack the fire with the equipment provided if possible, but do not take any personal risks. Report the fire situation to the fire control centre via the fire telephone;

      iii) leave the building and proceed to the assembly point at......

b) Outside normal office hours (if a fire marshal is available):

   1) if the "alert" signal or general alarm sounds:

      i) ensure that floor evacuation is complete;

      ii) if the fire is located on your floor, attack the fire with the equipment provided if possible, but do not take any personal risks. Report the fire situation to the fire control centre via the fire telephone;

      iii) leave the building and proceed to the assembly point at...........

Annex Y (informative) Examples of evacuation strategies

Y.1 Buildings provided with evacuation lifts

Y.1.1 Structural protection

The evacuation strategy in buildings provided with evacuation lifts depends on the type of structural protection available in the building. There are three options:

a) protected lobbies used as refuges – each lift and stairway is protected from fire in the accommodation by two fire doors and may be used from any level;

b) storeys divided into two refuges – the wall separating the two fire compartments is needed to ensure a safe route between the lift lobby and the storey exit; each compartment also acts as a refuge from the other in the event of a fire;

c) single-stair building – the accommodation on each floor comprises a single fire compartment; the lift and stairway is protected from fire in the accommodation by two fire doors and may be used from any level.

Y.1.2 Evacuation sequence

A typical evacuation sequence in a building provided with an evacuation lift is as follows.

a) Disabled people move to the lift lobby to await the lift.

b) The designated lift operator collects disabled people and takes them to the final exit level.

c) If the lift lobby becomes untenable before the lift arrives:

   1) the disabled people move to positions outside the door to the stairway in a compartment not yet affected by the fire, to await assistance in moving to a lower floor;

   2) the disabled people await the lift at a lower level, or if the lift has failed or is unsafe to use, progressive movement is continued down the stairway towards the final exit level.

Y.1.3 Communications

In a typical evacuation, the following communication procedures are carried out.

a) The alarm is sounded before evacuation commences.

b) Any necessary information about disabled people requiring evacuation is passed to the person controlling the evacuation.

Y.2 Buildings without evacuation lifts

A typical evacuation sequence in a building without an evacuation lift is as follows.

a) On hearing the alarm, disabled people move to the nearest refuge.

b) The designated competent person, after completing their evacuation/search procedure, proceeds to the refuge.

c) The disabled people are assisted down the stairway towards the final exit level.

Annex Z (informative) Example messages for use in a phased evacuation

Z.1 Alert messages

An example of alert messages is as follows.

a) *First sequence:*

May I have your attention please.

May I have your attention please.

A fire has been reported in the building.

While this report is being investigated please remain at your work place.

Further information will follow shortly.

b) *Second sequence:*

May I have your attention please.

May I have your attention please.

You are reminded to remain at your work place whilst the fire alert exists.

Z.2 Evacuation message

An example of an evacuation message is as follows.

May I have your attention please.

May I have your attention please.

A fire has been reported in the building.

Please leave the building by the nearest exit.

Please leave the building immediately by the nearest exit.

Please do not use the lifts since they may be needed.

Do not use the lifts but leave the building by the nearest stair.

Z.3 Test message

An example of a test message is as follows.

May I have your attention please.

May I have your attention please.

The public address and fire alarm systems are about to be tested.

The fire alert signal will sound first followed by the fire evacuation signal.

Please take no further action.

Signal – sound alert.

Signal – sound evacuate.

The test is now complete.

If you had difficulty in clearly hearing messages or fire alarm signals please advise the fire control centre.

Thank you for your cooperation.

A suggested sequence of tones, messages and time lapse between each element for automatic broadcast is detailed in **Z.4**.

Z.4 Alert messages, signals and timings

Suggested alert messages, signals and timings (in seconds) are as follows.

a) *First sequence:*
   - alert tone: 10 s [intermittent (1 ± 0.5) s on and (1 ± 0.5) s off];
   - silence: 5 s;
   - alert message (first sequence) [see **Z.1**a)];
   - silence: 5 s;
   - alert tone: 10 s [intermittent (1 ± 0.5) s on and (1 ± 0.5) s off];
   - silence: 5 s;
   - alert message (first sequence).

b) *Second sequence:*
   - after 3 min, broadcast second sequence alert message [see **Z.1**b)];
   - continue to repeat this message at 3 min intervals.

Z.5 Evacuation messages, signals and timings

Suggested evacuation messages, signals and timings are as follows:

- evacuate tone: 10 s;
- silence: 5 s;
- evacuation message (see **Z.2**);
- silence: 5 s;
- evacuate tone: 10 s;
- silence: 5 s;
- evacuation message.

Continue to repeat this message.

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