## CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Fire Safety Needs</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Fire Protection System</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Categorisation of Building</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Prevention of Fire</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Fire Growth Control</td>
<td>11</td>
</tr>
<tr>
<td>7</td>
<td>Detection &amp; Alarm</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>Means of Escape</td>
<td>18</td>
</tr>
<tr>
<td>9</td>
<td>Structural Stability</td>
<td>41</td>
</tr>
<tr>
<td>10</td>
<td>Compartmentation</td>
<td>50</td>
</tr>
<tr>
<td>11</td>
<td>External Fire Spread Control</td>
<td>63</td>
</tr>
<tr>
<td>12</td>
<td>Fire Control Equipment</td>
<td>72</td>
</tr>
<tr>
<td>13</td>
<td>Fire Service Facilities</td>
<td>76</td>
</tr>
<tr>
<td>14</td>
<td>Special Risk Areas</td>
<td>84</td>
</tr>
<tr>
<td>15</td>
<td>Large &amp; Complex Buildings</td>
<td>86</td>
</tr>
<tr>
<td>16</td>
<td>Fire Safety Management</td>
<td>91</td>
</tr>
<tr>
<td>17</td>
<td>Fire Safety Engineering</td>
<td>94</td>
</tr>
<tr>
<td>18</td>
<td>Existing Buildings</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Fire Performance &amp; Installation Standards</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>Definitions</td>
<td>107</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 This code is formulated in compliance with the Building Regulations for fire safety issued under the authority of the State of Sao Paulo.

1.2 The Code contains provisions to ensure that the design, construction and the use of a building to which it applies is such that the probability of the occurrence of a fire is minimised and if a fire does occur the safety of the occupants is assured.

1.3 The Code provisions are not primarily aimed at reducing property damage but following the technical recommendations will assist in controlling fire damage. Special needs in this connection may require additional measures which should be arrived at by discussion with the insurers.

1.4 The technical recommendations contained in the code, if followed, will assure a reasonable level of safety for the occupants of the building and others who may be in or around the building, allow the fire services to carry out rescue and the necessary fire control activities. It may be possible to achieve the necessary level of safety by adjusting the requirements for a specific building use. In such a case it is the responsibility of the designer to give assurance to the controlling authority that his solution will provide a comparable level of safety to that achieved by following the recommendations.

1.5 For complex and unusual buildings a satisfactory standard of fire safety may require alternative approaches such as the use of fire engineering solutions. Such solutions will allow a total fire safety package to be developed and reference is made to this in Chapter 17. If a fire engineering solution is provided for all or part of the fire safety system it is the responsibility of the designer to provide full evidence of the basis on which such a design is made with supporting evidence.

1.6 Each chapter of the Code deals with a selected topic, the first three chapters give an introduction to the basis concepts of the Code followed by 9 chapters, Chapters 5 to 13, with precise technical requirements. Each technical chapter begins with the objective of the requirement, the general principle of the solution and then makes recommendations. Chapters 14 and 15 provide additional information for special risks and complex buildings. Chapter 16 deals with fire safety management and the general background to fire safety engineering is given in Chapter 17. Requirements for existing buildings are briefly dealt with in Chapter 18 and the fire standards and the codes are referred to in Chapter 19.
CHAPTER 2

FIRE SAFETY NEEDS

2.1 To provide an adequate level of fire safety in buildings and other structures consideration needs to be given to a whole range of connected design and use aspects. Prevention of fires is an important component of this system and it relies for its effectiveness on the safe installation and use of heat producing and energy consuming devices as well as the safe conduct of operations which may involve hazard of ignition. Precise rules for this purpose are outside the scope of this Code but reference is made to the need in various sections as appropriate.

2.2 An important aspect of fire prevention is concerned with the human responsibility in ensuring that accidental fires are not allowed to start. Training and education at all levels plays an important part in this and the management responsible for a building has a responsibility to ensure that people in the building understand the risk attached to various activities they undertake.

2.3 If a fire does occur it is essential that occupants become aware of it as soon as possible and have awareness of the actions they need to take to move to a place of safety. This requires a knowledge of the safety provisions which have been made and an easy identification of the route to follow to reach safety outside the building. In large and complex buildings this may be a progressive process through areas of increasing safety. It is not normally expected that the occupants will use on-site facilities to control a fire but where these are available it is possible that use can be made of them to tackle a small fire and extinguish it.

2.4 Un-aided evacuation of occupants may not be possible under all cases and provision may need to be made for the rescue services to give assistance particularly where the occupant mobility is below normal.

2.5 In addition to the safety of occupants within a building where a fire occurs, the safety of others in adjacent buildings is also important. The adjacent building may be physically attached to the building on fire or it may be located a short distance away. The separation of buildings should be such that there is little chance of fire in one of the buildings spreading to the next. This consideration also requires attention to be paid to the hazard that may be created when high rise buildings are involved in a fire. The maintenance of the stability of the building can be critical and this demands higher standards to be applied compared with similar occupancies in low rise buildings.

2.6 The stability of a structure is dependent on the likely severity of a fire within that building. This is controlled not only by the amount of the fuel or the fire load but also its burning characteristics and the availability of air for combustion. A simple system divides buildings into categories on the basis of their use and adds factors of safety to take account of the size of the
building. A single building can sometimes have areas with differing potential fire severities and where these can be clearly identified it is necessary to separate them by structures of adequate fire resistance.

2.7 Ideally if a fire starting in one part of a building can be contained, the hazard becomes controllable. In practice this may not be possible due to demands in connection with the use of space. However in all buildings certain parts because of their importance must be separated by fire barriers to either prevent a fire entering those areas or a fire within those areas spreading to other parts. This is termed as essential compartmentation. In addition it is also necessary to reduce the risk due to large spaces and impose additional requirements for compartment sizes. Where required compartments should have well defined boundaries, preferably following the normal divisions in a building.

2.8 The maintenance of the integrity of such compartment boundaries is critical and strict control is needed to ensure that these are not breached by inadequate separation. This is particularly the case where pipes, ducts and other services penetrate compartment boundaries.

2.9 It is normally assumed that adequate levels of fire safety are achieved by the construction of the building and facilities provided within the building. However in buildings of a large size where large number of people may be present the fire service rescue facilities can play an important role in preventing disasters. It is therefore necessary to make suitable provisions for the fire brigade access to and within the building.

2.10 Achievement of fire safety requires an integrated approach to the provision of safety measures and their maintenance in good order. Constant vigilance is needed to ensure that fire does not become a problem for the occupants of a building.
CHAPTER 3

FIRE PROTECTION SYSTEM

3.1 The fire protection system specified in this Code is primarily concerned with the layout, design, construction and use of the building. The designer is required to consider the purpose of the building according to the classification system given in Chapter 4. Further chapters specify the recommendation for the provision of means of escape, for structural stability, fire containment, separation of buildings and the provision of fire brigade facilities.

3.2 The fire protection system comprise ten main components, listed below, which apply in varying degrees to different buildings or different parts of a building. The main components are;

- Prevention of fire
- Fire growth control
- Detection & alarm
- Means of escape
- Structural stability
- Compartmentation
- External fire spread control
- On-site fire control
- Fire brigade facilities
- Fire safety management

3.3 Fire safety management has an overall role and some advice in this connection is given in Chapter 16. Buildings or parts of buildings where special hazard may exist are also dealt with in a special chapter.

3.4 The code describes recommendation for each of the above headings in separate chapters for convenience. It needs to be remembered that for the achievement of the appropriate level of fire safety all components of the system should be regarded a forming an integral package. Different components inter-act with each other, sometimes different parts of a component may do so as well. This means that by considering the system as a whole adjustments can be made in one part of the system provided an appropriate compensation can be provided in another part. This will permit a degree of flexibility in the operation of the Code.

3.5 Fire protection system relies on the availability of appropriate standards and codes for judging the performance of materials and products intended to be used in the building. Without the availability of a complete set of standards implementation of the code may present some problems. In the absence of suitable Brazilian standards reference is made to International or other national standards which may be used until suitable standards become
available in Brazil. Coupled with the standards there is also a need for suitable laboratory facilities which allow the testing and classification of products. If such facilities are not available reliance has to be placed on test evidence being provided from other countries.

3.6 The operation of the requirements of the fire safety Code in a rational manner requires that designers and the controlling authorities have an understanding of the fire protection system and the basis of the requirements. This is particularly necessary where due to particular need of a building some adjustment may need to be made in the Code requirements. This will be particularly so if a designer wishes to employ fire engineering methods. In order to provide such an understanding educational and training facilities are needed and these can be provided either at a technical institute or the fire service educational establishment.
CHAPTER 4
CATEGORISATION OF BUILDINGS

4.1 Categorisation of buildings is a simple method of expressing fire safety needs for different types of occupancies. It identifies the safety issues related with the use of the building on the basis of the type of occupancy and the activity undertaken. This chapter covers all buildings with the exception temporary structures.

4.2 Buildings are divided into two main groups, the residential type buildings which provide sleeping facilities for the occupants either on a permanent or a temporary basis. The other group includes non-residential buildings where people work, go for commercial or recreational reasons and where goods are produced or stored.

4.3 Each category shown in Table 4.1 represents a particular use within that group and whilst in general the risks are similar in all buildings of that type there will difference in relation to the size and the nature of the fire load. Technical recommendations make such distinctions where necessary and the table makes sub-categories in a number of cases to grade the risks. Storage and industrial buildings cover a wide range of risks from relatively inert contents and operations to hazardous usage.

4.4 Some of the recent developments in the commercial field raise difficulties for simple categorisation, for example huge shopping or recreational developments may include many different types of activities under one roof and consequently incorporate a mixture of risks. In such cases different risks would need to be separated from each other and a judgement made on the appropriate standards of protection needed. A fire engineering approach may provide a suitable technique for assessing the safety needs in different parts.

4.5 If a mixed use involves parts with sleeping risks such as apartments and another usage for commercial, office or parking purposes, the apartment part must be completely isolated. For other mixed uses if no complete separation is provided and the separate usage is more than 20% of the floor area, the requirements appropriate for the more hazardous category shall apply.
**TABLE 4.1 DIFFERENT BUILDING CATEGORIES**

<table>
<thead>
<tr>
<th>NAME</th>
<th>GROUP</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| Domestic        | A     | A1- Single family dwelling  
A2- Apartment building  |
| Other residential | B     | B1- Hotels, motels, lodging houses  
B2- Hostels, childrens homes  |
| Commercial      | C     | C1- Small shops for retail trade, markets  
C2- Supermarkets, department stores  
C3- Shopping Centres  |
| Office          | D     | D1- Administration, banks, institutions, post offices, police station, fire service  |
| Educational     | E     | E1- Primary & secondary schools, colleges  |
| Assembly        | F     | F1- Places of worship, sports stadia, airports, rail & bus stations, clinics, surgeries, medical centres, play centres, libraries  
F2- Conference centres, theatres, exhibition halls, museums, galleries, restaurants, bars, dance halls, circus  |
| Car parking     | G     | G1- Automatic car parks, open sided car parks  
G2- Fully enclosed car parks, car parks with service station  |
| Health          | H     | H1- Hospitals, nursing homes (staying facilities)  
H2- Institutions for mental treatment or old people homes  |
| Institutional   | I     | I1- Reform & correction institutes, prison, jails  |
| Industrial      | J     | J1- High fire load (>1200 MJ/m²), joinry, studios  
J2- Low fire load (<1200 MJ/m²), metal, concrete industries  |
| Storage         | K     | K1- High fire load (>1200 MJ/m²), flammable liquids, explosives  
K2- Low fire load (<1200 MJ/m²), car storage, general goods  |
Notes.

1. Where the use of the building is not covered by the description in the table the nearest similar use shall be considered.

2. Factories manufacturing or repairing furniture, using large quantities of flammable plastics materials, processing flammable liquids are to be considered as examples of high hazard activity.
CHAPTER 5

PREVENTION OF FIRE

OBJECTIVE

5.1 The objective of measures for fire prevention is to reduce the probability of a fire starting in a building or premises to which the Code requirements apply.

BACKGROUND

5.2 Studies of fires have shown that most accidental fires start from three main causes;

- Malfunctioning of equipment
- Misuse of heat sources
- Human error

5.2 By paying attention to simple precautions it is possible to reduce the chance of a fire starting and thereby increase fire safety. The Code is not intended to provide full details of these precautions as they are properly dealt with in other standards and specifications. It however draws attention to these in general terms to provide a basis for more positive actions.

5.3 As far as the prevention of human error is concerned it is primarily a question of education and management. It is in the interests of the owners and managers of premises to ensure that the building occupants are aware of fire hazards and are encouraged to be careful in the handling of heat sources and equipment to avoid a fire starting.

REQUIREMENTS

5.4 All fixed equipment which generates heat or utilises energy, such as heaters, cookers, refrigeration units etc, shall be installed according to the provisions contained in the standards dealing with their use in buildings. The equipment shall be maintained in good working order and no repairs or modifications shall be carried out by unqualified people.

5.5 All operations which can be potentially hazardous shall be carried out in a safe manner by staff trained to undertake such operations.

5.6 Operations which require the use of flammable materials shall be controlled so that only a small quantity of material necessary for the operation is present and the rest is kept in a safe place from which it can be withdrawn as needed. Such materials shall be stored in a separate protected place with limited access to specified personnel.
5.7 There shall be a ban on smoking in those areas where flammable materials are present e.g. in stores, factories using or producing such materials. In such cases special facilities shall be made available for the staff who need to smoke.

5.8 Smoking and the use of naked flames should also be prohibited from premises where a fire can cause special problems for the escape of people, such as cinema, theatres, hospital wards, public transport etc. Notices shall be displayed to draw attention to the prohibition on smoking and where the ambient light conditions are poor the notices shall be illuminated.

5.9 Cooking appliances using bottled gas should be properly installed with connections made to a good standard, if possible the cylinder shall be located in a protected place at a safe distance from the appliance. Spare gas cylinders shall be kept in a safe place away from the appliance.

5.10 In organisations where more than 20 people work the management shall draw attention of the staff to the danger of a fire and hold regular drills and instruction courses to advise them of the safe measures to use. Large organisations shall have specially appointed people with responsibility for safety.
CHAPTER 6

FIRE GROWTH CONTROL

OBJECTIVE

6.1 The purpose of measures for fire growth control is to ensure that were a fire to start in a building it will not develop so rapidly as to prevent people from making their escape.

BACKGROUND

6.2 Hazard to occupants of a building is caused by the products of combustion of a fire and the heat which is produced. If the rate of heat generation is reduced there is a corresponding reduction in the quantities of smoke and other toxic products that may be released and consequently the risk to occupants can be minimised.

6.3 Fire statistics indicate that most fires start in contents and consequently the presence of less flammable contents is the first line of defence. However it is not possible to control contents in all buildings and such control may be restricted to only those occupancies where special problems exist.

6.4 Once the fire reaches the surfaces of the room enclosure their nature has a strong influence on its rate of growth. Easily ignitable surface materials and those which release large quantities of smoke can create special difficulties for the evacuation of occupants and could invalidate the provisions made for this purpose. The main contribution is made by wall and ceiling surfaces, in some cases the control of floor coverings may be needed for additional safety.

6.5 It is important to ensure that nothing is done during the use of a building, by over-coating or decoration which impairs the performance of surfaces as originally provided.

REQUIREMENTS

6.6 The exposed surfaces of all rooms and other areas in a building shall be not inferior than the standard given in Table 6.1

6.7 A small room is a room which has a floor area not exceeding 5m² in apartments, offices, shops and assembly buildings and not exceeding 10m² in other categories.
### TABLE 6.1 REQUIREMENTS FOR SURFACES IN BUILDINGS

<table>
<thead>
<tr>
<th></th>
<th>Wall/ceiling linings</th>
<th>Floor coverings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Circulation area, escape routes</strong></td>
<td>Grade A</td>
<td>Class I</td>
</tr>
<tr>
<td><strong>Other rooms except small rooms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Institutional buildings</td>
<td>Grade B</td>
<td>Class II</td>
</tr>
<tr>
<td>b. Other buildings</td>
<td>Grade C</td>
<td>No requirement</td>
</tr>
<tr>
<td><strong>Small rooms</strong></td>
<td>No requirement</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

6.8 The grades for wall surfaces and floor coverings shall be established by means of tests specified in Chapter 19. The grading applies to the surface finish as it will be present in use and does not apply to the product as supplied on site.

6.9 Notice boards and decorative features may be used on walls in circulation areas provided they are not more than 2m² individually and do not cover more than 20% of any wall surface.

6.10 Fitted furniture may be used on walls other than in circulation areas provided it does not cover more than 25% of the wall surface.

6.11 Plastics materials of thermosetting type used as wall surfaces shall be tested as other products and classified accordingly.

6.12 Plastics materials of thermoplastic type which cannot be tested by the method given for other products shall be of low flammability, as determined by the test in Chapter 19, and shall be restricted to individual panels not more than 2m² and covering not more than 25% of the wall or ceiling surface.

6.13 In hospitals and other institutional buildings where occupants have special escape problems the furniture and furnishings shall be of low flammability as established by the test method specified in Chapter 19.
CHAPTER 7

DETECTION & ALARM

OBJECTIVE

7.1 An early awareness of a fire is necessary to give occupants of a building sufficient time to make use of the escape provisions to a place of safety. This is particularly necessary where the occupants have some restriction on their freedom of movement due to disability, age, condition or restriction, and where the complex nature of the building and the occupancy level may create special problems.

BACKGROUND

7.2 When a fire starts it produces heat, smoke and other toxic products. The conditions in the fire zone can deteriorate quickly and the occupants need to leave this area as rapidly as possible. These products will progressively spread to other parts, depending on the layout of the space and the presence of fire barriers, gradually the conditions in other parts of the same floor, and on other floors, can also start to deteriorate making it unsafe for occupants to stay.

7.3 The time available for occupants, specially in and adjacent to the fire zone, depends on the time of awareness of the fire and the time by which conditions become untenable. Consequently earlier the awareness of the fire more time the occupants have available to move to safety.

7.4 The time needed to move to a place of safety depends upon a number of human factors including the number, the nature and the condition of occupants. In a hospital environment and confinement areas the movement is likely to be at a comparatively slow rate, in buildings with large number of occupants the speed of movement may also decrease significantly. In buildings with sleeping risk the awareness of a fire may not be prompt.

7.5 Another factor which can cause awareness delay is the occurrence of a fire in unoccupied parts of a building or parts which are not normally obvious such as concealed spaces. This can be the case specially with high risk areas in buildings containing electrical equipment or flammable materials which are not normally manned.

7.6 In the fire zone the occupants should become aware of the fire quickly if the space is not too large and the people are awake and carrying on normal activities. The automatic human detection of fire becomes less reliable as compartment sizes increase, spaces are divided by rooms and barriers are introduced.

7.7 The alternative to human detection is the use of electro-mechanical devices which respond to one or the other of fire manifestations, such as
smoke, heat or flames. The detectors sense the existence of a fire and need to be connected to a warning system to make the management and the occupants aware of the fire and to prompt them to follow an agreed procedure for evacuation and other actions. The selection of a suitable system should follow the recommendation in the Code dealing with the design and the installation of systems.

7.8 The requirements specify three types of systems:

Type M - manual alarm systems with alarm buttons in suitable locations for operation by the occupants.

Type L1 - automatic detection systems installed in rooms or areas communicating with the escape route or in areas of special risk due to nature of the use or to detect a hidden fire.

Type L2 - automatic detection system installed throughout the building.

In cases of L1 and L2 systems a manual system is always provided for the use of occupants.

7.9 In order to ensure the continued effectiveness of a fire protection system it is important to maintain the system in good working order and for this purpose regular inspection and maintenance should be carried out.

REQUIREMENTS

7.10 The requirements for alarm and detection system are given primarily for life safety purposes, where property protection is an additional consideration the system should be upgraded to serve the property protection needs as well.

7.11 The manually operated alarm triggers, shall be connected to sounders or other suitable warning devices. Automatic fire detection systems shall have suitable fire sensors connected to a control panel for the reception of the signal from the detector. The signal can be used in a variety of ways to inform the occupants, by directly operated sounders throughout the building or in selected parts, informing the management prior to public warning and simultaneously informing the fire brigade or rescue services.

7.12 The public warning can be by sounders, visual signals or recorded messages depending on the nature of the occupancy and the most suitable method of communication with occupants.

7.13 All buildings other than small single storey structure where not more than 10 people are likely to be present shall be provided with a fire alarm system. Table 7.1 shows the minimum type of system for different categories of buildings depending on the height of the building or the expected occupancy level. In most cases a distinction is made between low height or low occupancy buildings and others.
7.14 Special risk areas, Chapter 14, and other buildings with special escape problems, such as atria, large shopping complexes and mixed usage complexes, defined in Chapter 15, shall be considered for the provision of an automatic fire detection system. Large concealed spaces containing electric supplies or other potential fire sources, shall be provided with an automatic fire detection system.

7.15 Type L systems require a control panel to receive the signal from detectors and to utilise the information for warning purposes. The alarm may be given directly to occupants to leave the premises in case of apartments, hotels and other buildings of low height or low occupancy level. In other cases an agreed evacuation procedure shall be used by the management. This may be a two stage system where phased evacuation has been used for the design of the escape provisions, see Chapter 8. In such cases the evacuation signal shall be given to the occupants on the fire floor and the floor immediately above, if any. The other occupants shall be given an alert signal to be prepared to evacuate the premises.

7.16 The detection and alarm system shall be selected and installed in compliance with the recommendations made in the standard on Fire Detection and Alarm Systems, Chapter 19. The standard provides information on the suitability of different detectors, control equipment and the method of communicating the information to the occupants.

7.17 The occupant may be informed by means of sounders, light signals or audio messages. Care shall be exercised in the use of recorded messages as to their appropriateness and the ability to avoid panic. Live messages are usually better able to deal with the precise fire situation. Where there is continuous background noise, the audio signals shall be accompanied by visual means to attract attention.

7.18 In the case of institutional buildings, and other buildings with a large population, in excess of 500, the system shall be designed to give the initial information to the management, which shall then follow an agreed procedure for the evacuation of occupants in stages or simultaneously, as appropriate, by the help of the staff as necessary. Staff assistance shall be available when dealing with occupants who are physically not fit, or not able to make their escape without assistance.

**TABLE 7.1 PROVISION OF FIRE ALARM AND DETECTION SYSTEM**
<table>
<thead>
<tr>
<th>Occupancy category</th>
<th>Maxm height/ storeys</th>
<th>Occupancy level</th>
<th>Minimum system</th>
<th>Additional option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic - A2</td>
<td>2 storey &gt; 2 storeys</td>
<td>Any</td>
<td>NR M</td>
<td></td>
</tr>
<tr>
<td>Other residential - B1</td>
<td>2 storey &gt; 2 storey</td>
<td>Any</td>
<td>NR L1 M</td>
<td></td>
</tr>
<tr>
<td>Commercial - C2/3</td>
<td>2 storey &gt; 2 storey</td>
<td>&lt; 20 &gt; 20 Any</td>
<td>M L1 L2</td>
<td>Single storey small shops excluded</td>
</tr>
<tr>
<td>Office</td>
<td>2 storey &gt; 2 storey</td>
<td>&lt; 20 &gt; 20 M</td>
<td>L1 L2</td>
<td></td>
</tr>
<tr>
<td>Assembly - F1</td>
<td>2 storey &gt; 2 storey</td>
<td>&lt; 50 &gt; 50 M</td>
<td>L1 L2</td>
<td>Theatres (1)</td>
</tr>
<tr>
<td>Car parking - G2</td>
<td>&gt; 2 storey/ basement</td>
<td>Any</td>
<td>L2</td>
<td></td>
</tr>
<tr>
<td>Health - H1</td>
<td>Any</td>
<td>&lt; 10 &gt; 10 NR L2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional</td>
<td>2 storey &gt; 2 storey</td>
<td>Any</td>
<td>L1 L2</td>
<td>Detention centres (2)</td>
</tr>
<tr>
<td>Industrial - J2</td>
<td>Any 2 storey &gt; 2 storey</td>
<td>Any &lt; 20 &gt; 20 M L1 L2</td>
<td>Detectors should match use environment</td>
<td></td>
</tr>
<tr>
<td>Storage - K2</td>
<td>Any &lt; 10m &gt; 10m</td>
<td>&lt;20 &gt;20 M</td>
<td>L1 L2</td>
<td>Special equipment(3)</td>
</tr>
<tr>
<td>Special risk areas</td>
<td>Any</td>
<td>Any</td>
<td>L2</td>
<td></td>
</tr>
<tr>
<td>Atria building</td>
<td>&lt; 4 storey &gt; 3 storey</td>
<td>Any</td>
<td>L1 L2</td>
<td></td>
</tr>
<tr>
<td>Shopping complex or mixed use complex</td>
<td>Any</td>
<td>Any</td>
<td>L2</td>
<td></td>
</tr>
</tbody>
</table>

Notes to Table 7.1:

(1) - Theatres and other buildings which have flammable materials such as scenery in storage require special detection facilities.
(2) - Detention centres such as prisons require equipment which can not be interfered with.
(3) - Special risk areas vary in the type of risk and require detection equipment which is uniquely suitable for the type of fire to be expected.

7.19 The decision to inform the fire brigade or the rescue services shall be dependant upon previous consultation between the management and the appropriate fire authorities.

7.20 It shall be the responsibility of the management in all large buildings and in the case of special risk areas to have in place a system to ensure the regular maintenance and upkeep of the alarm and detection system; provision shall be made for keeping appropriate records for this purpose.
CHAPTER 8
MEANS OF ESCAPE

OBJECTIVE

8.1 The building shall have adequate means of escape for the occupants such that in case of a fire they are able to move safely to the outside directly or in stages. The means of escape shall be protected as necessary and remain available at all times the building is occupied.

BACKGROUND

8.2 When a fire starts it releases heat, smoke and other undesirable products. Due to buoyancy these gases rise to the ceiling and spread sideways. In a room the smoke layer gradually deepens and then moves to other areas if the door is open. It is the presence of these products with the associated heat which creates hazardous conditions for the occupants.

8.3 In the vicinity of the fire the conditions become unsafe fairly quickly and deterioration of conditions in other areas is progressive as smoke and other gases travel to these areas. As soon as the gases reach a vertical shaft or opening they preferentially move upwards. Their progress depends on the continuation of the fire and the availability of free passages. Obstructions to the flow of gases by fire barriers or other means will slow their progress and delay the pollution process.

8.4 The ability of occupants to escape from the fire zone depends on a number of factors such as the awareness of the fire, speed of growth of fire, time available before the environment becomes unsafe and the adequacy of escape routes.

8.5 This chapter deals with the provision of adequate means of escape in different types of buildings and, where necessary, their protection for a sufficient time to give the occupants opportunity to make their escape. Other associated matters are dealt with in other chapters on detection and alarm systems, fire growth control, fire resistance, compartmentation and fire rescue facilities.

8.6 The design of means of escape is a complex process and requires the establishment of the occupant needs and to match the escape provisions to these needs. The important factors are the size of the building, the use to which it is put, the number of occupants, their physical condition and their familiarity with the surroundings.

8.7 Occupants need to be aware of the route they need to take and in most cases they should be able to find a safe place without requiring assistance. The routes should remain available to occupants as long as they require to use them. The routes must be adequate in number and size to prevent
congestion and queuing, and where necessary steps should be taken to prevent them getting smoke logged.

8.8 The escape process may be completed in one stage, as in most single storey and low rise buildings, or it may be progressive from the fire zone through a partially protected area to a fully protected area and finally to the outside. Occupants in the fire zone need to pass quickly through the area where the conditions are deteriorating and the time taken to travel through this area should be as short as possible. Once the comparative safety of a protected zone is reached more time is available to reach the ultimate safety outside the building.

8.9 For some large and complex buildings total evacuation of the building may be neither necessary nor desirable. In such cases the concept of phased evacuation can be used by evacuating occupants from the floor where the fire has occurred and one floor above. In such cases additional precautions are needed and the rest of the area occupants kept in a state of alert ready to leave if the fire is not controlled.

8.10 Whilst un-aided escape is the general principle used in the design of the facilities in most building in some case, e.g. hospitals, occupants need assistance with escape and their speed of movement is likely to be slow. Initially they may need to move horizontally to the relative safety of an adjacent compartment before moving away from the floor of fire.

8.11 Lifts are not normally allowed to be used for escape purposes but in special cases when dealing with disabled people and provided the lift enclosure is specially protected, this may be an acceptable means of escape for such occupants.

REQUIREMENTS

Escape route planning

8.12 Every building where people are likely to be present shall be planned so that adequate means of escape exist. For single storey buildings the escape route shall lead directly to the outside. With complex layout, particularly with large floor areas, the escape route may be through protected zones before reaching the safety of the outside. With multi-storey buildings an examination of the layout shall be carried out at the initial planning stages to establish the most convenient route for the occupants. This shall, as far as possible, be the route occupants use to enter and leave the building. Attention should be paid at the initial stages to any special requirements for the occupancy under consideration such as any physical disability or other restriction to movement. Figure 8.1 shows some of the essential components of means of escape.
Occupancy levels

8.13 It is necessary to establish the number of occupants that are likely to be within a building during its normal use. In some occupancies the precise numbers are known at the design stage because of the facilities that are provided. For example cinema, theatres etc have provision of seats, hotel have known bedroom capacity, institutional buildings have declared occupancy levels. These values shall be obtained and used for the design of escape route capabilities.

8.14 For many other buildings this information is not precisely known at the design stage but may be estimated from the size of the building. Table 8.1 gives the notional space that may be occupied by each person in different occupancies, by dividing the floor area of each storey by occupancy factor the number people that need to be considered for escape design can be calculated. Where the precise use is not given the nearest use should be taken into consideration.

8.15 The estimated or specified occupancy levels are needed for each storey and each room on the floor from which provision has to be made of the escape facilities.

Travel distances

8.16 The critical factor in the escape of the occupants from any where in the building to the nearest exit is amount of time available before conditions become untenable. This is not easy to define in a general way as it will be influenced by the rate of growth of a fire and the speed with which the gas layer deepens. In practice maximum travel distance is used as a substitute factor which takes account of occupancy characteristics in a general way.If only one route is available the occupants need to leave the area quickly before it becomes unusable within the limited available time. If an occupant can move in more than one direction to reach a place of safety he has more available time and longer travel distances are permissible.

8.17 Travel distance is measured from any point in a room where a person may be present to the storey exit or the entry to the protected part such as a corridor or a lobby either by the shortest route or by a route which the occupants have to follow if there is restriction to free movement, as in areas with fixed seats.

8.18 Alternative escape routes from a single room require the presence of two or more doors as far apart as possible. If the angle between lines of travel from the point of measurement to the doors is less than 45º then one of the exits shall be discounted, Figures 8.2 and 8.3 show examples of alternative routes.

TABLE 8.1 - OCCUPANCY FACTOR
### TYPE OF OCCUPANCY

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>OCCUPANCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>m²/person</td>
<td></td>
</tr>
</tbody>
</table>

1. Spectators standing \( 0.3 \)  
2. Assembly halls, bars, dance floors, clubs, open concerts \( 0.5 \)  
3. Shopping malls, concourses \( 0.75 \)  
4. Committee room, conference room, meeting room, staff room, restaurant \( 1.0 \)  
5. Exhibition halls \( 1.5 \)  
6. Shop, supermarket, department store, repair of goods, cleaning, treatment etc \( 2.0 \)  
7. Offices (open plan), factory, workshop, art gallery etc \( 5.0 \)  
8. Offices (cellular), library, kitchen, shops for bulky goods (furniture etc) \( 7.0 \)  
9. Bed rooms, study rooms \( 8.0 \)  
10. Bed/sitting rooms, games rooms \( 10.0 \)  
11. Storage buildings \( 30.0 \)  
12. Car parks \( 2 \) persons /car

8.19 An automatic detection and alarm system provides an early awareness of fire and therefore gives more time for the occupants to escape. A fast response sprinkler system provides an awareness of a fire coupled with controlling its rate of growth. Where a suitable detection and alarm system or a sprinkler system has been provided the allowable travel distances can be increased by 25%. If special provisions are made to keep the unprotected part of the travel route clear of smoke, e.g. smoke extraction, the travel distances in these areas can be increased by 50%.

**TABLE 8.2 - MAXIMUM TRAVEL DISTANCES**
8.20 The distances given in Table 8.2 are the actual travel distances, where these are not known direct distances may be used, these should not exceed 75% of the value shown above.

**Escape route size**

8.21 The minimum headroom at any part of an escape route shall not be less than 2 m, when passing through doorways this may be reduced by 100mm due to the depth of the door frame.

8.22 The minimum width of the escape route and exits shall not be less than 800 mm. The width shall be adjusted according to the number of people expected to use the route as shown in Table 8.3 below;

8.23 In assessing the width of the exit where a door is provided the width may be locally decreased by not more than 100 mm due to the door frame.

**TABLE 8.3 - WIDTH OF ESCAPE ROUTES AND EXITS**

<table>
<thead>
<tr>
<th>Building category</th>
<th>Use of premises</th>
<th>Maximum travel distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>one direction only m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>more than one direction m</td>
</tr>
<tr>
<td>A</td>
<td>Apartment - internal</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>- circulation area</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>Other residential - bed rooms</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>- corridors</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>C</td>
<td>Commercial</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Office</td>
<td>40</td>
</tr>
<tr>
<td>D</td>
<td>Educational</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Assembly</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>G</td>
<td>Car park</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>H</td>
<td>Health</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Institutional</td>
<td>20</td>
</tr>
<tr>
<td>J</td>
<td>Industrial - low hazard</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>- high hazard</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>K</td>
<td>Storage</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>L</td>
<td>Area of special risk</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>
8.24 The width of escape stairs should not be less than the width of the exit route serving that stairway. The actual width necessary shall be calculated according to the number of people expected to use the stairway depending on the evacuation concept used and the number of stairs provided. The minimum width, in any case, should not be less than the size shown in Table 8.4 below;

<table>
<thead>
<tr>
<th>No of people using the route mm</th>
<th>Minimum width route or exit -</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50</td>
<td>800</td>
</tr>
<tr>
<td>≤ 100</td>
<td>900</td>
</tr>
<tr>
<td>≤ 200</td>
<td>1100</td>
</tr>
<tr>
<td>&gt; 200</td>
<td>5 mm/person</td>
</tr>
</tbody>
</table>

8.25 The actual width of stairs will be determined by the number of people expected to use the stairs in case of an emergency. Two factors which influence this are the number of escape stairs that have been provided and whether total or phased evacuation concept has been used.

8.26 In calculating the stair capacity it is often assumed that one of the stairs may become smoke logged and therefore be not available for the occupants. However this discounting is not necessary if;

a. The building is provided with an automatic detection and alarm system, or

b. The stairs are approached by a protected lobby or corridor, a protected lobby is not needed for the top floor, or

c. A mechanical smoke control system is provided to keep the stairs clear of smoke, or
d. A fast response sprinkler system is installed in the building.

**TABLE 8.5 - SIZE OF STAIRS FOR TOTAL EVACUATION**

<table>
<thead>
<tr>
<th>No of floors</th>
<th>Stair width for the total number of person to be evacuated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000 mm</td>
</tr>
<tr>
<td>1</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>190</td>
</tr>
<tr>
<td>3</td>
<td>230</td>
</tr>
<tr>
<td>4</td>
<td>270</td>
</tr>
<tr>
<td>5</td>
<td>310</td>
</tr>
<tr>
<td>6</td>
<td>350</td>
</tr>
<tr>
<td>7</td>
<td>390</td>
</tr>
<tr>
<td>8</td>
<td>430</td>
</tr>
<tr>
<td>9</td>
<td>470</td>
</tr>
<tr>
<td>10</td>
<td>510</td>
</tr>
</tbody>
</table>

8.27 Table 8.5 shows the width of stairs for total evacuation of the building, these values shall also be used when estimating the stair width for basements.

8.28 The width of stairs for taller buildings can be calculated by the following formula:

\[ P = 200w + 50(w-0.3)n \], where

- \( P \) is the number of people,
- \( w \) is the width of stairs, and
- \( n \) is the number of storeys served by the stairs, if one stairway is to be discounted \( n \) is reduced by one.

8.29 Where phased evacuation is used the stairs have to be able to deals with occupants from two floors, Table 8.6 below shows the width of stairs for different occupancy loadings:

8.30 The stair width for other occupancy levels can be calculated by the following formula:

\[ w = [(P \times 10) - 100], \text{ where} \]
w is the width in mm, and
P is the number of people.

TABLE 8.6 - STAIR WIDTH FOR PHASED EVACUATION

<table>
<thead>
<tr>
<th>No of people on any storey</th>
<th>Stair width mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>120</td>
<td>1100</td>
</tr>
<tr>
<td>130</td>
<td>1200</td>
</tr>
<tr>
<td>140</td>
<td>1300</td>
</tr>
<tr>
<td>150</td>
<td>1400</td>
</tr>
<tr>
<td>160</td>
<td>1500</td>
</tr>
<tr>
<td>170</td>
<td>1600</td>
</tr>
<tr>
<td>180</td>
<td>1700</td>
</tr>
<tr>
<td>190</td>
<td>1800</td>
</tr>
</tbody>
</table>

8.31 If the stair width exceeds 1400 mm a central handrail should be provided to assist with the full use of stairs specially in tall buildings.

Exits

8.32 Each room on a floor, and each storey should have at least 2 exits, a single exit is acceptable from rooms with occupancy level less than 20 and from storeys if the occupancy level is less than 50 for buildings other than institutional buildings. For institutional buildings one exit is permissible if the occupancy level does not exceed 30. The number of exits required is adjusted according to the number of people on a floor as specified in Table 8.7.

8.33 Escape from a room should be directly to the circulation area, passage through an outer room to the circulation area is acceptable only provided;

a. the occupancy level of the inner room is not more than 50
b. the travel distance is within the permissible value from Table 8.2
c. the access room is not a special risk area
d. the inner room is not a bed room
e. an automatic fire detection system is provided, or
   the separating wall between the inner and the access room has glazed area to make a fire visible.

8.34 If a room has two or more exits these should not form with each other an angle of less than 45° to be considered as separate exits, Figure 8.2. If a storey has two or more exits these shall be as far apart as possible and shall not communicate with each other without a fire barrier such as a fire door. If
a building is provided with central core for stairs, lifts etc, the circulation area leading to the stairs shall be provided with fire doors to prevent direct communication between various stairs, Figure 8.3.

**TABLE 8.7 - MINIMUM NUMBER OF EXITS FROM ROOM OR STOREYS**

<table>
<thead>
<tr>
<th>Number of occupants</th>
<th>Minimum number of exits or routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>2</td>
</tr>
<tr>
<td>1000</td>
<td>3</td>
</tr>
<tr>
<td>2000</td>
<td>4</td>
</tr>
<tr>
<td>4000</td>
<td>5</td>
</tr>
<tr>
<td>7000</td>
<td>6</td>
</tr>
<tr>
<td>11000</td>
<td>7</td>
</tr>
<tr>
<td>16000</td>
<td>8</td>
</tr>
<tr>
<td>&gt;16000</td>
<td>8 + e*</td>
</tr>
</tbody>
</table>

*e = [n - 16000]/5000 where n is the number of occupants

**Evacuation philosophy**

8.35 Buildings can be designed for total evacuation or phased evacuation. Phased evacuation means that initially only two floors need to be evacuated, i.e. the fire floor and the floor immediately above. Total evacuation concept must be used for the following situations;

- Basements,
- Buildings with open plan accommodation,
- Assembly and Other residential buildings.

8.36 If phased evacuation concept is used for the planning of the escape routes, the following additional conditions must be satisfied;

i. A protected corridor or lobby shall lead to the stairway,
ii. Every floor shall be a compartment floor,
iii. The building shall be fitted with an automatic detection and alarm system
iv. If high rise, i.e. over 30 m in height, the building shall be provided with a sprinkler system
v. A communication system should exist to transmit messages from the control room to occupants on all floors

**Travel in unprotected zone**

8.37 The first part of travel from a room or other location is through an unprotected zone leading to the storey exit directly or through a protected
corridor. The maximum travel in the unprotected zone should not be more than the values shown in Table 8.2. If the escape route passes through a corridor the travel distance restrictions of Table 8.2 applies if it is not a protected corridor. If the corridor is designed as a protected corridor the travel distance restriction applies up to the entry to the corridor. Similarly the travel distance restriction applies to the entry to a protected lobby where such a lobby is provided.

8.38 Dead-end corridors, i.e corridors with only one direction of travel, should not be longer than the one direction limit of Table 8.2 and it should be constructed as a protected corridor separated from the main corridor by fire doors. A short length dead-end corridor, not more than 4.5 m in length, may be of unprotected type.

**Travel in protected zone**

8.39 Once the occupants have entered a protected zone, a corridor, a lobby or a stairway, they are in relative safety and have more time available to reach the safety of the outside. There is no limit on the distance or time for travel in the protected zone but it must lead to the final exit from the building. The travel time in a protected corridor or the lobby should be fairly short in order to reach the safety of the protected stairway, Figure 8.4.

8.40 The protected stairs should lead to the final exit from the building. If there is a distance of more than 2 m from the stairs to the final exit a protected zone should be provided to enable occupants to get out safely from the building.

**Protected lobbies**

8.41 Entrance to the escape stairs should be through a protected lobby in the following cases;

i. The building has a single escape stairway,
ii. The building is over 20 m in height,
iii. Phased evacuation concept has been used,
iv. Stairs lead to the basement area,
v. The stair serve a special risk area.

8.42 Where protected lobbies are provided when estimating the size of stairs for evacuation purposes all stairs serving that floor can be taken into account.

8.43 When protected lobbies are being provided in a building they are not required for the top most floor.
Protected stairways

8.44 All escape stairs shall be constructed as protected stairways having the fire resistance specified in Chapter 9 for the type of occupancy.

8.45 Protected stairways shall be fully isolated from each other. Where two protected stairways exist together in a central core or any other arrangement, they shall be separated by a fire resisting construction and have separate entrances. They shall not be served by a common lobby. Where a protected stairway also serves the purpose of a firefighting shaft additional requirements of Chapter 13 shall also apply.

8.46 The enclosure containing protected stairs should not incorporate any facilities which can cause the start of a fire. Only lifts, toilets with minimum of combustible goods, fire hydrants etc are permitted. If gas pipes are located these shall be properly isolated.

External stairs

8.47 An escape stairway can be external to the building and its acceptability depends on its location and protection. An enclosed stairway on the outside wall of the building is equivalent to an internal stairway provided the travel distances are within acceptable limits. An external stairway away from the wall is still acceptable if it is enclosed and has protected access from the storey exit.

8.48 An external open escape stairway is permitted in the following cases, Figure 8.5;

   i. It is not the only escape stairway,
   ii. The top floor it serves is not more than 6m above ground,
   iii. The doors to the landings are fire resisting,
   iv. The wall against which the stairs are built is fire resisting and imperforate for a distance of 1.8 m each side of the stairs

8.49 In special cases the escape route from each floor may lead to an adjacent building through connecting balconies provided the following conditions are satisfied;

   i. The access doors to the other building are kept unlocked whilst the buildings are occupied,
   ii. The balconies are fully enclosed or there are no window openings in the external wall of the buildings within 5m of the balconies from either side.
**Basement**

8.50 The basement stairs must be protected more than those above ground because of the tendency for the smoke to rise. All doors to basement stairs must be of smoke control type. If the occupancy loading of the basement is more than 20 at least two stairs shall be provided.

8.51 The basement stairs should preferably not continue above ground floor, this is not allowed where a single basement escape stair is provided.

8.52 If a basement is served by a single stairway it shall have a protected lobby entrance. If the basement is used as a car park or has special fire risk areas the stairs should be provided with protected lobbies.

**Smoke control**

8.53 It is important to ensure that the escape routes stay clear of smoke for as long as necessary for the escape of the occupants. Smoke can be kept out of the stairways by one of the following means;

i. pressurisation of stairways,
ii. provision for the removal of smoke by natural ventilation or by mechanical means,
iii. by providing protected lobbies and smoke control doors

8.54 If a natural ventilation based system is employed the design shall ensure that the required rate of extraction can be maintained in most weather conditions. Provision shall be made for the high level smoke extract clear of the building and not subject to down pressures. A low level fresh air inlet shall be provided to replace the smoke-laden air removed from the lobby or the stairway. If a smoke shaft is provided to remove smoke from a lobby it shall have a high level extract and preferably with a provision for low level fresh air inlet to replace the smoke.

8.55 Provisions shall be made for smoke control in the following cases;

i. all institutional buildings with occupancy level >20,
ii. stairways and lobbies in all high rise buildings
iii. basement areas when used as car parks
iv. assembly buildings with occupancy loading of more than 500,
v. Large shopping complexes, atria buildings and large multi- use complexes

**Ventilation and air conditioning systems**

8.56 If a building is provided with a ventilation and/or air conditioning system, it shall be so designed that it does not spread smoke in case of fire. The system should either automatically close down, or stop recirculation of
air to other parts of the building or disperse the extracted smoke from the fire zone to the outside.

8.57 The system may be designed to provide smoke control by its ability to reverse flow, if necessary, and to be able to be boosted to high flow rates.

8.58 If smoke control is provided by a pressurisation system in case of a fire this should over-ride the normal air conditioning and ventilation system.

**Lighting**

8.59 All circulation areas should have adequate artificial lighting for occupants to be able to see the routes clearly. All escape routes should be provided with lighting which comes into operation if the normal supplies fail so that occupants can find their way to the protected escape zones.

**Signs**

8.60 Other than apartment buildings, all building should have the exit routes clearly marked with signs. In the absence of daylight the signs should be illuminated so that they are visible from a distance.

8.61 Escape routes in hotels, institutional buildings and buildings where public has access should be clearly marked to enable occupants to find their way to the storey exits. Low level duplicate signs may be needed where the risk of smoke logging exists.

**Special requirements - Apartment buildings**

8.62 Buildings not more than 4 storeys can be provided with a single escape stairway provided;

   a. The stairway is fully protected,
   b. The travel distance to the stairs in not more than 7.5 m from any of the apartments.
   c. Smoke control facilities are provided for the stairs or the access lobby

8.63 Maisonettes shall be provided with a protected internal stairway inside the apartment, with entrance through fire doors.

8.64 The entrance door of an apartment shall be of fire resisting construction to atleast a 30 min standard.

8.65 Long corridors shall be sub-divided by smoke control doors such that the maximum travel distance between such doors or to a storey exit is not more than 30m.
8.66 Within an apartment the layout shall ensure that occupants can reach the exit without difficulty in case of a fire. Unless a smoke detector is provided the entrance to the kitchen shall not be close to the entrance door and the maximum travel distance from any room to the entrance door, or the protected stairway for a maisonette, shall not exceed 5 m.

**Health & Institutional buildings**

8.67 Hospitals and other buildings with occupants unable to make their escape without assistance shall be divided at each floor into at least two compartments if the occupancy level is more than 20. This shall enable progressive evacuation by horizontal movement of occupants during the first phase of evacuation to an area of relative safety before movement from the floor becomes necessary, Figure 8.6.

8.68 If the buildings are not under full time supervision by the staff an automatic detection and warning system shall be installed when the occupancy level exceeds 20. The warning shall be initially given to the staff for rescue and escape provisions to be put into operation.

8.69 Buildings where the occupants are under restriction, e.g. prisons, shall also make provision for progressive evacuation so that occupants can be moved in stages from the fire zone to other areas of relative safety.

**Other residential**

8.70 Hotels, boarding houses and other similar establishments where the occupants are transitory shall be provided with a smoke detector in each bedroom if the building is more than 2 storeys in height with an occupancy level of more than 20.

8.71 Each occupation unit shall be a fire resisting cell with the entrance door designed as a smoke control fire door.

8.72 The entrance to the stairs shall be through a protected lobby for buildings more than 4 storeys in height and the stairs shall be protected.

8.73 On leaving each unit there shall be a clear indication of the direction to the storey exit with illuminated signs, the location of alarm buttons and any first aid fire fighting equipment shall be clearly indicated.

**Commercial**

8.74 Small buildings, not more than 2 storeys high and with an occupancy loading of not more than 20, can have a single unprotected escape stairway.
CHAPTER 9

STRUCTURAL STABILITY

OBJECTIVE

9.1 Buildings shall be designed and constructed such that if a fire occurs in any part of the building, the building structure and other elements shall possess sufficient resistance to the effects of the fire to retain their stability and to fulfill their fire safety function.

BACKGROUND

9.2 Building structure and components are usually designed to fulfill certain functions of stability and separation and it is important to ensure by design or other protective means that these functions will be fulfilled in the event of a fire. Generally this implies that the building retains its stability and that those parts of the building which have been designed as fire separations maintain their integrity.

9.3 This characteristic of building elements is defined as their fire resistance which is established by means of a standard test or by calculation, see Chapter 17. The test measures the time for which criteria for fire resistance can be satisfied. It should be remembered that this time is not the actual time for which a fire in a building may last but is an arbitrary time scale used for design purposes. The two times can be related with reference to producing the same effect on the structure.

9.4 The design fire resistance times are related to the expected fire severity in a given type of occupancy and are adjusted to take account of special safety needs. The consequences of failure in a tall building are more severe than a lower height building and therefore taller buildings require an additional factor of safety. The maintenance of stability in a low rise building may only be required primarily for ensuring the safety of occupants and therefore some relaxation in requirements is possible. Conversely fires in basement areas are more difficult to deal with and therefore higher fire resistance standards can be justified.

9.5 The fire resistance requirements in these Regulations are primarily for the safety of occupants in the building and safeguarding others in the adjacent buildings. They are not concerned with the protection of property and/or the re-use of the building after a fire. If these considerations apply then the designer needs to consult the appropriate bodies, e.g. insurance companies, to obtain their precise requirements.

9.6 The severity of a fire can be significantly decreased if provisions are available to reduce the rate of burning. A properly designed and maintained sprinkler system is capable either of extinguishing a small fire or controlling the intensity of a larger one until the fire brigade can take steps to
extinguish the fire. Consequently adjustments are possible in the design fire resistance times where a suitable sprinkler system exists. It is important to stress the need to maintain such systems in good working order at all times.

9.7 In the fire resistance requirements for different categories of buildings reference is made to the height of the building, the height for this purpose is not the actual height of the building but the height of the top most occupied floor where people may be present.

REQUIREMENTS

9.8 The fire resistance requirements apply to the following elements of a building:

i. Loadbearing
   structural frame,
   columns,
   hangers or galleries
   beams,
   internal and external walls,
   floors except the floor next to the ground
   compartment walls and compartment floors
   roofs if designed as part of the structure
   protected stair/lift enclosures
   protected shafts

ii. Non-loadbearing
   internal compartment walls
   external walls required to possess fire resistance
   doors and shutters
   protected stair/lift enclosures
   protected shafts

9.9 Fire resistance requirements for different categories of buildings are given in Table 9.1 and these can be adjusted if an approved sprinkler installation is provided, Table 9.2. If the precise building category is not shown the nearest appropriate category shall be used. Where an element is inter-acting structurally with another element the higher appropriate fire resistance requirement shall apply.

9.10 All compartment wall and compartment floors required to have a fire resistance of more than 60 minutes shall be constructed of non-combustible materials. All external walls 1m or less from the boundary shall be constructed of non-combustible materials.

9.11 The basement floor separating the basement area from the above ground construction shall possess the higher fire resistance requirement applicable to the building above ground or the basement.
9.12 All internal floors within a maisonette need be designed for 30 minute fire resistance.

9.13 All compartment walls separating different occupancies within a building or adjoining buildings shall have minimum fire resistance of 60 minutes.

**Performance criteria**

9.14 The performance criteria which are applicable to different elements of construction are given in Table 9.3, the appropriate tests and criteria are specified in Chapter 19.

9.15 The criteria can be adjusted for some elements, e.g. doors and external walls, due to use conditions removing contact with combustible materials. In the case of doors in addition to fire resistance the ability to restrict the passage of smoke from one side to the other is also important and a new category for a smoke control door is specified.

9.16 Load bearing external walls and external walls ≤1 m from the boudary shall have the fire resistance as specified for the building in Table 9.1. Other external walls may have reduced fire resistance requirement if they are sufficiently away from the boundary, Chapter 11. External walls ≤1 m from the boudary shall be judged for fire resistance when exposed to a fire from either side, other external walls need to be assessed against an internal fire only and the insulation criterion only applies for 30 minutes or half the period of fire resistance, whichever is greater.

9.17 Only roofs which are structural, or needed for escape purposes, or abut an external wall with openings or escape stairs shall be of fire resisting construction. Fire resisting roofs shall be assessed against an internal fire and the insulation criteria shall be applied for half the fire resistance period.

9.18 The enclosure containing a protected stairway, with or without lifts and other services, shall be tested for fire resistance from the outside. Fire resistance against an internal fire is required for half the period only.

9.19 If all or part of the boundary of the protected lobby or a protected corridor has a compartmentation function that part shall provide the minimum fire resistance requirement for the building.

**TABLE 9.1 MINIMUM FIRE RESISTANCE REQUIREMENTS**

[Without sprinkler installation]
<table>
<thead>
<tr>
<th>Building category</th>
<th>Minimum fire resistance (minutes) for building elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basement storeys Ground / upper storeys</td>
</tr>
<tr>
<td></td>
<td>Depth of basement Height of top floor above ground</td>
</tr>
<tr>
<td></td>
<td>&gt; 10 m ≤ 10 m ≤ 5 m ≤ 15 m ≤ 30 m &gt; 30 m</td>
</tr>
<tr>
<td>A1 - Dwellings A2 - Apartment</td>
<td>NA 30 30 NA 90 NA 120</td>
</tr>
<tr>
<td>Other residential B1 - Hotels, hostel</td>
<td>60 60 30 60 90 120</td>
</tr>
<tr>
<td>Commercial C1 - Small shops C2 - Stores C3 - Shopping centre</td>
<td>NA 60 30 60 NA 120 180</td>
</tr>
<tr>
<td>Office D1 - Administration</td>
<td>90 60 30 60 90 120</td>
</tr>
<tr>
<td>Educational E1 - Schools, College</td>
<td>90 60 30 60 90 120</td>
</tr>
<tr>
<td>Assembly F1 - Low hazard F2 - High hazard</td>
<td>90 60 30 60 90 120 180</td>
</tr>
<tr>
<td>Car parking G1 - Low hazard G2 - High hazard</td>
<td>60 60 30 60 90 120 120</td>
</tr>
<tr>
<td>Health H1 - Hospitals H2 - Mental hospital</td>
<td>90 60 60 90 120 120 120</td>
</tr>
<tr>
<td>Institutional I1 - Prisons</td>
<td>90 60 60 90 120 120</td>
</tr>
<tr>
<td>Industrial J1 - Low hazard J2 - High hazard</td>
<td>90 60 30 60 90 120 120</td>
</tr>
<tr>
<td>Storage K1 - Low hazard K2 - High hazard</td>
<td>60 60 30 60 90 120 180</td>
</tr>
</tbody>
</table>
**TABLE 9.2 MINIMUM FIRE RESISTANCE REQUIREMENTS**

[With sprinkler installation]

<table>
<thead>
<tr>
<th>Building category</th>
<th>Minimum fire resistance (minutes) for building elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basement storeys</td>
</tr>
<tr>
<td></td>
<td>Depth of basement</td>
</tr>
<tr>
<td></td>
<td>&gt; 10m</td>
</tr>
</tbody>
</table>

| A1 - Dwellings | NA | NA | NA | NA | NA | NA |
| A2 - Apartment | NA | NA | NA | NA | NA | NA |
| Other residential | 60 | 60 | 30 | 60 | 60 | 90 |
| B1 - Hotels, hostel | 60 | 60 | 30 | 60 | 60 | 90 |
| Commercial | NA | NA | NA | NA | NA | NA |
| C1 - Small shops | 60 | 60 | 30 | 60 | 90 | 120 |
| C2 - Stores | 60 | 60 | 60 | 60 | 90 | 120 |
| C3 - Shopping centre | 60 | 60 | 60 | 60 | 90 | 120 |
| Office | 60 | 60 | 30 | 60 | 60 | 90 |
| D1 - Administration | 60 | 60 | 30 | 60 | 60 | 90 |
| Educational | NA | NA | NA | NA | NA | NA |
| E1 - Schools, College | NA | NA | NA | NA | NA | NA |
| Assembly | 60 | 60 | 30 | 60 | 90 | 120 |
| F1 - Low hazard | 60 | 60 | 30 | 60 | 90 | 120 |
| F2 - High hazard | 60 | 60 | 60 | 60 | 90 | 120 |
| Car parking | 60 | 60 | 30 | 60 | 90 | 120 |
| G1 - Low hazard | 60 | 60 | 30 | 60 | 90 | 120 |
| G2 - High hazard | 60 | 60 | 60 | 60 | 90 | 120 |
| Health | NA | NA | NA | NA | NA | NA |
| H1 - Hospitals | NA | NA | NA | NA | NA | NA |
| H2 - Mental hospital | NA | NA | NA | NA | NA | NA |
| Institutional | NA | NA | NA | NA | NA | NA |
| I1 - Prisons | NA | NA | NA | NA | NA | NA |
| Industrial | NA | NA | NA | NA | NA | NA |
| J1 - Low hazard | 90 | 60 | 30 | 60 | 90 | 120 |
| J2 - High hazard | 90 | 60 | 60 | 60 | 90 | 120 |
| Storage | 90 | 60 | 30 | 60 | 90 | 120 |
| K1 - Low hazard | 90 | 60 | 60 | 60 | 90 | 120 |
| K2 - High hazard | 90 | 60 | 60 | 60 | 90 | 120 |

NA - the use of sprinklers is usually not considered in such occupancies

**TABLE 9.3 - MINIMUM PERFORMANCE CRITERIA FOR DIFFERENT ELEMENTS**
<table>
<thead>
<tr>
<th>Type of element</th>
<th>Loadbearing capacity</th>
<th>Integrity</th>
<th>Insulation</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural frame, beam, column or hanger</td>
<td>Table 9.1/9.2</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Loadbearing wall, compartment wall</td>
<td>Table 9.1/9.2*</td>
<td>Table 9.1/9.2</td>
<td>Table 9.1/9.2</td>
<td>see 9.13</td>
</tr>
<tr>
<td>External wall</td>
<td>Table 9.1/9.2*</td>
<td>Table 9.1/9.2</td>
<td>Table 9.1/9.2</td>
<td>see 9.15</td>
</tr>
<tr>
<td>Floor</td>
<td>Table 9.1/9.2</td>
<td>Table 9.1/9.2</td>
<td>Table 9.1/9.2</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>Table 9.1/9.2*</td>
<td>Table 9.1/9.2</td>
<td>Table 9.1/9.2</td>
<td>see 9.17</td>
</tr>
<tr>
<td>Protected stairway/lift enclosure</td>
<td>Table 9.1/9.2*</td>
<td>Table 9.1/9.2</td>
<td>Table 9.1/9.2</td>
<td>see 9.18</td>
</tr>
<tr>
<td>Fire fighting shafts</td>
<td>120*</td>
<td>120.</td>
<td>120.</td>
<td>See Chapter 13</td>
</tr>
<tr>
<td>Protected lobby</td>
<td>30*</td>
<td>30</td>
<td>30</td>
<td>see 9.18</td>
</tr>
<tr>
<td>Protected corridor</td>
<td>30*</td>
<td>30</td>
<td>30</td>
<td>see 9.19</td>
</tr>
<tr>
<td>Fire &amp; smoke control doors</td>
<td></td>
<td></td>
<td></td>
<td>See Table 9.4</td>
</tr>
<tr>
<td>Glazing</td>
<td>N/A</td>
<td>Table 9.1/9.2</td>
<td>Table 9.1/9.2</td>
<td>See 9.20</td>
</tr>
<tr>
<td>Insulated</td>
<td>N/A</td>
<td>Table 9.1/9.2</td>
<td>Table 9.1/9.2</td>
<td></td>
</tr>
<tr>
<td>Uninsulated</td>
<td>N/A</td>
<td>Table 9.1/9.2</td>
<td>N/A.</td>
<td></td>
</tr>
<tr>
<td>Suspended ceiling</td>
<td>N/A</td>
<td>Table 9.1</td>
<td>N/A</td>
<td>See 9.21</td>
</tr>
<tr>
<td>Cavity barrier</td>
<td>N/A</td>
<td>30</td>
<td>30</td>
<td>See 10.27</td>
</tr>
</tbody>
</table>

* means that the criterion of loadbearing capacity applies only if the element is designed as such, N/A means not applicable.

9.20 Glazing in fire barriers or fire doors shall be of fire resisting type, i.e it can satisfy the integrity and the insulation criteria of the standard test. Uninsulated glazing capable of retaining its integrity only under fire conditions shall be used only in limited amounts and in conditions given in Table 9.4.

9.21 Ceilings when forming part of the floor system shall be tested together with the floor and classified as part of the system. When used with other floors evidence shall be provided of their suitability for the proposed use. Suspended ceiling may be tested with a standard or simulated floor system and shall be used with other floor systems if evidence of their fitness is provided. Suspended ceiling which are easily demountable shall not be used in Institutional, Assembly or Commercial buildings or where the fire...
resistance of more than 60 minutes is required from the floor assembly. If used in such cases the floor shall provide the necessary fire resistance without the help of the suspended ceiling.

9.22 Where fire resistance is provided by a protective material or system, the designer shall provide evidence of the suitability of the material for use in the proposed conditions. This shall be particularly necessary where the products may be exposed to humid or aggressive atmosphere.

9.23 Table 9.2 gives concession on fire resistance when a sprinkler installation is provided in the building. The sprinkler system shall be designed and installed in accordance with the specification in Chapter 19. It is important that provisions are made for regular maintenance of such systems and records kept of their inspection and repair. If either the complete or a part of the system is undergoing repairs the management must discuss with the fire authority the additional safety provisions that should be made while the system is inoperative.

9.24 The performance of the fire doors shall be assessed by the method given in Chapter 19 and the performance standards shown in Table 9.4 shall apply to such doors.

9.25 Fire doors are tested and classified as fire resisting or smoke control on the basis of their ability to control the transfer of fire or smoke or both. Fire doors are graded as follows:

Fire control door - FD 30/15, is a fire door which satisfies the integrity criterion for 30 min and insulation criterion for 15 min.

Smoke control door - SD, which does not exceed the leakage limitation given in Chapter 19

Fire & Smoke control door - FSD x/x means a door which satisfies the fire resistance integrity and insulation criteria for x minutes to be obtained from Tables 9.1/9.2 for the building, and also satisfies the smoke leakage limit criterion.

9.26 Care shall be exercised in using door furniture, i.e. hinges, handles and other fittings, different from that subjected to the fire test. Expert assessment shall be obtained if such changes are to be made.

TABLE 9.4 PERFORMANCE REQUIREMENTS FOR FIRE & SMOKE CONTROL DOORS
9.27 If fire or smoke control doors are fitted with self-closing devices and these are needed to keep the door in a closed position the door shall be tested with such devices in place. If doors are provided with hold open devices which can keep the door open under normal use and the door is closed by the operation of a detection system or a switch the door in the closed position shall be capable of providing the necessary integrity with the normal provision to keep it closed.

9.28 Table 9.5 shows the amount and the position of uninsulated glazing which is permitted in fire doors and fire barriers. If larger amounts are to be used in fire resisting walls the glazed areas shall be separated from each other by insulated parts of at least the same width as the glazed parts.
### TABLE 9.5 - LIMITATION ON THE USE OF UNINSULATED GLAZING

<table>
<thead>
<tr>
<th>Element</th>
<th>Position</th>
<th>Maximum amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected corridor wall or partition</td>
<td>1.2 m above floor</td>
<td>individual panes ( \leq 5 \text{ m}^2 )</td>
</tr>
<tr>
<td>Protected lobby</td>
<td>1.2 m above floor</td>
<td>50 % of wall</td>
</tr>
<tr>
<td>Fire resisting wall</td>
<td>1.5 m above floor</td>
<td>No limit</td>
</tr>
<tr>
<td>Fire door in protected corridor, lobby or stair</td>
<td>1.2 m above floor</td>
<td>50 % of the door</td>
</tr>
<tr>
<td>Fire doors in walls</td>
<td>1.2 m above floor</td>
<td>( \leq 1 \text{ m}^2 )</td>
</tr>
<tr>
<td>Corridor division doors</td>
<td>0.5 m above floor</td>
<td>( \leq 50 % ) of door area</td>
</tr>
</tbody>
</table>
CHAPTER 10
COMPARTMENTATION

OBJECTIVE

10.1 The internal space within a building shall be sub-divided, as necessary, to prevent the unrestricted spread of fire from one part to another particularly safeguarding the escape routes. All communicating services and all concealed spaces which can provide a passage for the transfer of fire shall be protected to maintain the necessary degree of compartmentation within the building.

BACKGROUND

10.2 Once a fire has reached an advanced stage it will tend to spread throughout the building, threaten the escape routes for occupants and create difficulties for the fire brigade to carry out rescue and fire fighting operations. It is therefore necessary to consider the provision of fire compartmentation within the building so that a fire can be contained within specified boundaries.

10.3 The purpose of compartmentation is to prevent the transfer of fire beyond the compartment of origin. There are two types of compartmentation to consider, one type may be termed as essential compartmentation which ensures that specified areas are always separated such that a fire in one is not be able to make the conditions in the other untenable. The second type of compartmentation is concerned primarily with controlling the size of the fire to reduce the hazard to occupants and to facilitate fire control operations.

10.4 Separation of escape routes and parts of the construction which communicate between different areas such as service shafts and cavities can be considered as essential compartmentation. If a fire were to enter such areas, it can endanger occupants and spread unseen to different parts. Stairways, lift shafts, ventilation ducts, service ducts, ceiling and wall cavities are some examples of the routes available for a fire to spread in this way.

10.5 The degree of compartmentation is related to the use of the building and its size, including its height. In the case of small low rise buildings the whole building could be considered to be one compartment, Whereas with large and tall buildings frequent sub-division are needed to provide a number of compartments, Figure 10.1

10.6 Another purpose of compartmentation is to separate different risks and different occupancies. Fire separation between buildings and fire separation between different occupancies in the same building are examples of such compartmentation. With certain new types of buildings such as large multiple
shopping centres where perfect compartmentation may be difficult to achieve additional safety measures have to be provided as a compensation.

10.7 The rules for the acceptable size of compartments are empirical in nature and are primarily concerned with life safety issues. For purposes of property protection different sizes may be more appropriate and the designer needs to consult the insurance authorities for their rules.

10.8 In practice problems often arise because of penetrations which are made in compartment boundaries. Inadequate protection at these points is frequently responsible for fire spread from one part to another. Where external walls are part of the compartment perfect separation is not possible due to the presence of windows. Under favourable conditions a fire is able to by-pass the intermediate floors and spread from a lower to a higher storey. Where it is essential to eliminate this hazard additional safeguards would be needed such as fire resisting glazing.

10.9 Active fire protection measures such as sprinkler installations which influence the severity of a fire have also a beneficial effect on the maintenance of compartmentation.

**REQUIREMENTS**

**Provision of compartment walls and floors**

10.10 Suitable compartment walls and/or compartment floors shall be provided in the following cases:

a. A wall separating two buildings,
b. A wall and/or a floor separating different occupancies in a building,
c. All floors in health & institutional building more than 2 storeys in height,
d. All floors in assembly buildings and other residential category more than [3] storeys in height,
e. All floors in high rise buildings, i.e. more than 30 m in height.
f. All floors separating basement areas and a basement from the above ground construction.
g. Garages attached to or part of buildings.
h. Walls or floors forming boundaries of compartments according to Table 10.1

10.11 The following parts of a multi-storey building shall be constructed as separate compartments:

a. Enclosures for protected stairways,
b. Enclosures for lift shafts if not enclosed within a protected stairway enclosure,
c. All ducts, chutes, shafts for services or other purposes which pass
through compartment walls or floors,
d. All special risk areas.

Compartment sizes

10.12 In addition to the provision of essential compartmentation listed above the maximum size of compartments in buildings shall be controlled to the limits given in Table 10.1.

Construction

10.12 A compartment wall shall have the fire resistance appropriate for the building as shown in Tables 9.1/9.2. Compartment walls required to have fire resistance of 60 minutes or more shall be constructed of non-combustible materials, excluding decorative finishes. They shall be imperforate when separating two buildings or occupancies. Any door in a compartment wall shall have the same fire resistance as the wall. Any service passing through a compartment wall shall be protected to prevent the transfer of fire through the service or around the service where it passes the wall.

10.13 A compartment wall shall continue to the face of the building or the roof or to the non-combustible material which forms the outer layer of the other element.

10.14 A compartment floor shall have the fire resistance appropriate for the building as shown in Tables 9.1/9.2. Compartment floors required to have fire resistance of 60 minutes or more shall be constructed of non-combustible materials excluding floor finishes. They shall be generally imperforate with any services enclosed in fire resisting shafts and enclosures.

10.15 Where an escalator or other similar means of transport passes though a compartment floor it shall be either enclosed in a protected shaft or provided with automatically closing shutters operable through fusible links or other suitable means of detection unless an approved sprinkler installation is provided.

10.16 The junctions between compartment walls and floors and with other elements shall be designed to prevent any transfer of fire from one side to the other. Particular care shall be exercised at the junction between a compartment wall and a roof. If the roof has uneven surface underneath or if cavities exist the openings shall be properly sealed with suitable material such that the fire transfer is prevented, Figure 10.2.
### TABLE 10.1 MAXIMUM SIZE OF COMPARTMENTS IN MULTI-STOREY BUILDINGS

<table>
<thead>
<tr>
<th>Building category</th>
<th>Height of top storey m</th>
<th>Maximum floor area - m² or volume m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Basement (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above ground</td>
</tr>
<tr>
<td>Apartment</td>
<td>Any</td>
<td>No limit</td>
</tr>
<tr>
<td>Other residential</td>
<td>Any</td>
<td>1000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No limit</td>
</tr>
<tr>
<td>Commercial (2)</td>
<td>≤ 15 m</td>
<td>any depth</td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td></td>
<td>1000 m²</td>
</tr>
<tr>
<td>Sprinklered</td>
<td>&gt; 15 m</td>
<td>2000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5000 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>2500 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>5000 m²</td>
</tr>
<tr>
<td>Office (2)</td>
<td>≤ 15 m</td>
<td>any depth</td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td></td>
<td>1000 m²</td>
</tr>
<tr>
<td>Sprinklered</td>
<td>&gt; 15 m</td>
<td>2000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10000 m²</td>
</tr>
<tr>
<td>Educational</td>
<td></td>
<td>No limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No limit</td>
</tr>
<tr>
<td>Assembly (2)</td>
<td>≤ 15 m</td>
<td>any depth</td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td></td>
<td>1000 m²</td>
</tr>
<tr>
<td>Sprinklered</td>
<td>&gt; 15 m</td>
<td>2000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5000 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>2500 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>5000 m²</td>
</tr>
<tr>
<td>Car Park</td>
<td></td>
<td>any height</td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td></td>
<td>any depth</td>
</tr>
<tr>
<td>Sprinklered</td>
<td></td>
<td>1000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2000 m²</td>
</tr>
<tr>
<td>Health</td>
<td></td>
<td>No limit</td>
</tr>
<tr>
<td>Institutional</td>
<td>Any</td>
<td>1000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000 m²</td>
</tr>
<tr>
<td>Industrial (2)</td>
<td>≤ 15 m</td>
<td>any depth</td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td></td>
<td>1000 m²</td>
</tr>
<tr>
<td>Sprinklered (low hazard)</td>
<td>&gt; 15 m</td>
<td>2000 m²</td>
</tr>
<tr>
<td>(high hazard)</td>
<td>&gt; 15 m</td>
<td>2000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7500 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15000 m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10000 m²</td>
</tr>
<tr>
<td>Storage (2)</td>
<td>≤ 15 m</td>
<td>any depth</td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td></td>
<td>5000 m³</td>
</tr>
<tr>
<td>Sprinklered</td>
<td>&gt; 15 m</td>
<td>10000 m³</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>40 000 m³</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>20 000 m³</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>40 000 m³</td>
</tr>
</tbody>
</table>

**Notes**

1. For basements the requirements apply irrespective of depth.
2. For buildings ≤ 15 m in height the limit given is irrespective of a sprinkler installation.

10.17 Where the compartment wall meets an external wall there shall be no window openings for a distance of 1.5 m on either side. Similarly where the compartment wall meets the roof there shall be no roof lights for a distance of 1.5 m on either side of the junction.
10.18 No combustible material shall be built into or taken across the ends of a non-combustible compartment wall in such a way as to create the risk of fire penetration. Either the passage of the combustible material shall be interrupted or if it is of small cross-section, upto 100 x 100 mm, it shall be bedded completely in inert material leaving no air gaps around it.

**Protecting enclosures and shafts**

10.19 The protecting enclosure for stairs, lifts and other services shall be designed as a compartment and shall have fire resistance specified in Tables 9.1/9.2. A fire fighting stairway required by Chapter 13 shall have a minimum fire resistance of 120 minutes. If the entrance to the shaft is directly from accommodation the door to the enclosure shall have the same fire resistance as the enclosure. If the enclosure is approached from a protected lobby or a protected corridor the individual fire resistance of some parts may be reduced provided the overall fire resistance is not impaired, Figure 10.3.

10.20 Any uninsulated glazing use in the lobby wall shall be in accordance with the specification in Table 9.5

10.21 Ventilation ducts where they pass through compartment walls and floors shall not create a local weakness allowing penetration of fire. This shall be prevented either by the provision of a fire damper within or on face of the wall or the floor. The damper shall be provided with an automatic means of closure either by the use of a fusible link or a fire detection linked system.

10.22 Any vertical or horizontal shaft containing cables, piped services or other facilities shall be designed as protected shafts having the appropriate fire resistance for the building. At each compartment floor or wall the space inside the duct shall be closed with a barrier capable of preventing the transfer of fire. It may consist of precast concrete with openings for services or be prepared after the services have been installed. In both cases the gaps between the services and barrier shall be filled with suitable inert material to retain the integrity of the barrier.

10.23 Any access doors to the protected shafts shall have the same integrity as the shaft enclosure but the insulation requirement can be for half the period provided any combustible materials in the shaft is at least 200 mm from the inside face of the wall.

10.24 Any refuse chutes or similar devices for the transmission of material from different floors in a building shall be constructed of non-combustible material and provided with suitably designed access doors or flaps which remain closed and form a good seal with the opening to prevent the transfer of smoke and fire. The flaps shall not be made of combustible material.
**Pipes and ducts**

10.25 Small size ducts and pipes can pass through compartment walls and floors provided they meet the size limitations in Table 10.2. Larger pipes shall be enclosed within protected shafts or ducts.

### TABLE 10.2 MAXIMUM SIZE OF PIPE OR DUCTS THROUGH COMPARTMENT WALLS AND FLOORS

<table>
<thead>
<tr>
<th>Element penetrated</th>
<th>Steel, copper and similar (1)</th>
<th>Aluminium, lead, PVC &amp; similar (2)</th>
<th>Other plastics (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compartment wall/floor</td>
<td>150</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Other fire barrier</td>
<td>175</td>
<td>125</td>
<td>75</td>
</tr>
<tr>
<td>Apartment boundary</td>
<td>175</td>
<td>150</td>
<td>75</td>
</tr>
</tbody>
</table>

Notes: (1) - Pipes having a melting point of 1000°C or more  
(2) - Low melting point metallic or PVC pipes  
(3) - Plastics pipes excluding highly flammable products

10.26 Where the above pipes emerge from the fire walls or floors the gaps around the pipes and the wall shall be filled with suitable sealing material capable of maintaining its integrity under fire conditions, Figure 10.5.

**Cavities**

10.27 To prevent the spread of a fire through cavities and other concealed spaces these shall be protected in such a way that either the fire is unable to enter the cavity or if does enter it is not able to spread to other parts. Two type of cavities are considered in this connection, the constructional cavities and cavities resulting from the spacing of elements, such as between a roof and the ceiling underneath.

10.28 All constructional cavities shall be stopped at the boundaries or edges of the element in such a way that a fire entering the cavity is unable to go past the element. In the case of masonry walls widow or door frames or suitable plaster filling can provide this protection. For combustible constructions of timber framing the ends shall be filled with rigid slabs of mineral wool at least 50 mm thick or timber battens at least 35 mm thick. With steel framed systems, walls, floors or roofs the stopping or sealing shall be provided at the edges as well as the boundaries of the fire divisions such as compartment walls and floors.
10.29 There shall not be continuous space in a ceiling/roof void such that it connects two compartments. The compartment wall should be continued above the ceiling or an alternative construction provided with the same degree of integrity as the wall. If the ceiling is independently shown to be of a fire resisting type the cavity barrier needs to possess integrity for 30 minutes only, Figure 10.4.

10.30 If the ceiling/roof space is used for the location of cables, pipes, or ducts of combustible type with a fire load of more than [200 MJ/m²] then an automatic detection system shall be provided in the space to give warning of the occurrence of a fire.

10.31 Where a floating floor is provided with the cavity more than 250 mm deep the compartment walls shall be extended down to provide a fire barrier or the gap sealed with some other suitable material. If the space underneath is used for services such as cables, pipe etc giving a fire load of more than [200 MJ/m²] then an automatic detection system shall be provided in the space to give warning of the occurrence of a fire.

Health buildings

10.32 Hospitals and other health care buildings where the occupants are not mobile and need assistance with evacuation shall be provided with compartmentation at each floor if the occupancy level is more than [20]. To allow them to be moved safely into another part of the same floor, as the first stage of the escape process, the space shall be divided by fire resisting walls even if the size is not large enough to require compartmentation. Such walls shall have fire resistance of at least 30 minutes. All floors in such buildings shall be constructed as compartment floors.

Shopping complexes

10.33 Large shopping complexes present special problems with compartmentation, particularly if shops are individually owned and the circulation areas are covered and provide common access. The shops shall be separated from each other by compartment walls and floors and if the front is fully or partially open the shops shall be provided with a sprinkler system. The common circulation areas shall have provision for natural or mechanical smoke extraction.

Atria buildings

10.34 Buildings incorporating an atrium can not always provide complete compartmentation inside without destroying the open feature provided by an atrium. In such buildings additional safety measures are required to minimise the possibility of fire and smoke spread via the atrium area. Natural or mechanical smoke extraction systems should be provided which keep the smoke layer at a high level where barriers prevent its entry into the
accommodation area. In addition a sprinkler installation along the atrium corridors is needed if the building is more than 5 storeys in height.

**Car parks**

10.35 There are no size limitations on the above ground car parks but they shall be constructed entirely of non-combustible materials except for decorative finishes. There are limitations on the size of basement car parks as given in Table 10.1. All car parks shall be separated by fire resisting construction from the adjoining buildings and from other parts of the same building.

10.36 Basement car parks require ventilation provisions to keep them clear of any accumulation of flammable gases. It is also necessary to have a smoke control system to prevent smoke logging of the area. The ventilation may be by natural means by having opening at high level equal to 2.5% of the floor area which exhaust smoke clear of the building. Mechanical systems, if provided, should provide at least 6 air changes/hour for normal use which can be boosted to 12 air changes/hour during a fire. The equipment used for this purpose should be able to operate under high temperatures, fans capable of operation at 300°C for 60 minutes and ducts able to withstand temperatures upto 800°C are required. It is preferable to have a dual system with separate electric supplies.

**Special risk areas**

10.37 special risk areas, see Chapter 14, shall be separated from the rest of the building by compartment walls and floors having a minimum fire resistance of 120 minutes. If such areas contain flammable stores they shall have restricted access and shall be provided with an automatic fire detection system if more than 10 m² in floor area.
8.75 Shops with open sales areas with occupancy levels exceeding 50 shall be provided with a visible warning system in case of a fire and designed for total evacuation.

8.76 In multi-storey department store type establishments if escalators are provided they shall be either completely enclosed or partially enclosed with a rapid response sprinkler system. For buildings more than 4 storey in height there shall be provision for automatic closure of escalator openings.

8.77 Storey exits and/or final exits if controlled by restricted passages shall be so designed that in case of an emergency free flow of occupants is possible. Additional passages shall be provided where the restriction reduces the width necessary for the evacuation of occupants.

8.78 Some further needs for shopping malls are given in Chapter 15

Assembly

8.79 Assembly buildings with fixed seating arrangements shall have adequate sized passageways to allow the occupants to leave the room quickly. There shall be sufficient doors to ensure that the travel distance from any seat is within the limits of Table 8.2

8.80 Where security need demand the use of doors which cannot be opened from the outside, these doors shall be provided with rapid response opening devices to allow the occupants to escape in case of an emergency. The movement of occupants shall not be restricted to just one side of the room.

8.81 Illuminated signs shall show during a performance the position of exit doors. There shall also be signs clearly prohibiting smoking inside the room or the hall.

8.82 In exhibition halls on the occurrence of a fire all signs other than those necessary for the evacuation of the public shall be switched off. The evacuation signs shall be positioned so that they be seen clearly and indicate the direction to be taken by the occupants.

8.83 If an exhibition hall is designed to accommodate more than 500 people it shall be provided with smoke control facilities to maintain a clear zone at least 3m high for the time needed for the evacuation of the hall.

Atria buildings

8.84 Some fire safety concepts for atria buildings are described in Chapter 15. Where different floor levels are open to the atrium occupants should not be required to move towards the atrium to reach the storey exit.

8.85 Stairs and escalators opening to the atrium shall not provide the means of escape for the occupants.
Compartment sizes

10.12 In addition to the provision of essential compartmentation listed above the maximum size of compartments in buildings shall be controlled. The compartment size for basements in building categories A2, B, C, D, F, G, I, and J shall be limited to 1000 m² without a sprinkler installation and to 2000 m² with a sprinkler installation. The compartment size in basements for building category K shall be limited to 5000 m³ without a sprinkler installation and to 10000 m³ with a sprinkler installation. The compartment size limits for construction above ground for the above listed building categories are shown in Table 10.1. No compartment size limits apply to other building categories.

Construction

10.12 A compartment wall shall have the fire resistance appropriate for the building as shown in Tables 9.1/9.2. Compartment walls required to have fire resistance of 60 minutes or more shall be constructed of non-combustible materials, excluding decorative finishes. They shall be imperforate when separating two buildings or occupancies. Any door in a compartment wall shall have the same fire resistance as the wall. Any service passing through a compartment wall shall be protected to prevent the transfer of fire through the service or around the service where it passes the wall.

10.13 A compartment wall shall continue to the face of the building or the roof or to the non-combustible material which forms the outer layer of the other element.

10.14 A compartment floor shall have the fire resistance appropriate for the building as shown in Tables 9.1/9.2. Compartment floors required to have fire resistance of 60 minutes or more shall be constructed of non-combustible materials excluding floor finishes. They shall be generally imperforate with any services enclosed in fire resisting shafts and enclosures.

10.15 Where an escalator or other similar means of transport passes though a compartment floor it shall be either enclosed in a protected shaft or provided with automatically closing shutters operable through fusible links or other suitable means of detection unless an approved sprinkler installation is provided.

10.16 The junctions between compartment walls and floors and with other elements shall be designed to prevent any transfer of fire from one side to the other. Particular care shall be exercised at the junction between a compartment wall and a roof. If the roof has uneven surface underneath or
if cavities exist the openings shall be properly sealed with suitable material such that the fire transfer is prevented, Figure 10.2.

**TABLE 10.1 MAXIMUM SIZE OF COMPARTMENTS IN MULTI-STOREY BUILDINGS**

<table>
<thead>
<tr>
<th>Building category</th>
<th>Height of top storey m</th>
<th>Maximum floor area - m² or volume m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Above ground</strong></td>
</tr>
<tr>
<td>Apartment</td>
<td>Any</td>
<td>No limit</td>
</tr>
<tr>
<td>Other residential</td>
<td>Any</td>
<td>No limit</td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td>≤ 15 m</td>
<td>5000 m²</td>
</tr>
<tr>
<td>Sprinklered</td>
<td>&gt; 15 m</td>
<td>2500 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>5000 m³</td>
</tr>
<tr>
<td>Office</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td>≤ 15 m</td>
<td>no limit</td>
</tr>
<tr>
<td>Sprinklered</td>
<td>&gt; 15 m</td>
<td>5000 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>10000 m²</td>
</tr>
<tr>
<td>Educational</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td>≤ 15 m</td>
<td>5000 m²</td>
</tr>
<tr>
<td>Sprinklered</td>
<td>&gt; 15 m</td>
<td>2500 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>5000 m³</td>
</tr>
<tr>
<td>Car Park</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td>any height</td>
<td>2500 m²</td>
</tr>
<tr>
<td>Sprinklered</td>
<td></td>
<td>5000 m³</td>
</tr>
<tr>
<td>Health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional</td>
<td>Any</td>
<td>1000 m²</td>
</tr>
<tr>
<td>Industrial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td>≤ 15 m</td>
<td>10000 m²</td>
</tr>
<tr>
<td>Sprinklered (low hazard)</td>
<td>&gt; 15 m</td>
<td>7500 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>15000 m²</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>10000 m²</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-sprinklered</td>
<td>≤ 15 m</td>
<td>40 000 m³</td>
</tr>
<tr>
<td>Sprinklered</td>
<td>&gt; 15 m</td>
<td>20 000 m³</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 m</td>
<td>40 000 m³</td>
</tr>
</tbody>
</table>

Note - For buildings ≤ 15 m in height the limit given is irrespective of a sprinkler installation.
10.17 Where the compartment wall meets an external wall there shall be no window openings for a distance of 1.5 m on either side. Similarly where the compartment wall meets the roof there shall be no roof lights for a distance of 1.5 m on either side of the junction.

10.18 No combustible material shall be built into or taken across the ends of a non-combustible compartment wall in such a way as to create the risk of fire penetration. Either the passage of the combustible material shall be interrupted or if it is of small cross-section, upto 100 x 100 mm, it shall be bedded completely in inert material leaving no air gaps around it.
CHAPTER 11

EXTERNAL FIRE SPREAD CONTROL

OBJECTIVE

11.1 The outside envelope of the building should be reasonably resistant to ignition from emerging flames and when exposed to a fire in an adjacent building the spread of fire on the external surfaces should be controlled and the possibility of fire spread between buildings eliminated.

BACKGROUND

11.2 In case of fire in a building flames emerge from the windows and attack the external wall surfaces. This can also happen from a fire in an adjacent buildings which can subject the wall and roof surfaces to radiant heat as well as burning brands carried by air.

11.3 The risk which has to be safeguarded against is the transfer of fire externally either in the upper levels of the same building due to emerging flames or from the flames and flying brands from an adjacent fire.

11.4 Where the external fire spread is likely to cause concern because of its effect on the safety of occupants the nature of the external surfaces needs to be controlled. If there is no vertical compartmentation in the building or if it extends over a number of floors then a limited possibility of fire spread has been accepted if it does not place the occupants at risk. The external spread on wall surfaces can be controlled by preventing the use of combustible surfaces which are capable of rapid flame spread.

11.5 Fire exposure risk to an adjacent building is due to flames emerging from windows and the ignition of any flammable external cladding. The hazard is primarily due to radiated heat assisted by burning brands. The fire can enter the adjacent building by causing the external combustible surfaces to ignite and spread to flammable materials through the openings. As the designer does not always know the nature of the building which may be exposed it is usual to assume that the other building across the boundary is a mirror image of the building under consideration.

11.6 If the roof of a building is made of or finished with combustible materials it could also become ignited from an adjacent fire, particularly so if the buildings are adjoining and have a common compartment wall. Roofs are not normally designed to resist collapse in case of fire, it is often considered beneficial to exhaust flames through the roof to limit the internal fire spread. However it is necessary to ensure that the occupants of the adjoining building are not being put unnecessarily at risk.

11.7 Prevention of vertical spread of fire by flames entering the windows at a higher level or causing ignition of combustible materials near the windows
is more difficult to avoid. Windows in external walls are needed for purposes of light and ventilation, the glazing fails early in a fire leading to the emission of flame from windows. To completely avoid any hazard due to this feature the windows sizes will need to be unacceptably small or windows provided with fire resisting glazing. However certain precautions can be taken to reduce the possibility of external spread with normal glazing. These consist of a vertical or horizontal barrier at floor level and the avoidance of ceiling finishes of highly flammable materials.

11.8 Hazard due to fire exposure can be estimated from a knowledge of the size of the fire and its intensity. The fire size is taken to be the area of the flame covered surfaces, i.e. the sum of the openings, such as windows, within the boundaries of a fire compartment and the flaming area due to combustible finishes. If the building is internally divided into compartments the fire size will be limited to a single compartment on the assumption that the fire will be contained by the compartment boundaries. For sake of simplicity fires are divided into two groups for estimating the intensity of radiation from the openings, the normal intensity fires which radiate heat at 84 KW/m² from the openings and higher intensity fires which radiate at twice this rate. The combustible surfaces are unlikely to produce heat of this intensity and therefore their reduced contribution is reflected by only considering 50% of the combustible surface area. If the building is provided with a sprinkler system this will also have a reducing effect on the intensity of the fire which is assumed to be reduced by 50%.

11.9 The exposure hazard to the facade exists if the level of radiant heat it receives exceeds 12.6 KW/m². Spontaneous ignition will not occur at this level of exposure but if burning brand were present then the possibility of ignition of normal wood and wood based products exists.

11.10 The hazard to the roof surface is related to the nature of the surface material and the extent of its use. With non-combustible finishes there is no hazard of ignition from an external source but if combustible finishes or roof lights are provided then these could ignite and lead to a transfer of fire to the inside. If the whole surface is covered with combustible finishes then the building separation should ensure that these will not become ignited.

11.11 For adjoining buildings small projection of the compartment wall through the roof or the external wall is not likely to prevent flames from one building attacking the other. Either the projection has to be substantial or alternatively the part of the roof next to the compartment wall to be constructed of non-combustible materials.

REQUIREMENTS
Notional boundary

11.3 The requirements for the external surfaces and building separation are related to the distance which separates buildings. A notional boundary is assumed to exist for this purpose which in some cases may be the actual boundary between buildings. Where buildings adjoin each other the notional boundary is the compartment wall separating the buildings. Where buildings are separated a notional boundary may be the centre of a street or road or some other natural barrier such as a stream. Where two different properties already exist the notional boundary is the actual boundary between the two. If the buildings are on the same site then the notional boundary is an arbitrary line to which each building has to refer for the separation distance depending on its use and openings, Figure 11.1.

11.4 The notional boundary has to be considered for each side of the building and it is usually parallel to the external wall but may make an angle of 10° or less.

Unprotected area

11.5 The unprotected area for an external wall is the aggregate of actual or assumed openings and parts of the wall with inferior fire resistance. If the building is not compartmented then the whole surface of the wall on a given side of the building is considered for calculating the unprotected area. If a building is compartmented with compartment walls and/or floors then each compartmented part of the external wall is considered separately to establish the unprotected areas.

11.6 In estimating the unprotected area the sizes of all windows are aggregated unless these are provided with fire resisting glazing. For fire resisting glazing of an insulated type the window area is completely ignored, for non-insulated fire resisting glazing only 50% of the window area is taken into account. If the external wall is of a non-fire-resisting type or has less fire resistance than required by Chapter 9 or this chapter, the whole of such a wall is considered to be an unprotected area. Small openings for ventilation and other purposes can be ignored provided each opening is not more than 0.1m² and separated from other openings by a distance of 1.5m. The aggregated area of such openings should not exceed 10% of the wall surface, Figure 11.2.

11.7 If a fire resisting wall has a combustible cladding 50% of such an area is also taken into account as an unprotected area. Where a protected shaft or stairway exists the part forming the external wall is not considered for estimating unprotected areas.

Separation of window openings

11.8 In order to minimise the possibility of external fire spread the space between the top of a window opening and the bottom of the window above shall be separated by a non-combustible construction. The separation shall be at least 1m across a compartment boundary and at least 0.5m in all other
cases, Figure 11.2. If the windows are nearer than this distance a horizontal separation, e.g. a balcony of non-combustible construction shall be provided.

11.9 Where the top of a window opening is less than 0.5m from the ceiling the surface the finishes near the window shall not be inferior than Class A or B.

**External wall close to the boundary**

11.10 If an external wall is 1m or less from the boundary it is assumed to be virtually on the boundary and it shall then be provided with fire resistance appropriate for the building according to Chapter 9. A non-fire resisting construction is allowed if the wall is non-loadbearing, can be treated as unprotected area, is more than 1m from the notional boundary, and is not protecting another fire resisting element.

11.11 Any external cladding on a wall which is 1m or less from the boundary or more than 15 m in height shall be non-combustible. Other walls may have a combustible cladding provided it is not inferior than Class B and the distance from the notional boundary is not less than necessary for the area covered by combustible cladding to be within limits of the permissible unprotected area.

**Distance from the boundary**

11.12 Small residential buildings in categories A and B, up to 3 storeys in height and not more than 24 m in any one dimension, shall be located so that the distance to the boundary is at least that given in Table 11.1.

<table>
<thead>
<tr>
<th>Unprotected area (not more than - m²)</th>
<th>Distance from boundary (not less than - m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>&gt;30</td>
<td>6</td>
</tr>
</tbody>
</table>

11.13 Table 11.2 gives the distance from the boundary of other buildings which are not more than 10 m in height or which are internally compartmented so the height of any compartment is not more than 10 m.
11.2. The height restriction does not apply to open-sided car parks. The unprotected area is calculated as percentage of the appropriate wall area.

**TABLE 11.2 MINIMUM DISTANCE FROM BOUNDARY FOR SMALL BUILDINGS**

<table>
<thead>
<tr>
<th>Unprotected area not more than -%</th>
<th>Building category A,B,E,F,G1,I,H,K1</th>
<th>Building category C,D,G2,K2,J2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>no restriction</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>40</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>60</td>
<td>7.5</td>
<td>15</td>
</tr>
<tr>
<td>80</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>100</td>
<td>12.5</td>
<td>25</td>
</tr>
</tbody>
</table>

11.14 If the building is provided with a sprinkler system the values for boundary distance shown in Table 11.2 may be reduced by 50% but should not be less than 1 m in any case.

11.15 It is possible to make more precise calculation of the safe distance from the boundary by calculating the configuration factor of the radiating wall and the radiation received by a mirror image wall across the boundary. Reference is made to a publication in Chapter 19

**Roofs**

11.16 The roof covering shall not be inferior than the grade shown in Table 11.3 for the distance from the boundary of a building from any side where an adjacent building exists or may be built. The grade of the roof covering is determined by the test procedure described in Chapter 19. Where the boundary is a street, a road or a stream the distance to the boundary can be taken to the centre of the separation.

**TABLE 11.3 MINIMUM DISTANCE FROM BOUNDARY FOR DIFFERENT ROOF COVERINGS**

<table>
<thead>
<tr>
<th>Grade of roof</th>
<th>≤ 5m</th>
<th>≤ 10m</th>
<th>≤ 15m</th>
<th>&gt; 15 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
11.17 Where two buildings are adjoining with a common compartment wall the roof covering within a distance of 1.5 m from the boundary shall be of grade A.

11.16 If roof lights are provided in the roof they shall be either tested for their grading or if they cannot be graded due to their thermo-plastic nature the amount shall be restricted. Each roof light can have a maximum size of 5 m² and it shall be separated from an adjacent rooflight by a distance of at least 3m. This restriction shall also apply to the distance of the rooflight from the edges of the roof and the compartment wall or any other fire resisting barrier, Figure 11.3.
CHAPTER 12

FIRE CONTROL EQUIPMENT

OBJECTIVE

12.1 Adequate fire control facilities shall be provided which can deal with a fire incident as it starts by the provision of on-site fire control devices such as portable extinguishers, hose reels or fixed fire extinguishing systems. These shall take into consideration the level of risk and the needs arising from the use of the buildings.

BACKGROUND

12.2 Most fires start in a small way by the ignition of a combustible content which makes contact with a heat source. If the occupants become aware of a fire at an early stage it can be extinguished easily by the help of a portable device. Some experience is needed in effectively handling portable extinguishers and in the hands of trained personnel they have been shown to be very effective. With untrained people the chances of their effective use are more limited.

12.3 Different types of portable extinguishers are available for dealing with different fire categories, the major types are listed below:

<table>
<thead>
<tr>
<th>Extinguishing media</th>
<th>Category of fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Class A (normal combustible materials e.g. wood, cloth, paper)</td>
</tr>
<tr>
<td>Foam, protein</td>
<td>Class B (flammable liquids, petrol, paint, paraffin, oils, grease etc)</td>
</tr>
<tr>
<td>Foam, AFFF type</td>
<td>Suitable for Class A &amp; B fires</td>
</tr>
<tr>
<td>Powder</td>
<td>Classes A &amp; B, and electrical equipment</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>Class B and live electrical equipment</td>
</tr>
<tr>
<td>Halon</td>
<td>Class B fires</td>
</tr>
</tbody>
</table>

12.4 In most occupancies of residential type and others where people work in offices, shops etc, water and powder type extinguishers are adequate for the majority of fires. In industrial applications other more appropriate type extinguishers would be needed selected to deal with the expected type of fire and the materials involved.
12.5 Portable extinguishers have only a short operating time, a few minutes only, and where more persistent application of water is foreseen a hosereel provides a better means of controlling fires. They can be for the use of the occupants or the fire services when they arrive on the scene and find that the fire does not require the application of large quantities of water. A standard fire hose is not suitable for use by occupants of a building and can not be substituted for a hosereel.

12.6 In situations requiring an automatic response a fixed installation needs to be provided which comes into operation once the fire reaches a certain size. The most common fixed installation is a sprinkler system which sprays water on a fire once it reaches the size to cause fusible links or other operating mechanism to function. The capacity of the system is related to the expected size of the fire which is usually expressed on a hazard scale such as, extra light hazard, ordinary hazard or heavy hazard.

12.7 In special cases of fire risk other types of fixed installations may be required such a carbon dioxide systems, foam systems or Halon injection systems. Due to concern with the environmental consequences of releasing CFCs into the atmosphere the use of Halon systems should be strictly restricted to special situations where no other alternative is available.

12.8 The design and the choice of a suitable system is outside the scope of this Code, the information on these aspects is contained in the appropriate codes of practice. The regulations draw attention to the situations where such systems need to be provided and design of such systems should be to the satisfaction of the fire authority.

12.9 The facilities required by the Fire Brigade for fire control & rescue purposes are additional and are dealt with in Chapter 13.

REQUIREMENTS

12.10 All buildings to which public has access, except category A buildings, having occupant capacity of [20] or more shall be provided with portable fire extinguishers. These shall be of the type suitable for general risks, e.g. water based and/or of powder type. They shall be located near exits or stair entrances in a conspicuous position mounted on a wall such that they can be easily removed for use. If other equipment is also provided such as alarm call points, hose reels, the location, known as a fire point, shall be clearly marked and visible from a distance.

12.11 In buildings with multiple escape stairs, the fire points shall be provided near each entrance to the stairs or the lobby. Buildings with long corridors shall have additional fire points in corridors so that an extinguisher is within a distance of 30 m from the position of any occupant.

12.12 Buildings of industrial type, car parks and certain storage buildings shall have extinguishers of a suitable type in relation to type of fire expected in that location. Where more than one type is provided together they shall be
clearly distinguishable from each other. Space around the extinguishers shall be kept clear and no obstruction placed to make access to them difficult.

12.13 In special risk areas, such as kitchens, extinguishers of powder and/or foam type will be found to be more suitable. Where the possibility of an electric fire exists or heavy electrical equipment such as switchgear is installed no water based extinguishers shall be located.

12.14 In buildings with an occupancy loading of 50 or more people, hose reels shall be installed at each floor level, near to the escape stairs. The type of hose reel shall be suitable for the occupancy and hose length shall not be less than [30] m and their location such that all points on a floor are within the range of application of the water jet. Hose reel installation shall be at a height of 1-1.5 m from the floor and their position clearly marked.

12.15 The provision of a fixed extinguishing system is required only in a few specified cases listed below. In other situations it may be provided to obtain concessions on compartment size or fire resistance, or to gain more favourable fire insurance premiums. A fixed fire extinguishing system is required for;

a. Underground car parks with floor area in excess of [1000] m²,
b. Electrical switchgear or transformer stations for high rise buildings,
c. Stores containing flammable materials in excess of 1000 MJ when not provided with fully fire resisting barriers,
d. Shops in a shopping complex without full compartmentation,
e. Area surrounding an atrium without a fire resisting separation.

12.16 The choice of the system shall be in accordance with the appropriate design codes for such systems.

12.17 Provisions shall be made for the regular upkeep and maintenance of all active fire protection systems. The management shall keep records of inspection and maintenance work carried out on such systems. In large buildings the management shall have staff trained in the use of portable extinguishers and fire hoses.

12.18 If the fixed extinguishing system is undergoing repairs or modifications such that it is not available fo the whole or part of a building, the management shall make special provision for continuous surveillance of the premises and provide additional portable extinguishers. The fire brigade shall be informed if the fixed system is expected to be out of use for more than a week.
CHAPTER 13

FIRE SERVICE FACILITIES

OBJECTIVE

13.1 Buildings shall be provided with facilities for fire brigade access to facilitate rescue and fire control and, where necessary, protected areas shall be provided within buildings from which rescue and fire control activities can take place.

BACKGROUND

13.2 Fire brigade personnel are trained to rescue people from buildings in case of fire and to undertake fire control activities. In order to facilitate this work it is essential to ensure that the fire service personnel and equipment can reach the building after an alarm has been received. In large buildings where it may be necessary for the personnel to enter the building safely, protected zones should be available from which rescue and control operations can be carried.

13.3 In the case of small buildings access to a nearby hydrant should be available from which hoses can be run to the site. However for larger buildings the fire appliances need to get right up to the building. These may be pumping appliances, tankers, turntable ladders and hydraulic platforms depending on the equipment the fire brigade possesses and the severity of the fire. A strong base and clear space is needed to permit the appliances to get close to the building.

13.4 The size of the building will determine the number of sides from which the fire appliances should be able to approach the building. Whilst approach from one side may be sufficient for small buildings for large ones the possibility of fighting a fire from all sides has to be considered. The primary basis used for this purpose is the total floor area of the building.

13.5 For tall buildings it is necessary for protected zones to exist inside the building within which the fire personnel are safe. These are known as fire fighting shafts and contain fire fighting stairs and have a specially protected lobby known as fire fighting lobby at each floor level. In some cases they are also required to contain a fire fighting lift which has a protected electric supply to ensure their continued operation. The enclosure to the fire fighting shaft is designed to have a fire resistance of at least 120 minutes.

13.6 Where fire fighting shafts are provided they should contain water mains with connections for the attachment of fire hoses. For low rise buildings the mains may not be continuously charged with water which can be either turned on by the fire brigade or the main charged by the pumping equipment brought to the site by the fire brigade. However for larger buildings the mains
should always be in a charged state, known as wet mains, with provision for replenishment of water as necessary. The design of the mains should follow the appropriate standard for this purpose.

13.7 Rescuing people and fighting fires in basements presents special problems due to the limited access and to the tendency for the smoke to try to enter the escape routes. Except for very small basements it is necessary to provided means for the clearance of smoke from basements either by natural or mechanical ventilation.

**REQUIREMENTS**

**Acess to buildings**

13.8 Facilities shall be available for the fire appliances to get within 45m of a building of any size. For larger buildings access is needed close to the building, from one or more sides as shown in Table 13.1 if the building has no provision for fire mains.

**TABLE 13.1 ACCESS FOR BUILDINGS WITHOUT FIRE MAINS**

<table>
<thead>
<tr>
<th>Total floor area - m²</th>
<th>Height - m</th>
<th>Access from sides</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2000</td>
<td>≤ 10</td>
<td>one side (1)</td>
</tr>
<tr>
<td></td>
<td>&gt; 10</td>
<td>one side</td>
</tr>
<tr>
<td>2000 - 8000</td>
<td>≤ 10</td>
<td>one side</td>
</tr>
<tr>
<td></td>
<td>&gt; 10</td>
<td>two sides</td>
</tr>
<tr>
<td>8000 - 16000</td>
<td>Any</td>
<td>two sides</td>
</tr>
<tr>
<td>16000 - 24000</td>
<td>Any</td>
<td>three sides</td>
</tr>
<tr>
<td>&gt; 24000</td>
<td>Any</td>
<td>four sides</td>
</tr>
</tbody>
</table>

Note (1) For small buildings having a floor area of less than 2000 m² and height of ≤ 10 m access is only necessary to within 45 m from one of the building sides.

13.9 The side from which the access is available shall have an entrance door not less than 750 mm wide.
13.10 The vehicle access shall be available for the fire brigade equipment such as pumps, tunttable ladders and hydraulic platforms with the minimum sizes of the access routes shown in Table 13.2. Any projections in front of the building, balconies, decorations etc shall not interfere with the vehicle access to the building, Figure 13.1.

### TABLE 13.2 VEHICLE ACCESS ROUTE MINIMUM DIMENSION

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Min road width - m</th>
<th>Min gate width - m</th>
<th>Min turning circle - m (kerbs)</th>
<th>Min turning circle - m (walls)</th>
<th>Min clearance height - m</th>
<th>Min carrying capacity - tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump</td>
<td>3.7</td>
<td>3.1</td>
<td>16.8</td>
<td>19.2</td>
<td>3.7</td>
<td>12.5</td>
</tr>
<tr>
<td>High reach equipment</td>
<td>3.7</td>
<td>3.1</td>
<td>26.0</td>
<td>29.0</td>
<td>4.0</td>
<td>17.0</td>
</tr>
</tbody>
</table>

Note: Consultation shall be held with the fire authority to ensure that the minimum dimensions given above are adequate for the appliances currently available or being considered for future application.

13.11 If the building is provided with fire mains the essential need is for the pumping appliances to get close to the building, to a distance of at least 18 m from the fire main inlet connection point or replenishment point. For access for other appliances the need shall be established with the fire authority.

**Access within a building**

13.12 Provision shall be made for protected access for fire service personnel in all buildings according to the criteria in Table 13.3. All buildings above 15 m height and all basements deeper than 10 m shall be provided with a fire fighting shaft. A fire fighting lobby shall provide access to the fire fighting shaft, the enclosure designed to have a fires resistance of 120 minutes. The fire fighting shaft can serve a basement only, or above ground area only or both. Access to the shaft shall be available from each floor through which it passes, Figure 13.2.

### TABLE 13.3 PROTECTED ACCESS WITHIN BUILDINGS
13.13 The number of fire fighting shafts provided in the building shall be based on the floor area of the largest floor above 15 m height. With a building without a sprinkler system there shall be one fire fighting shaft for each 900 m² or part thereof of the floor area. If the building is provided with a sprinkler system the number of fire fighting shafts shall be according to Table 13.4

### TABLE 13.4 NUMBER OF FIRE FIGHTING SHAFTS IN A BUILDING WITH A SPRINKLER SYSTEM

<table>
<thead>
<tr>
<th>Largest floor area - m²</th>
<th>Number of fire fighting shafts</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 900</td>
<td>1</td>
</tr>
<tr>
<td>900 - 2000</td>
<td>2</td>
</tr>
<tr>
<td>&gt; 2000</td>
<td>2 + one for each additional 1500 m² or part floor area</td>
</tr>
</tbody>
</table>

13.14 The fire fighting shaft shall be located in such a position that the distance from the entrance to the fire fighting lobby and the furthest point served by that shaft is not more than 40 m in a direct line.

**Smoke control**

13.15 Provision shall be made to keep the fire fighting shaft reasonably clear of smoke. This may be achieved either by pressurising the shaft or by making provision for smoke removal from the shaft. Natural ventilation may be
provided by having an openable vent at the top of the shaft equal to 5% of the cross-sectional area with additional openable vents at each floor level equal to 15% of the cross-sectional area which can be controlled by the fire service personnel.

13.16 As an alternative a smoke shaft may be provided to serve the protected shaft and/or the lobbies. The smoke shaft should have an internal size of 3 m² or 25% of the lobby floor area when serving lobbies and the stairways or 1.5 m² or 15% of the stairway if serving the stairway alone. The shaft shall be fully open at top and bottom or be openable by linking to an automatic fire detection system.

Control of lifts

13.17 The fire fighting lift may be used as a normal lift but under conditions of fire it shall return automatically to the access floor for use by the fire brigade. It shall have an over-ride switch which puts it under fire brigade personnel control. This switch shall be protected from use by unauthorised persons. All normal lift controls outside the lift shall be rendered inoperative when the special switch is operated and the lift will be manually controlled from within the lift car.

13.18 The lift shall be provided with protected electric supply from a separate source which remains available in case of a fire. No fault in any other lift circuit shall render the fire fighting lift in-operative. In special cases the lift may be served from a separate stand-by supply.

13.19 The lift car should have a minimum capacity of 8 passengers or load capacity of 630 kg, a floor area of not less than 1.1 m x 1.4 m with an entrance door at least 800 mm wide. Fuller details for fire fighting lifts and shafts are given in the standard referenced in Chapter 19.

Fire mains

13.20 All buildings which are provided with fire fighting shafts, with or without a fire fighting lift, shall be provided with rising fire mains. The fire mains shall be adequately sized for the supply of water to the fire service hoses.

13.21 The rising fire main shall be fully charged at all times if the building height is more than 30m. In other cases a dry main capable of being charged by the pumping appliance may be provided. At the access level, usually the ground floor, the dry main shall be provided with connection for the pumping appliance. The wet mains shall have a replenishment connection at the access level if it is necessary to further charge them.

13.22 The wet rising mains shall be initially supplied from the normal water supply if enough water flow is available or from a local pump and/or a high level tank in the building.
13.23 The rising mains shall be located in the fire fighting lobby of each fire fighting shaft with suitable connectors for the fire hoses. The water supply for the rising mains shall be separate from that of a sprinkler system if one is provided.

**Smoke venting from Basements**

13.24 All basements shall have provision for the clearance of smoke in case of fire except for small basements which,

a. are in apartment buildings and not used for car parking,

b. have floor area less than 200m²,

c. are not more than 3 m deep.

13.25 Basements up to 900m² in area can be provided with natural ventilation provisions by means of ducts or grills connected to the outside at the perimeter. They shall discharge to the outside through vertical outlets located away from the front door or other exits to be used for escape purposes.

13.26 Each basement level shall have separate smoke outlets. The aggregate area of the outlets for any one floor shall not be less than 2.5% of the floor area of the basement they serve. Special fire risk areas shall be provided with separate smoke exits.

13.27 Mechanical ventilation may be provided, in conjunction with a sprinkler installation, if provided. The system shall be designed to provide at least 10 air changes/hour. All ducts and other equipment shall be capable of operation at a temperature of 400°C for at least 60 minutes.

13.28 The air extraction system should come into operation on the occurrence of a fire either by means of an automatic detection system or when the sprinkler system operates.

13.29 Basement car parks are required to be provided with an extract system for clearing the fumes. This may be used as a smoke extract system under fire conditions provided it satisfies the requirements in 13.27 & 13.28.
CHAPTER 14

SPECIAL RISK AREAS

GENERAL

14.1 In most buildings there are areas where special risks are present due to the nature of the use or the activity carried out. The special risk may be due to hazardous fire loads, fuel and power supplies or the heat generating equipment. Usually such areas present additional risk to that associated with the building and therefore extra precautions need to be taken. This chapter highlights some of the common risks, others may exist which require discussion with the fire authority to see if other safety provisions are needed.

ELECTRIC POWER SUPPLIES

14.2 Most large buildings require electric supply to be brought in at a low level, may be in the basement, and then redistributed to various parts. Often the supply may be brought in at high voltage and the voltage reduced by transformers for the normal equipment in use. In some cases there may also be other electrical apparatus like large fan units or pumps or similar appliances requiring heavy cabling. There will also be associated switchgear to go with the supply and the equipment.

14.3 It is important that these areas are isolated from the rest of the accommodation for normal safety and fire protection purposes. They should preferably be located external to the building or against an external wall so that entry from outside is possible. In buildings with occupancy levels of more than [200], other than in industrial occupancies, such areas shall be separated from the rest of the accommodation by fire resisting construction having at least [90] minute fire resistance but not less than that specified for the rest of the building. Where such areas are not under continuous supervision of trained staff they shall be provided with an automatic fire detection system. In large installations, exceeding [10 MW] a fixed extinguishing system is desirable.

FUEL STORAGE

14.4 Where large quantities of fuel are required to be stored the storage facilities shall meet the standards laid down for that type of fuel, e.g. petroleum, diesel or LPG. If the quantity stored is more than [5000 litres or 1000 MJ fire load] the tanks shall be in a protected enclosure away from the building or on the outside so that external deliveries can be made. The storage area shall be separated from the rest of the building by a 120 minute fire resisting construction. It shall be ventilated to the outside to prevent accumulation of flammable vapours.
14.5 The separated and unattended areas shall be provided with an automatic fire detection system to warn the management of a fire incident. It is recommended to provide a suitable fire extinguishing system appropriate for the nature of the fire load.

STORES FOR FLAMMABLE GOODS

14.6 In a number of occupancies flammable goods need to be stored for either usage in the building or as a part of the manufacturing process. In industrial applications special rules will be applied by the appropriate authorities for the safe handling and storage of such goods. In other buildings if large quantities are to be stored, i.e. in excess of 10 litres of liquids or 10 kg of solids, special storage cupboards shall be provided so that only small quantities are withdrawn at a given time.

14.7 Large stores of flammable goods shall be separated from the rest of the building by fire resisting construction and if the area is larger than 100 m² it shall be provided with an automatic fire detection system linked to a central control panel. In some cases it would be desirable to provide an automatic extinguishing system suitable for the type of contents. In theatres and similar buildings similar precautions are required for the rooms where scenery is stored or manufactured.
CHAPTER 15

LARGE AND COMPLEX BUILDINGS

GENERAL

15.1 Fire safety regulations which have been specified in the previous chapters has assumed some general risk levels with certain types of occupancies and dealt with the conventional types of buildings even though some of them may be tall. It is possible to find buildings now which are not easy to classify in terms of their hazard using the traditional approaches due to their complex layout and particularly the multi-purpose use of space. Such occupancies need to be examined for the risk to the occupants and the appropriate safety provisions on an individual basis. They may not present a greater hazard but may still require a different combination of protective measures. Three types of buildings have been identified in this connection but there may be others which require the designer to consult with the safety authority at an early stage of development. It is not intended to provide a full design solution to the problems in this chapter but to draw attention to the issues and suggest sources of information.

SHOPPING MALLS

15.2 Single and multi-storey shopping malls are large shopping areas with a cover to provide a comfortable environment for the shoppers. Unlike the traditional shopping streets the shops have mostly open fronts leading to a circulation area with means of communication to other levels and other shopping streets. In case of a fire in a shop the smoke will emerge from the shop front and enter the circulation area travelling to other parts depending on the layout of the building. It will rise to the highest part and the smoke layer will deepen if it cannot escape to the outside. The flames from the fire will also attempt to spread to other parts of the shopping mall.

15.3 Smoke in the mall or the circulation areas is the main problem affecting the safety of occupants and the ability of the smoke to rise to upper levels and spread laterally can make the entire area unsafe in a short time. Problems associated with smoke movement and smoke control in such occupancies have been studied and design guides have been developed for this purpose. In addition to smoke control other fire protection provisions will need to be considered. Such occupancies will benefit from the use of a fire engineering approach looking at total risk and developing an integrated fire safety system.

MULTI-USE OCCUPANCIES

15.4 Part use of a building for a different purpose than its main category has been referred to in Chapter 4 on building categorisation. Usually this means
that part of the building may be a car park or shops may exist at one or two lower levels whilst the rest of the building is an office. There is usually a clear demarcation between different parts and their layout.

15.5 A new type of development which has been taking place concerns the conversion of old large buildings or the construction of new ones with multiple uses such as shopping areas, entertainment areas, conference facilities, sometimes with hotels and restaurants. Entertainment may consist of cinemas, theatres, clubs etc. The layout of many such buildings is intentionally inter-linked so that customers can move from one facility to another without leaving the complex. Such occupancies present a mix of risks under one roof.

15.6 The most important consideration is to provide adequate means of escape for all occupants and at the same time to keep different occupancies separate from each other. The escape route from a hotel or an office should not be common with that from a cinema. The separation of escape areas and the application of differing requirements for each category of occupancy is an essential design consideration for such buildings. Because of the mixing of occupancies and of the occupancy levels such complexes should be provided with an automatic fire detection systems designed in such a way that phased evacuation concept can be applied. If there are large number of interlinked circulation areas it may be necessary to consider facilities for fire control by a fixed suppression system, as well as automatic mechanical smoke control systems to keep circulation areas clear of smoke.

15.7 Proper procedures for fire safety management will be essential for a complex of this type with a core of trained fire safety personnel on duty all the time the facilities are in use. A fire safety manual should be prepared to highlight the essential safety features and specify the actions to be taken once a fire is detected. Constant surveillance is essential in such a facility to cut down the number of fire accidents.

ATRIA BUILDINGS

15.8 The provision of atria in multi-storey building has gained popularity over the recent years. An atrium has become a design feature of certain types of hotels and office buildings and has found great architectural favour. Basically its existence may be seen to contradict the concept of separation between different floors in a building as it provides a common space between different areas. Concern has been expressed the effect this may have on the spread of smoke and fire were a fire to enter the atrium area.

15.9 If a fire occurs in an area open to the atrium the smoke will enter the atrium space and rise upwards. In its movement upwards it will trap air, become diluted and lose buoyancy, tending to spread sideways before reaching the top. If the smoke is unable to escape from the top of the atrium it will spread sideways and deepen spilling into the adjacent floor areas.
15.10 If the atrium can be fully enclosed, by glazed screens of fire resisting type, then the spillage of smoke to other areas can be prevented. There will be still need to evacuate the smoke which enters the atrium shaft. However such a closure is architecturally not always acceptable and other means have to be found to control the spread of smoke. Partial closure at high level and suitable smoke extraction and air replacement systems can ensure that for specified fire sizes smoke can be dealt with effectively, Figure 15.1. Additional measures are also worth considering for inclusion such as automatic fire detection, sprinkler control in rooms close to the atrium, design of escape routes such that occupants move away from the atrium to protected routes, are some of the measures which can be examined. Each atrium presents its special problems and needs a fire safety system tailored to its particular characteristics.

15.11 The type of unusual and complex buildings described in this chapter require different approach for the provision of fire safety in comparison with traditional occupancies. The fire safety issues need to be considered for each individual risk and the fire safety system designed to meet the particular characteristics of the building. It is suggested that the fire safety provisions should consider the following issues and prepare a package of measures for discussion with the safety authority. A number of publications are available which can provide the technical background to the design of the safety system.

a. Control on the use of combustible goods and fittings in the common circulation areas,

b. Automatic fire detection system,

c. Fitting of automatic sprinkler systems in shops and other areas where fire control is needed,

d. Sub-division of circulation areas with well sign posted escape routes,

e. Provision of smoke reservoirs in the roof space of large open areas to limit the spread of smoke,

f. To provide smoke curtaining in multi-storey malls for directing the smoke towards the roof,

g. Provisions for the clearance of smoke from the circulation areas and escape routes by natural or mechanical extraction systems,

h. Adequate means of escape, separate provisions should be made in multi-occupancy buildings for each part,

i. Well illuminated signs should show the escape routes, all advertising signs to be switched off on the occurrence of a fire,

k. First-aid fire fighting measures,
1. Well trained staff to guide people to safety,

m. A fire safety manual should be prepared for the building and agreed with the fire authority. The manual should give information on the fire safety provisions and highlight actions and responsibilities in case of fire.

1512 Some useful publications are available which may be used for the design of some of these systems. The next section lists some in connection with the use of fire engineering.
CHAPTER 16
FIRE SAFETY MANAGEMENT

OBJECTIVE

16.1 In order to ensure that fire safety provisions provided in the building are maintained during its use and that in case of a fire pre-planned actions will be taken to safeguard the occupants.

BACKGROUND

16.2 The design of fire safety in a building comprises a number of measures concerning the layout of building, its construction and other provisions, some of which come into operation on the occurrence of a fire. When the building is occupied it is subject to normal wear and tear and it is necessary to ensure that this does not distract from the effectiveness of the constructional features which have been provided. This is particularly important for those measures which come into operation on the occurrence of a fire, such as detection and extinguishing systems which need to be kept in an operational state at all times.

16.3 In buildings of health, institutional, assembly and commercial types and those with large number of people present or with special escape needs, it is necessary to have pre-planned procedures to deal with a fire emergency. This includes having trained staff who can deal with the emergency situation, provide assistance with the evacuation of occupants and guide the fire services on arrival.

REQUIREMENTS

16.4 The buildings categories which are considered to require a fire safety management system are listed in Table 16.1. The provision of fire safety management should be considered during the design of the building and shall be available when the building is occupied.

16.5 The management of the building shall consider fire safety management under the headings listed below. It should be the purpose to set up a system, incorporated in a manual agreed with the fire authority, which lists the essential components of the system.

Appointment of a fire safety manager
Fire prevention & surveillance measures
Upkeep of fire protection facilities
Maintenance of fire protection systems
Trained staff
Fire drills and Emergency plan
16.6 The management should appoint a senior person as a fire safety manager who has the direct responsibility for the observance of the fire safety procedures, keeping a check on maintenance needs and ensure that staff are conversant with the safety procedures and the occupants carry out their work in a safe manner particular where handling flammable products or hazardous equipment.

16.7 It is essential to ensure that care is exercised in the normal use of the building to prevent the occurrence of a fire paying particular attention to the disposal of rubbish, prevention of smoking where prohibited, proper repair of heating and energy consuming apparatus particularly in kitchens etc.

16.8 All fire protection facilities, particularly fire doors, should be kept closed unless provided with automatic closer systems, escape stairs remain available and are well marked, any damage caused to a fire barrier is quickly repaired.

16.9 All fire detection/alarm systems, fire extinguishers, hose reels etc should have a maintenance schedule prepared and records kept of their inspection and rectification. If repairs have to be carried out additional safety provisions should be made whilst the facility is out of commission. This may require temporary measures including increasing the number of security staff. If a sprinkler system has to undergo extensive repairs the advice of the fire brigade should be obtained on extra precautions needed when the system is out of commission.
16.10 In buildings with large population, high rise buildings etc it is necessary to organise regular fire drills for the staff to ensure that they remain aware of the appropriate means of escape, the location of exits and the routes they are expected to follow.

16.11 Trained staff should be provided in large building who will assist the safety manager in ensuring the maintenance of the fire safety systems, keep a watch on fire prevention and assist occupants to make their escape.

16.12 The management should have plans to deal with a fire emergency detailing actions to be taken and responsibilities of the staff, evacuation procedure to be followed, fire control provisions and assistance to be given to the fire brigade on their arrival. The plan should be discussed with the fire brigade and their agreement obtained on the proposed procedures.
17.1 Regulations for fire safety provided in the earlier chapters make certain assumptions about the use of the building, the level of fire risk and the relationship with fire safety measures. In an attempt to keep the system simple and easy to follow a number of simplifications are made at all levels. Generally the requirements tend to be appropriate for the majority of situations in a given category but not all. Ideally the regulations should consider the unique nature of each building and its use and tailor the requirements to that particular need. This is neither feasible nor necessary for a generalised approach.

17.2 To ensure that the safety requirements are appropriate for each case the code permits the use of alternative solutions which can be formulated to meet the precise needs of a particular building. One such method is by the application of fire engineering principles and procedures to achieving fire safety. Fire engineering implies making an assessment of the expected fire hazard in a building from a detailed knowledge of its use and to devise a specific fire safety package for that usage. In order to achieve this objective it is necessary to have available the necessary technical expertise and full details of the building use.

17.3 Over the last decade much development work has been carried out on development and the application of fire engineering procedures but the technology is being developed. Nevertheless designers need to be given the opportunity to use those parts of the technology which are available to develop application expertise. In addition there are newer developments in the building field which cannot be adequately dealt with by simple rules and require the use of engineering methodology for a cost-effective design. Large complex buildings and buildings with atria are examples of such constructions.

17.4 A complete fire engineering approach to a building requires the consideration of the potential fire risk, the hazard it will create for the occupants and the design of suitable solutions to reduce the hazard to an acceptable level. Assessment of the risk requires a knowledge of the use of the building and statistical data on the historical record of incidents. Fire hazard assessment can translate this information into a potential fire model for the building. Fire engineering methodology can be used to consider various provisions that can be made and their effectiveness calculated.

17.5 A typical package of measures for fire safety can consist of the following 10 components:
Management of fire safety
Prevention of fire
Detection of fire
Control of growth rate
Control of smoke movement
Provision of means of escape
Protection of the structure
Means for fire containment
Provisions to control fire
Facilities for fire fighting

17.6 It may not be necessary to incorporate all of these measures into a given design or to attach equal importance to them for every building. But the measures need to be considered and a choice made of those which are essential and the level of importance to be attached to them. The total approach permits adjustments to be made in a given if a particular measure can not be incorporated. A system for co-relating different measures is under development.

17.7 Progress has been made in the development of engineering based calculation methods for some parts of the system and the design engineers can make use of these in place of prescriptive requirements where an alternative approach is needed. If a designer does select to do so it is his responsibility to provide full information on the methodology used, its relevance to the problem and to convince the safety authority that the alternative solution can achieve at least the same level of fire safety as the more traditional approach.

17.8 The areas where progress has been made in the application of fire engineering techniques are:

- Fire growth pattern
- Movement of smoke and heat
- Escape of people from buildings
- Methods for smoke control
- Assessment of potential fire severity
- Behaviour of structures under fire conditions

17.9 The following is a brief list of publications which give information on calculation methods which can be used for fire engineering purposes.

a. The initial convective flow in fires - Heskestad G - 1979

b. Two layer modelling of smoke movement in building fires - Zukoski E E - 1980

c. A computer program for calculating safe egress time - Cooper L Y, 1985

d. Design principles for smoke ventilation in enclosed shopping centres - BRE 186/1990 - UK
e. Smoke management systems in malls, atria and large areas - 1991 edition - NFPA 92B - USA

f. Design guide structural fire safety - Fire Safety Journal - March 1986

g. Structural Eurocodes on concrete, steel, concrete & steel, timber and masonry - EN 1991-96 Parts 10, to be published by CEN.
CHAPTER 18

EXISTING BUILDINGS

GENERAL

18.1 The provisions given in the previous chapters of the Code are primarily intended for new buildings. There are instances where an existing building undergoes alterations and therefore becomes subject to regulatory control. In some cases it may not be possible to make structural changes to the building to satisfy the appropriate requirements. There are two possibilities to ensure that the building will provide an acceptable level of safety, to consider the whole building and assess its safety by using the fire engineering approach given in Chapter 17. Alternatively where only one fire safety component is not adequate to consider strengthening another complementary component.

RECOMMENDATION

18.2 Make an assessment of the fire safety measures in the existing building under the headings used in these regulations, i.e.

Fire prevention
Fire growth control
Detection & alarm
Means of escape
Structural stability
Compartmentation
External fire spread control
On-site fire control
Fire brigade facilities.

18.3 Identify the components which are either missing or deficient. The first consideration should be to examine the possibility of introducing additional features for the missing or deficient components. If not then consider the possibility of improving the other components to compensate for the shortcoming.

18.4 It is usually not difficult to install fire control equipment in an existing building but not easy to make structural changes. If combustible materials can not be replaced, they can be covered with a layer of a non-combustible material or treated with a fire retardant to make them safe.

18.5 If the wall and ceiling surfaces are below the specified standard they should either be replaced or protected with suitable lower flammability product. In some cases it may be possible to apply a flame retardant surface
coating which can improve the flammability characteristics. Care is necessary to select a durable treatment.

18.6 Shortcomings in means of escape can be a typical problem with existing buildings where either the travel distances are excessive or the escape route sizes can not deal with the occupancy level. Protection of part of the existing routes may be examined, if no protected lobby exists but one is required, perhaps this can be compensated for by protecting any corridor linking with the escape stairway. The fire resistance of the corridor and the doors in the corridor may be increased so that it becomes a protected area. Excessive travel distance can also be reduced by providing additional doors in the route to act as barrier to the passage of smoke. The performance of doors to the exits or stairways can be improved by fixing better quality doors.

18.7 If the number of exits or the escape stairways is not adequate it is difficult to completely compensate for this by other means. The provision of automatic detection and alarm system and particularly the provision of on-site fire control system, such as a fire response sprinkler system, will provide extra escape time which in some cases may be sufficient for life safety purposes.

18.8 If structural stability and/or compartmentation is not adequate then the provision of a sprinkler system may become necessary. Structural stability can sometimes be improved by the application of additional protective materials but if this is not possible it will be necessary to consider the provision of a suitable sprinkler installation.

18.9 Main problem with the external fire spread issue is likely to be the closeness of the building to the boundary. If this is a serious problem due to either a large opening factor or combustible cladding on the outside, then consideration should be given to the use of fire resisting glazing in the openings and the covering of the cladding with suitable material. In exceptional cases sparge pipes may be fitted to the openings.

18.10 On-site fire control facilities can be provided, usually without difficulties, in existing buildings and if these are of automatic type they can be relied on to reduce the severity of a fire. It should also be possible to provide improved access facilities for the fire brigade. If this can be coupled with the provision of water mains the problem of fire control may be less significant.

18.11 If there is a significant change of the building from low occupancy levels to high occupancy levels, e.g. converting an old warehouse to a shopping centre or an entertainment centre, it will become necessary to introduce a system of fire safety management. If the usage will require constant vigilance it is important to provide surveillance of the fire safety provisions and to provide trained staff to assist with the safe evacuation of occupants. They could furthermore provide the first line of defence by the use of on-site fire control appliances.
18.12 Each case of an existing building has to be examined to determine the best combination of fire safety measures to achieve the required level of safety. If additional features are not possible more substantial structural changes can become necessary.
CHAPTER 19

DETERMINATION OF FIRE PERFORMANCE & INSTALLATION STANDARDS

GENERAL

19.1 The Code makes frequent reference to the grading or the classification of materials or structural elements to be used in buildings. The performance of the materials or other products is determined by subjecting samples to the standard tests devised for this purpose. The tests given for this purpose are primarily those issued by the Brazilian Standards Organisation, however these do not at present cover the complete field of fire testing and therefore reference is also made to the procedures issued by the International Standards Organisation (ISO) and some other equivalent national organisations such the British Standards Institution (BSI) and the American Society for Testing Materials (ASTM).

19.2 It is also possible for the fire testing laboratories or expert fire engineers to make an assessment of the suitability of certain materials or constructions to meet the requirements of the Code. Where this approach is used the laboratory or the engineer must provide technical support for his assessment and the methodology used to the satisfaction of the approving authority.

NON-COMBUSTIBILITY

19.3 Building materials and many other products can be divided into two categories, combustible and non-combustible. Non-combustible materials make little or no contribution to the growth or development of a fire and are therefore safe to use in the construction and furnishing of buildings. These materials are basically inert but may contain a small amount of organic materials provided these do not increase the hazard due to the use of the materials.

19.4 Non-combustibility of a material or product shall be determined by subjecting samples of the material to the test specified in ISO 1182 in the absence of a suitable Brazilian Standard. To qualify as non-combustible the material must not flame during the test and the temperature of the furnace thermocouple should not rise by more than 20°C during the test. Completely inert materials such as metals, concrete, masonry, glass are inherently non-combustible.

FLAMMABILITY

19.5 The hazard presented by combustible materials in use depends on their flammability, i.e the degree to which they decompose, produce heat and other products undesirable products such as smoke and toxic constituents on their decomposition. Combustible materials range in their hazard from slight, inert
materials with small organic content, to highly hazardous products. The flammability characteristics are linked to the nature of the product and its use in a building. For this purpose a large number of tests are available which are related to the way in which the product is likely to be employed.

Linings

19.6 Linings are controlled under the regulations for their flammability characteristics which influence the rate of growth of a fire. They are classified into three groups for this purpose known as Grades A, B and C. The grading is established by the procedure specified in NBR 9442 which is identical to ASTM E 162.

Grade A - Fire spread index 0 to 25
Grade B - Fire spread index 26 to 75
Grade C - Fire spread index 76 to 150

Non-combustible materials automatically qualify for Grade A.

19.7 For test purposes the lining material should be examined in the largest thickness to be used and with the surface finish of the type to be applied. In many cases the performance of the product can deteriorate if an unsuitable finish is applied to the surface.

Floor Coverings

19.8 Floor coverings are examined for their flammability by a different test method in which the specimens are tested in a horizontal orientation. The test method used for this purpose is described in MB 3213 and the grading is defined as follows;

Class I - Flame spread not more than 400 mm @ 10 min,
Class 2 - Flame spread not more than 650 mm @ 10 min.

19.9 If plastics materials are going to be used they should ideally be subjected to the same tests as other materials. No problems are experienced with the testing of thermosetting plastics, i.e. plastics which do not soften when they are heated. Thermoplastics which soften on heating are difficult to test as they are not retained in position to be assessed for their flammability. Such materials are controlled in the amount that can be used and they must nevertheless possess low ignitability characteristics. For this purpose a small test is used specified in ASTM D 637-81 or BS 2782 Part 5 in the absence of a suitable Brazilian procedure..

Low flammability thermoplastic - the rate of burning not more than 25 mm
residual flaming not more than 5 sec.

Furniture and Furnishings
19.10 Special cases of occupancies where control is needed on the flammability of furniture and furnishings are typically represented by hospitals. Furniture, bedding and curtaining used in these occupancies should be resistant to ignition from small flames such as lighted match or a cigarette end. The following tests can be used for this purpose:

Ignitability of furniture - Resistant to ignition, glowing cigarette and heat source 3, [ISO 8191 Part 1 or BS 5852 Part 1].

Flammability of textiles - Rate of burning < xx mm [ISO 6940 - 1984]

**FIRE RESISTANCE**

19.11 Measurement of fire resistance of building elements such as walls, floors beam and columns is well recognised and both national and international procedures are available for this purpose. Test specification NBR 10636/MB 1192 are based on the international specification 834. The specification for fire doors is given in MB 564 which corresponds to ISO 3008. Tests are carried out on large size specimens, 3m or bigger, in specially made furnaces. More recently the international body, ISO, has been finalising specifications for specialised elements such as smoke control doors, fire dampers, ducts and fire penetrations.

19.12 In the fire resistance test determination is made of the ability of the construction to withstand high temperature exposure and retain its design functions for fire safety. Loadbearing elements must not collapse or become unstable, separating elements must prevent the transfer of fire from one side to the other. Fire transfer can take place either by the passage of hot gases or by the unexposed side becoming hot enough to cause decomposition of materials in contact. The first is determined by measuring integrity and second by determining insulation. The standard procedure measures the duration for which building elements retain these properties.

19.13 Fire resistance is expressed as the time for which the specimens satisfy the appropriate criteria in the test. This is the experimental time and should not be confused with the time for which a fire may last in a building. A relationship is assumed to exist between the two in terms of the consequences of exposure. The design objective is to ensure that the fire resistance time estimated for a building is such that the amount of damage to the building element is not more than that to be experience in a fire. Sometimes an additional factor of safety is added to minimise the chance of failure of a building element in a fire and retain the stability of the building after the fire.

19.14 Fire resistance requirements for various buildings have been expressed in standards steps with a minimum fire resistance of 30 minutes. The steps are 30, 60, 90, 120 and 180 minutes. The requirements for various buildings are expressed as the minimum time for which the proposed element should
satisfy the fire resistance requirements. Tables 9.1/9.2 gives the minimum requirements and table 9.3 shows the criteria which have to be satisfied.

19.15 Fire doors are assessed for two characteristics, their ability to resist the passage of fire as fire control doors and their ability to restrict the passage of smoke as smoke control doors. As fire doors are not expected to have combustible materials in contact under certain conditions of use the insulation criterion can be relaxed. This has been shown in Table 9.4. Smoke control doors are assessed by measuring the leakage of smoke and where it is necessary to control this for life safety purposes the leakage should be restricted to $30 \text{m}^3/\text{hr}$. The test procedure is described in ISO 5925 Part 1. (to be published in the near future).

19.16 Fire dampers may be of an insulated or uninsulated type. The insulated types can provide the same level of insulation as a fire barrier and can be used without any other qualification. Uninsulated fire dampers can be used only with insulated ducts or where the main consideration is to prevent the passage of hot gases. Fire dampers are tested in accordance with ISO 10294 Part 1 (to be published in the near future).

19.17 The effectiveness of fire penetrations to maintain the integrity of a fire barrier can be established by subjecting an assembly of the penetration with its sealing system to a test in accordance with ISO 10295 (to be published in the near future). If shown to be effective the penetration can be used without any restriction in a fire barrier for the appropriate level of fire resistance.

19.18 The performance of roofing constructions is measured by a different type of test to that used for internal linings and for fire resistance. The test method is being finalised at present by an international technical committee and will be able to classify roofing constructions on the basis of the ignitability of the covering and the ability of the roof to prevent a fire from penetration to the inside. The test allows the constructions to be graded into three categories, Grades A, B or C on the basis of the performance. In the interim the performance can be established by BS 476 Part 3:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Penetration time</th>
<th>Flame spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>=&gt; 60 min</td>
<td>none</td>
</tr>
<tr>
<td>B</td>
<td>=&gt; 30 min</td>
<td>&lt; 500 mm</td>
</tr>
<tr>
<td>C</td>
<td>=&gt; 15 min</td>
<td>&lt; 500 mm</td>
</tr>
</tbody>
</table>

Different fire tests specified in the Code and the corresponding Brazilian or other standards are shown in the Table below:

**TABLE 19.1 - FIRE TESTS SPECIFIED IN THE CODE**

<table>
<thead>
<tr>
<th>Fire Test</th>
<th>Brazilian</th>
<th>International</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Code/Standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-combustibility</td>
<td>ISO 1182</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flammability:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linings</td>
<td>NBR 9442</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermoplastics</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor covering</td>
<td>MB 3215</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furniture</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furnishing</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire resistance:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building elements</td>
<td>NBR 10636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire doors</td>
<td>MB 564</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire dampers</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire penetrations</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoke control doors</td>
<td>--</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* To be published

**INSTALLATION CODES**

19.20 In addition to requiring minimum behaviour characteristics of materials and products the Code also make reference to the proper installation fire protection systems. Most of these refer to the active fire protection systems and other devices needed in case of a fire. These require codes of practice which deal with the design of the system, the selection of the right components and the provision of the system to deal with the particular situation of a given building. The information required for this purposed is usually contained in a detailed code which provided the details of the system and the associated standards for the components.

19.21 Design and installation standards are needed for the following systems, reference has been given to standards available in Brazil and where these are not yet issued the equivalent standards from other countries are mentioned.

b. Fire fighting system by fire - Procedure
Draft 0:01.03-045:1984,

c. Fire extinguishing installations and equipment on premise, specification for sprinkler systems, BS 5306: Part 2: 1990

d. Sprinklers for fire fighting - Specification
EB-152 (1990)

e. Sprinklers for fire fighting - Procedure
NB-1135 (1990)

f. Fire extinguishing installations and equipment on premise, Specification for Halon systems, BS 5306: Part 5

g. Water type fire extinguishers - Specification
EB-149 (1974),

h. Carbon dioxide type fire extinguishers - Specification
EB-150 (1991)

i. Chemical powder type fire extinguishers - Specification
EB-148 (1989)

j. Halogen hydrocarbon type portable fire extinguishers - Specification
EB-1232 (1990)

k. Hydrant and hose reel systems - Procedure
Draft 24:302.04-001

l. Fire exits in buildings - Procedure
NBR-9077 (1985)

m. Horizontal bars in exit doors (anti-panic bars) - Procedure
EB 2081 (1990)

n. Emergency lighting system - Procedure
NBR 10898 (1990)

o. Independent system of safety lighting for floor signs and lighting - Procedure
NBR 10720 (1989)

p. Fire safety signs, notices and graphic symbols, specification for fire safety signs, BS 5499: Part 1: 1990

q. Fire precautions in the design, construction and use of buildings,
code of practice for smoke control in protected escape routes using pressurisation, BS 5588: Part 4: 1978,

r. Fire precautions in the design, construction and use of buildings, code of practice for firefighting stairs and lifts, BS 5588: Part 5: 1991

CHAPTER 20

DEFINITIONS

**Access room** - A room through which occupants of an inner room have to pass to reach escape route.

**Alternative escape route** - An escape route which is adequately separated from another escape route by virtue of fire resisting construction or separation by distance.

**Alternative exit** - One of two or more exits separated from each other.

**Atrium** - A vertical space within a multi-storey building which openly connects three or more storeys and it is closed at the top by a roof, usually translucent. It may contain stairs, lifts etc connecting different floors.

**Automatic fire detection system** - A system of fire detectors installed in a building or other space which are connected to a control panel capable of providing an automatic warning when a detector responds to a fire.

**Automatic sprinkler system** - A sprinkler installation provided with a fusible link or other sensing device which responds to a fire and sprays water on the contents. The system requires sprinkler heads, water supply and suitable control valves.

**Automatic release mechanism** - A device which allows a door held open to close automatically on receiving a signal from a fire alarm system, or a detection system or a manually operated switch.

**Automatic self closing device** - A mechanical device to close a door after it has been opened and released.

**Basement** - Part of a building below surrounding ground level which is intended to be used for accommodation, car parking or other purposes.

**Boundary** - Demarcation between buildings adjacent to each other or between a building and the centre of a road, street or stream.

**Cavity** - Concealed space within building elements or between building elements, such as in a hollow wall or between a ceiling and a roof.

**Ceiling** - Underneath side of a floor, or a separate construction provided below a floor or a roof with a gap above.

**Circulation space** - Common space used by occupants of a building to gain access from a room to an exit or a stairway or a lobby. It may be a corridor or a foyer or an entrance hall.
**Compartment** - An enclosed part of a building, on one or more floors, which is designed to prevent fire spreading outside its boundaries or a fire entering it from the outside. A whole building may form a single compartment.

**Compartment floor or wall** - A fire resisting floor or wall designed to separate one compartment or one occupancy from another such that it will prevent the transfer of a specified fire from one side to the other. All openings in a compartment floor or wall are protected to the same standard as the floor or the wall.

**Compartmentation** - Division of a building into compartments or separation of two buildings or occupancies by compartment floors or walls.

**Concealed cavity** - A hidden cavity or space within an element of construction or between different elements such a ceiling and a roof.

**Contents** - Materials which exist inside a building either for decoration, fittings, furniture, goods or products. Usually the reference is to combustible contents which can ignite and provide fuel for the fire.

**Dead-end corridor** - A corridor from which escape is possible in one direction only.

**Deep basement** - A basement in which the lowest useful floor is at a depth of more than 10 m from the ground level.

**Depth of a basement** - The depth of a basement is taken to be depth of the lowest floor from the surrounding ground level.

**Direct distance** - The shortest distance between two points, e.g. a lobby or stairway door and the part of a room where a person may be present who has to make his escape.

**Element (of construction)** - A building component required to possess fire resistance by the Code. Some typical elements of construction are:

- Beams and columns,
- Structural frame,
- Floors,
- Loadbearing walls,
- External walls
- Compartment floor or wall,
- Door,
- Suspended ceiling

**Emergency lighting** - Lighting provided to function when the normal lighting fails due to fire or some other reason.
**Escape lighting** - Emergency lighting provided for the illumination of escape routes.

**Escape route** - Route to be used by occupants to escape from a fire to a place of safety.

**External wall** - The outside wall of a building which may slope at an angle of 20° to the vertical.

**Exit** - A way out of a room or a floor of a building. See storey exit and final exit

**Final exit** - The door or opening leading from the building to the outside.

**Fire barrier** - A wall or a floor designed to prevent the passage of fire from one side to the other.

**Fire door** - A door designed to provide resistance against the passage of fire or smoke or both.

**Fire control door or fire resisting door** - A door which can be shown to resist the passage of fire if subjected to the standard test for fire resistance.

**Fire resistance** - The ability of a building element to provide protection against fire determined by subjecting a prototype to a standard test or by assessment. Fire resistance is expressed in units of time, the minimum fire resistance period is 30 minutes. Fire resistance time is not the same as the duration of a fire in a building, it is an arbitrary time scale which corresponds to the effects of fires of known severity.

**Fire stop** - A seal provided around a service installation, pipe or duct, where it passes a fire barrier to prevent the passage of fire through the gap.

**Firefighting lift** - A lift designed to operate in case of a fire by having protected electric supply with controls for the use of the fire service personnel. It is enclosed in a 120 minute fire resisting construction.

**Firefighting lobby** - A protected lobby providing access from the firefighting stairs to the accommodation and to a lift if provided.

**Firefighting stairs** - Stairs in a protected enclosure of 120 minute fire resistance, which provide access to and from a Firefighting lobby.

**Firefighting shaft** - A protected enclosure having a fire resistance of at least 120 minute which contains a firefighting stair, firefighting lobbies and in some cases a firefighting lift with its operating machinery.
**Fire load** - The combustible material present in a building which is able to burn and provide fuel for the fire. Fire load density is the amount of material per unit floor area.

**Fire rescue facilities** - Provisions made for the entry of and for assistance to the fire service personnel to enter the building and carry out the rescue of people who are still inside.

**First-aid fire fighting equipment** - These are devices which can be used to attack a fire at its inception such as portable extinguishers and hose reels. A sprinkler installation may be considered to be a first-aid fire fighting equipment.

**Flammable materials** - Materials which are easily ignitable as determined by appropriate test methods. Liquid fuels, some plastics are considered flammable.

**Furnishings** - Materials used for furnishing a room such as curtains, decorative fixing, pelmets etc.

**Height** - The height of a building is taken to be the height of the top storey floor from the surrounding ground level except in the case of storage buildings where it is the actual height of the building.

**High rise building** - A building which has a number of storeys with the top floor at a height of more than [30] m from the ground level.

**Inner room** - A room in a building from which access is possible only by passing through an outer room known as the access room.

**Means of escape** - The provision of route(s) from any point in a building to a place of safety for use of people in the building.

**Non-combustible material** - A material which will make a minimal contribution to the fire load as determined by a standard test. Most inert materials such as concrete, steel etc are inherently non-combustible.

**Notional boundary** - An imaginary boundary which exists between buildings on the same site or where the buildings have some other barrier such as a street, road or stream.

**Open planning** - The use of space on a floor without sub-division or separation as in open plan offices where no ceiling height barriers are provided.

**Places of special risk** - Areas containing high risk equipment or high fire loads such as transformer rooms, switch gear rooms, fuel stores, stores with fire load of flammable materials, rooms with petrol/diesel engines etc.
Pressurisation - A method of protecting a space against the entry of smoke by maintaining it at a higher pressure than the surrounding areas so that air flows away from the area. Pressurisation requires the use of suitable doors to the space.

Protected circuit - Electric supply which can function in case of a fire.

Protected corridor/lobby - A corridor or lobby is considered protected when its boundaries are fire resisting, i.e. fire resisting walls, doors, ceiling/floors etc. A protected corridor or lobby represents an area of relative safety.

Protected enclosure - An enclosure of fire resisting construction which is able to resist the entry of a fire of a pre-determined severity. A protected enclosure may contain circulation space, corridor, lobby and/or staircase.

Protected entrance hall/landing - Entrance hall or the landing area which is bounded by fire resisting construction and therefore safe from the immediate effects of a fire.

Protected shaft - A shaft of fire resisting construction which may enclose stairs, lifts or ducts which communicate between different compartments. A protected shaft prevents a fire entering it and transferring to another area provided its design is satisfactory. It could be considered to be a special type of compartment which traverses other compartments.

Protected stairway - A stairway which has a fire resisting enclosure with fire resisting doors. It is a protected shaft containing stairs. It provides a means of safe vertical travel in a building on the way to the final exit from the building.

Rooflight - A light transmitting component mounted in the roof of a building. It may consist of glass or a clear or translucent plastics sheet or dome.

Smoke control door - A door designed to restrict the flow of smoke from one side to the other. The performance is determined by a standard test and to qualify the door must not permit more than a specified amount of smoke leakage.

Storey - A floor or level of a building, a single storey building has only one floor usually the ground floor, a multi-storey building has more than one useful floor.

Storey exit - The exit leading to the protected stairway or a protected lobby from a given floor. On the ground floor the storey exit is also the final exit.

Suspended ceiling - A ceiling which is located below a floor and held in place by a suspension system of supporting members suspended from the structural floor or beams above. A suspended ceiling may be designed to provide fire protection to the construction above.
**Thermoplastic material** - A plastics material which when heated softens and deforms. Such materials tend to fall away from their fixings and require special tests to establish their flammability. Acrylic and PVC are examples of thermoplastics materials.

**Thermosetting material** - A plastics material which decomposes when heated without becoming soft and can therefore be tested by the procedures applied to non-plastics. Phenolic products and glass fibre reinforced plastics are examples of thermosetting materials.

**Travel distance** - The distance to be travelled by any occupant from any point on a floor to the nearest storey exit taking account of obstructions. The direct distance is usually less than the actual travel distance and is sometimes assumed to be 2/3 of the actual distance.

**Unprotected area** - The part of the external wall which is an opening or has less fire resistance than required for that wall or has combustible cladding on the outside more than 1 mm thick. An external wall without fire resistance is considered to have 100% unprotected area. For fire resisting wall all the openings in the wall, except very small ones and 50% of any combustible cladding are aggregated to give the unprotected area. It may be expressed as area or as a percentage of the wall surface.
Multi-use complexes

8.86 Any building with multiple occupancy either on a floor or a part of the building shall have separate escape provisions for each occupancy which are adequate for the estimated occupancy levels for each part. If a building is used partly for apartments or other residential purposes there shall be independent and protected exits and escape stairs for the residential part of the building. This requirement does not apply to a building provided with accommodation on the top floor for the staff or for occasional use.

8.87 Needs of large complexes with multi-use facilities are described in Chapter 15, the escape provisions for each part shall be designed as appropriate for that use. Multi-storey buildings which contain car parking floors shall have these area completely separated from the rest of the building with protected internal access.

Industrial

8.88 Single storey industrial buildings do not require any special provisions if there are sufficient exits to the outside for the travel distance limitations to be observed.

8.89 Any office accommodation for more than 10 persons shall be separated from the other parts by fire resisting separation with its own means of escape.

8.90 Industrial buildings for multiple use shall be provided with separation between occupancies and exits from each shall lead to protected escape routes. An automatic fire detection and alarm system shall be provided within the building.

Special risk areas

8.91 Areas presenting special risk in any type of occupancy shall be separated from the rest of the building. If not constantly manned these shall be provided with automatic detection and alarm system to warn the occupants of a fire.

8.92 There shall be adequate signs to identify such areas and access shall be limited to authorised personnel. In general if any work is to be done in such areas a two man team should be provided or for minor work the management informed if a single person is to be present. Some further guidance is given in Chapter 14.