Technical Report
FCRC-TR 96-06

BCA Fire Safety Requirements for Shopping Centres

FCRC Project 6
Fire Safety Systems for
Low-Rise, Sprinklered Shopping Centres

Fire **Code** Reform Research Program
June **1996**

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Background

The Fire Code Reform Research Program is funded by voluntary contributions from regulatory authorities, research organisations and industry participants.

Project 6 of the Program involved investigation into factors affecting fire-safety in low-rise, sprinklered shopping centres. In the early stages of this work a comprehensive study of the requirements set out in the 1990 edition of the Building Code of Australia (BCA 90) was undertaken.

This Report summarises the outcome of this study and was assembled by Dr Ian Bennetts of BHP Research, Melbourne Laboratories whilst located at 245 Wellington Road, Mulgrave, Victoria 3170. The Report includes examples, diagrams and summary tables of the specified requirements.

Acknowledgements

Mr Max Croxford, Commissioner of the Building Control Commission (BCC), Victoria was primarily responsible for the initiation of FCRC's Project 6 relating to "Fire Safety Systems in Low-Rise, Sprinklered Shopping Centres". BCC Victoria additionally provided significant financial support to the execution of this work. BHP Steel Division and BHP Research were further contributors of substantial funds to Project 6. Generous contributions were also received from other donors.

The Board and management of Fire Code Reform Centre Limited acknowledge with sincere thanks receipt of all these financial contributions. The company also acknowledges the kind permission of BHP Research to the t-e-production and publishing of this document.

Comments

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FIRE CODE REFORM CENTRE
PROJECT 6

BHPR/SM/R/045

BCA FIRE SAFETY REQUIREMENTS FOR SHOPPING CENTRES

by

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EXECUTIVE SUMMARY

The work described in this report was undertaken as part of Fire Code Reform Centre Project 6 "Fire Safety Systems for Sprinklered Low-rise Shopping Centres". This project is aimed at studying the factors affecting fire safety in shopping centres and will recommend modifications to the existing regulations where this is appropriate. Before this can be accomplished however, it is necessary to have a clear understanding of the current requirements for these buildings. This is the purpose of this report which gives an in-depth summary of the current BCA fire-safety requirements for these buildings.

CONTENTS

1 INTRODUCTION

In Australia, shopping centres are generally constructed as large plan area, low-rise buildings where the shops are connected at one or more levels by means of a large covered area or mall (Figure 1.1). A variety of shops including specialty shops, large department stores, food courts, cinema complexes, and recreational facilities are all part of the modern shopping centre. Car parking levels are also provided and may be located below the shopping levels or to one side with direct access into the building.

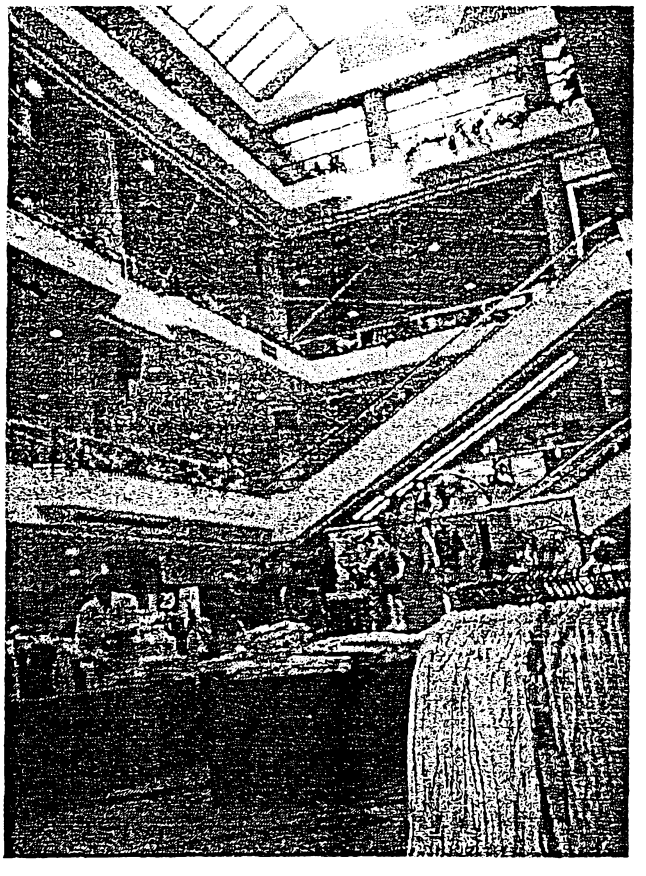

FIGURE 1. 1 TYPICAL INTERIOR OF A SHOPPING CENTRE

The trend towards large, open-space buildings with high levels of natural lighting, whilst at the same time providing protection from the weather, has been achieved through the provision of multi-level covered walkways to form shopping malls or atriums.

In November 1995 the Fire Code Reform Centre commissioned a research project to investigate the fire safety of low-rise (≤ rise in storeys of 4), sprinklered shopping centres. As part of this investigation it is necessary to have a clear understanding of the current Building Code of Australia (BCA) [1] fire-safety requirements for these buildings. The purpose of this report is to give an in-depth summary of these requirements.

Shopping centres are classified as Class 6 buildings by the BCA and are required to comply with its various requirements. If the building contains an atrium then the specific atrium provisions may also apply.

2 REQUIRED TYPE OF CONSTRUCTION

2.1 TYPE OF CONSTRUCTION

The BCA (cl C1.1) requires buildings to be constructed in Type A, B or C *fire-resisting construction.* Type A construction is the most fire-resistant and Type C the least fire-resistant of the types of construction.

The minimum Type of construction required is determined according to building classification and *rise in* storeys. The maximum floor area and volume of the *fire compartments'* associated with the buildings are restricted by the Type of construction.

For shopping centres, which are Class 6 buildings, the required Type of construction is summarised in the table below.

TABLE 1 TYPE

Limits	*Type of Construction*		
	A	*B*	*C*
	≥ 4	3	2
max. floor area of fire compartment or atrium (m^2)	5,000	3,500	2,000
of (m^3)	30,000	21,000	12,000

2.2 RISE IN STOREY

The BCA (cl C1.2) determines the *rise in storeys* of a building as:

"the greatest number of storeys at any part of the external walls of the building-

- above the finished ground next to that part; or
- if the part of the external wall is on the boundary of the allotment, above the ground level at the relevant part of the boundary."

As the rise in storeys of a building increases, a more fire-resistant Type of construction is required.

In the situation illustrated in Figure 2.1(a), the rise in storeys for the entire building is four. Alternatively, if the four storey part and the two storey part are separated by a fire wall between them (BCA cl C2.7), then the separate parts can be considered as separate buildings having different rises in storeys as shown in Figure 2.1(b). Different Types of construction would apply to each part. In the case of the building shown in Figure 2.1(c), the rise in storeys must be taken as four as one side the building is four storeys above ground level.

In relation to basement levels or floors situated below or partially below the ground level, there are supplementary criteria in calculating the rise in storeys. According to the BCA (cl C1.2), a storey is not counted if—

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of a is that a fire constrained to an enclosure
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- it is situated partly below the finished ground and the underside of the ceiling is ≤ 1 m above the average finished level of the ground at the external wall; and
- if the external wall is more than 12 m long, the average finished level of the ground at the external wall, is considered to be the average for the 12 m part where the ground is the lowest.

Thus storeys which are below ground are generally excluded when calculating the rise in storeys and are therefore not considered when determining the Type of construction required. In the example shown in Figure 2.1(d) the floor level is considered as a storey as the majority of the level is above ground i.e. the ceiling is more than 1 m above the ground level.

The buildings shown in Figure 2.1 (e) illustrates that a building with two basements and two storeys above ground is considered to have a rise in storey of 2, whereas a similar building with all storeys above ground (and more below) has a rise in storey of 4.

Certain additional requirements apply with respect to access and egress from basements. These are considered further in Chapter 5.

2.3 SIZE OF FIRE COMPARTMENT

The fire compartment sizes in Table 1 can be exceeded provided the requirements for large isolated buildings (BCA cls C2.3 and C2.4) are satisfied. These requirements relate to the provision of providing a sprinkler system and vehicular access. The vehicular access requirements are illustrated in Figure 2.2.

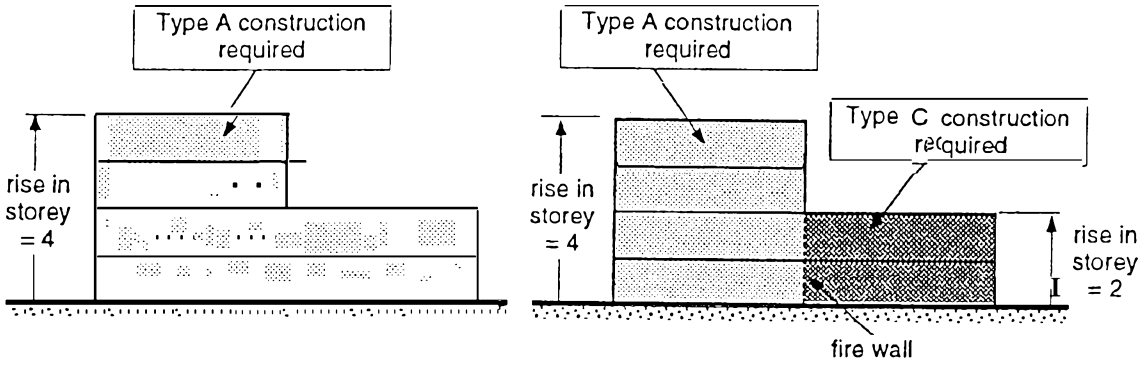
If the total floor area or volume of the building increases (Figure 2.2), the building is also required to be provided with a smoke exhaust or venting system in accordance with BCA Spec E2.2 or E2.4 respectively. These smoke control requirements are considered later.

The requirements for large isolated buildings apply almost universally to modem shopping centres due to their large floor area and volume and the general lack of fire compartmentation.

2.4 EFFECTIVE HEIGHT

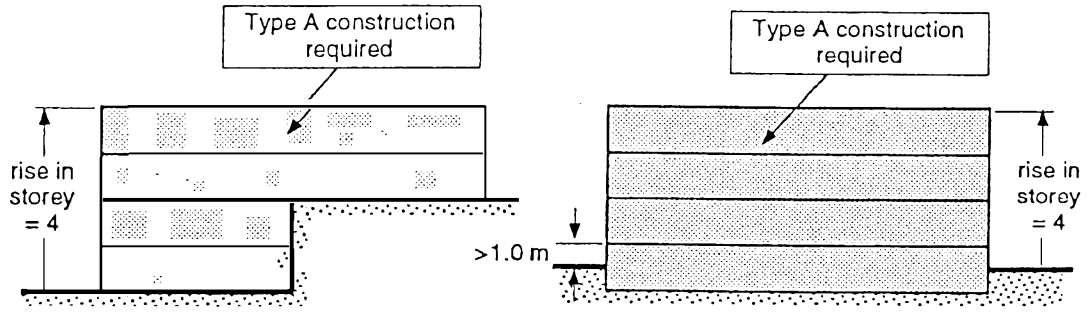
The effective height of a building is defined in the BCA (cl A1.l) as: "the height to the floor of the topmost storey (.....) from the floor of the lowest storey providing direct egress to a road or open space."

When the effective height of a building exceeds 25 m, additional fire safety requirements may apply (e.g. Grade I water supply for sprinkler systems (as required by AS 2118 [6]) and stair pressurisation etc.). These are discussed later.



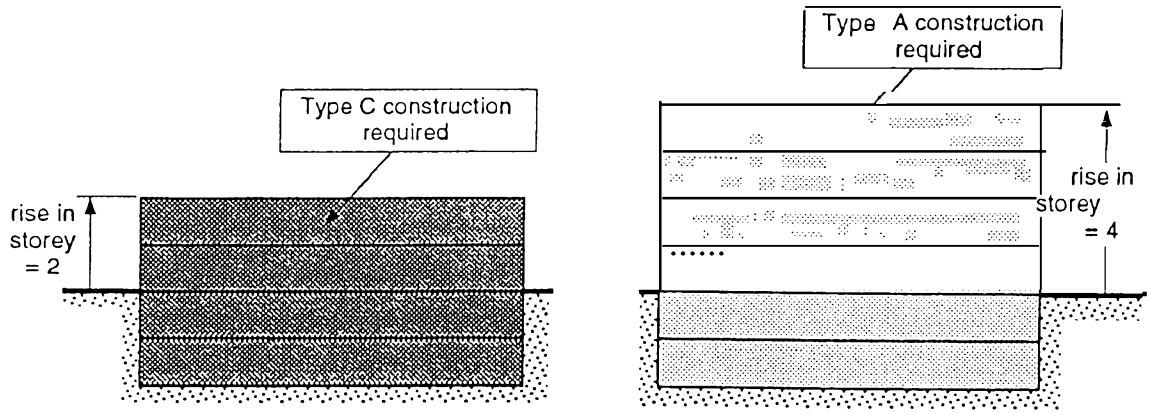
(a) considered as a single building

(b) considered as two separate buildings



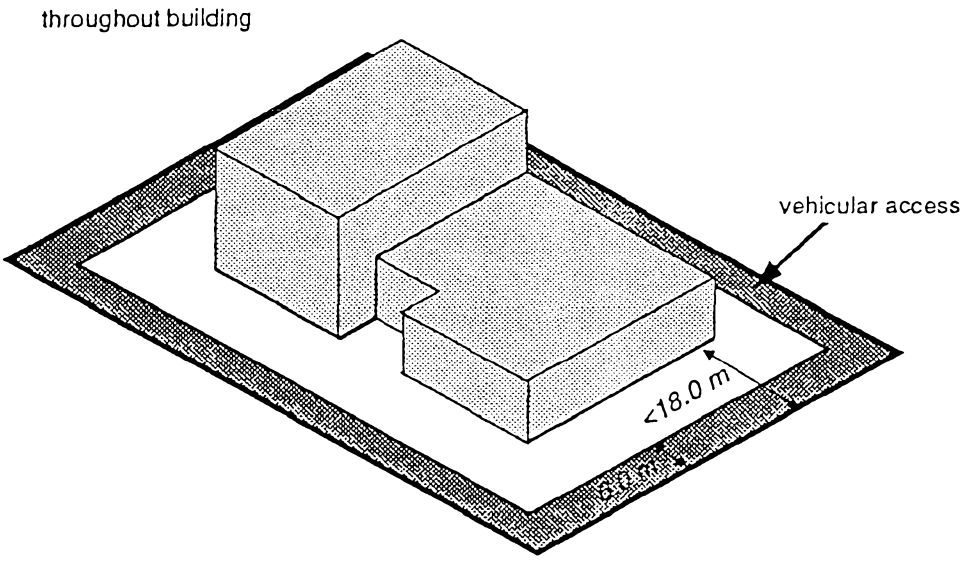
(c) entire buidling considered as having a rise in storey of 4

(d) storey below ground included in calculation of rise in storey

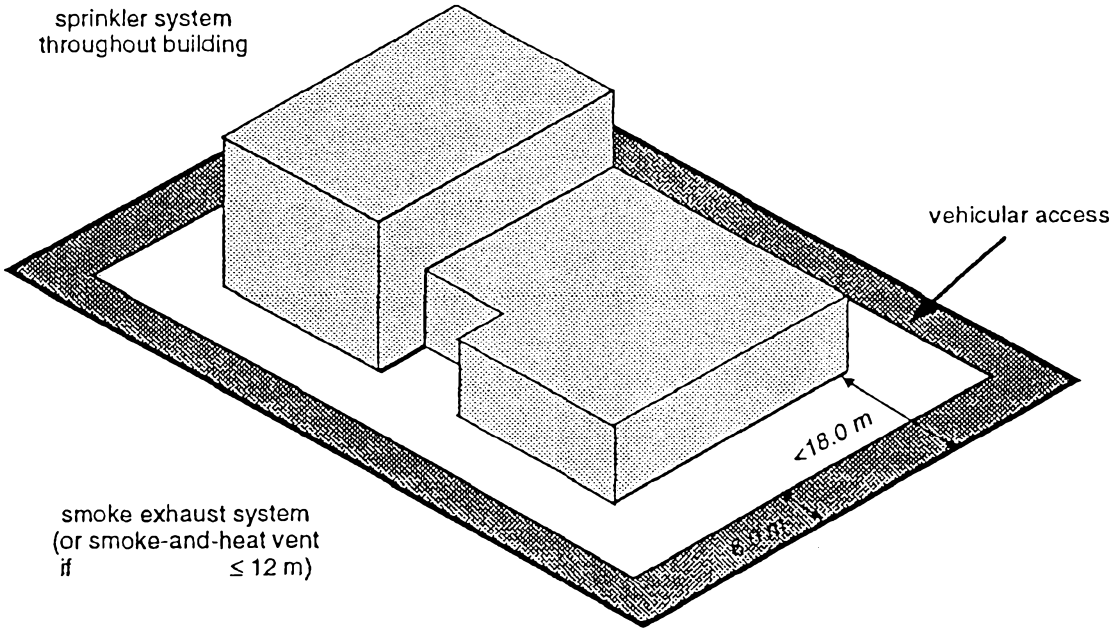


(e) basement levels are excluded when calculating rise in storey

FIGURE 2.1 RISE IN TYPE OF CONSTRUCTION



a) floor area ≤ 18,000 m², volume ≤ 108,000m³



b) floor area > 18,000 m², volume > 108,000m³

FIGURE 2.2 REQUIREMENTS FOR LARGE ISOLATED BULLDINGS
(SHOPPING CENTRES)

3 FIRE RESISTANCE REQUIREMENTS

For each Type of construction, the BCA requires the individual building elements within the buildings to demonstrate specificfire-resistance levels (FRL).

The fire resistance of a building element is determined by subjecting the element to standard fire test conditions as specified by AS 1530.4 [2] or must satisfy the deemed to satisfy tables of BCA Spec A2.3. Depending on the type of building element, the performance in the standard test is measured in relation to three failure criteria-structural adequacy, integrity and insulation.

The required FRL for various building elements, expressed in minutes in relation to the three failure criteria, are contained in BCA (Spec C1.l, Tables 3, 4 and 5). Those relevant to shopping centres (Class 6 buildings) are summarised in Table 2 of this report

It is to be noted that:

- For Type C construction, the fire resistance of the external walls need only be established by considering (by means of testing) exposure from outside of the building.
- Loadbearing external walls in Types B and C construction, and non-loadbearing external walls in all Types of construction, are not required to have an FRL if they are located a sufficient distance from *cfire-source feature* (FSF).
- Internal columns are required to have an FRL for both Types A and B construction but not for Type C construction, but are allowed various concessions, as explained in Section 3.1 of this report.
- Floors in buildings of Type A construction are required to have an FRL, but this is not explicitly[2] required for floors in buildings of Types B and C construction.
- Only roofs in Type A construction are required to have an FRL but are allowed various concessions, as explained in Section 3.1 of this report.
- Fire walls and common walls in buildings of any Type of construction, are required to have an FRL.
- There are no FRL requirements for internal walls bounding sole occupancy units (SOU's) in Type C construction and the walls are not required to be taken up to the underside of the next floor above; nor is the ceiling required to have a fire-resistance to incipient spread of fire. The requirements therefore allow a continuous ceiling void throughout the compartment.
- Buildings of Types A and B construction require fairly similar provisions to each other in respect of internal walls bounding SOU's. Only walls which are loadbearing are required to have an FRL of 180/-/-, with structural stability being the concern. Types A and B construction require different internal wall construction in relation to extending the walls to roofs, ceilings and floors.

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2 may be required to have a fire-resistance as a result of the support of of Spec C1.1. This is in Section 3.3.

TABLE RESISTANCE REQUIREMENTS BUILDING ELEMENTS

Building Element	Fire Resistance Level Required		
	Type C	Type B	Type A
EXTERNAL WALL			
Loadbearing parts:			
FSF < 1.5 m	90/90/90 ‡	180/180/180 †	180/180 /180 †
1.5 m ≤ FSF < 3 m	60/60/60 ‡	180/1 20/90 t	180/180/120 †
3 m ≤ FSF < 9 m	- J- /-	180/90/60 †	180/120/90 †
9 m ≤ FSF < 18 m	- /- /-	180/60/- †	180/120/90 †
18 m < FSF	- /- I-	- J- /- †	180/120/90 †
Non-loadbearing parts:			
FSF < 1.5 m	- l-f-	- /180/180 †	- /180/180 †
1.5 m ≤ FSF < 3 m	- f-l-	- /120/90 †	- /180/120 †
3 m ≤ FSF	- l-l-	- I- /- †	- /- I- †
EXTERNAL COLUMN			
FSF < 1.5 m	90/-/-	180/- /-	180/-/-
1.5 m ≤ FSF < 3 m	60/- /-	180/- /-	180/-/-
3 m ≤ FSF	- J- J-	- /- /-	- /- /-
INTERNAL WALL			
Common walls atuJire walls	90/90/90	180/180/180 †	180/180/180 †
Fire-resisting lift and stair shafts:			
loadbearing	- /- /-	180/120/120	180/120/120
non-loadbearing stair shafts only	- /-/-	- /120 /120	- /120 /120
non-loadbearing l.ft shafts only	- J-J-	- /-/-	-
Bounding public corridors, public hallways and the like:			
loadbearing	- J- /-	180/- I-	180/- /-
non-loadbearing	- /- J-	- J- /-	- /- /-
Between or bounding SOU's:			
loadbearing	-	180/-/-	180/-/-
non-loadbearing	- J- J-	- /-/-	-/-J-
Ventilating, pipe, garbage, and lift shafts not used for the discharge of hot products of combustion:			
loadbearing	- J- I-	- J- /-	180/120/120
non-loadbearing	- J- J-	- /- /-	- /120/120
Other loadbearing internal walls	- I- /-	180 /- /-	180/- /-
INTERNAL COLUMN	- /- /-	180/-/- §	§
FLOOR	- /- I-	- /- /-	180/180/180 §
ROOF	- /- /-	- /- /-	180/60/30
INTERNAL BEAM & TRUSSES	- J- I-	- /- /-	/-

Notes: † non-combustible

‡ only fire exposure from outside

§

Non-loadbearing internal walls bounding SOU's are not required to have an FRL and are not required to extend up to the floor above. This is also the case for non-loadbearing walls bounding public corridors, public hallways and the like.

3.1 CONCESSIONS TO FIRE RESISTANCE REQUIREMENTS

The BCA makes a number of *concessions*[3] in relation to the fire resistance requirements. These concessions are summarised below.

- *Column*— A steel column, other than one in a fire wall or common wall, need not have a FRL in a building that contains only one storey.
- *Roof-The* requirement for a roof in a building of Type A construction to have an FRL can be waived (BCA Spec C1.1, cl 3.5) if the roof has a non-combustible covering and:
  - the building is sprinklered; or
  - the building has a rise in storeys of 3 or less; or
  - the building has an effective height of less than 25 m and the ceiling immediately below the roof has a resistance to the incipient spread of fire of not less than 60 minutes.

  If the roof is required to have a non-combustible covering or an FRL, roof-lights including natural roof lighting, may only have an aggregate area of not more than 20% of the roof surface (BCA Spec C1.1, cl 3.6). Their location is also restricted to being not closer than 3 m to site boundaries or to other roof-lights of adjoining fire separated areas.

  It follows that non-combustible roofs in sprinklered shopping centres are not required to have an FRL but the aggregate area of natural lighting must not exceed the above limits. However if the roof is in an atrium, then cl G3.6 allows the roof, not to have an FRL if the roof supports and membrane are sprinkler protected. The aggregate area of natural lighting in this instance is not restricted by BCA Spec C1.l, cl 3.6.
- *Internal columns and loadbearing internal* walls--Internal columns and loadbearing internal walls (other than firewalls) within the top storey of a building of Type A and B Construction may have reduced FRLs.
  - Type A Construction (BCA Spec Cl. 1, cl 3.7) requires no FRL, if the rise in storeys is not greater than 3; and an FRL of 60/60/60, if the rise in storeys is greater than 3.
  - Type B Construction requires no FRL (also excludes shaftwalls).

[3]The term "concession" is frequently used throughout the BCA and corresponds to a requirement which represents an alternative to the normal regulatory requirement applying to a situation. As these alternative requirements are permitted, it follows that they must be considered to correspond to an equivalent level of safety in certain situations-i.e. the situations specified in the "concession". The use of the word "concession" unfortunately implies a lower level of safety. This is not the case.

3.2 SEPARATION OF PARTS OF DIFFERENT CLASSIFICATIONS

As explained in the introduction to this report, modem shopping centres frequently incorporate carparks and cinemas. The BCA classifies car-parks are Class 7 and cinemas are Class 9b buildings. It follows therefore, that shopping centres are often buildings of mixed classification- According to cl C2.8 of the BCA, if these parts of different classification occur on the one storey, then either:

- the FRLs associated with each building elements on that level must be the highest associated with the different classifications (e.g. the highest FRL based on the Class 6, 7 and 9b requirements is required for each building element, in the case of the above example) or,
- the parts must be separated by a fire wall having an FRL equal to the highest required for each of the classifications.

Access through a fire wall must be by means of a fire door. An example of this is shown in Figure 3.2.

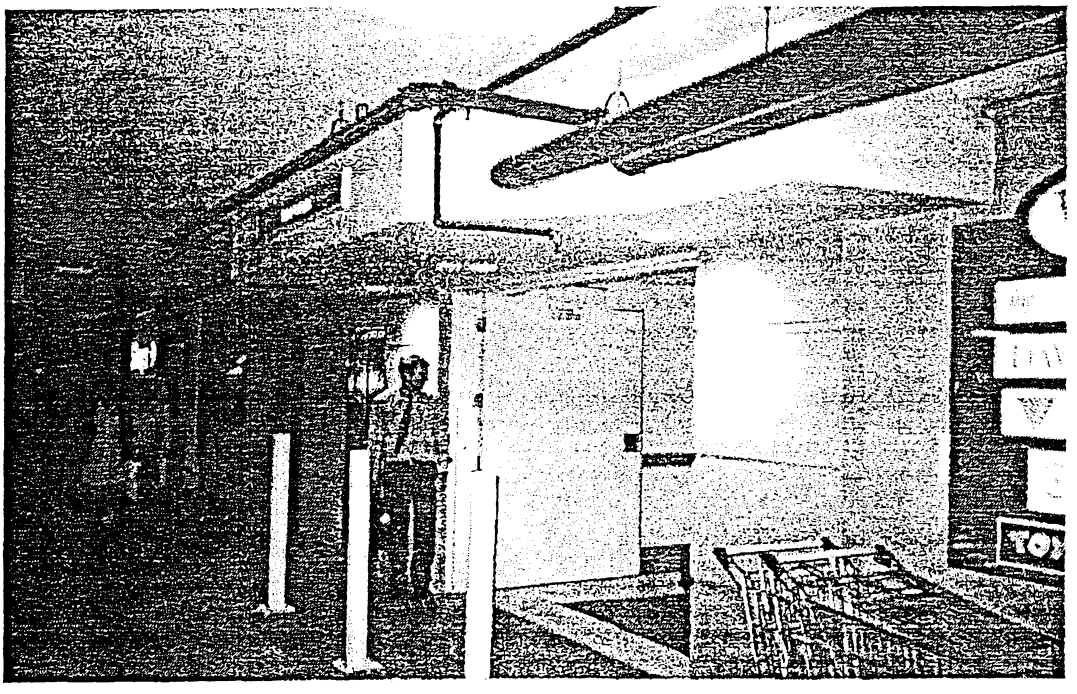

FIGURE 3.2 FIREDOOR THROUGH WALL

In the case of buildings that have different classifications, where one is located above the other, the BCA requires horizontal separation between these levels. The fire resistance level required for the floor between the adjoining parts must be not be less than that required for the classification of the lower storey. This is illustrated in Figure 3.3.

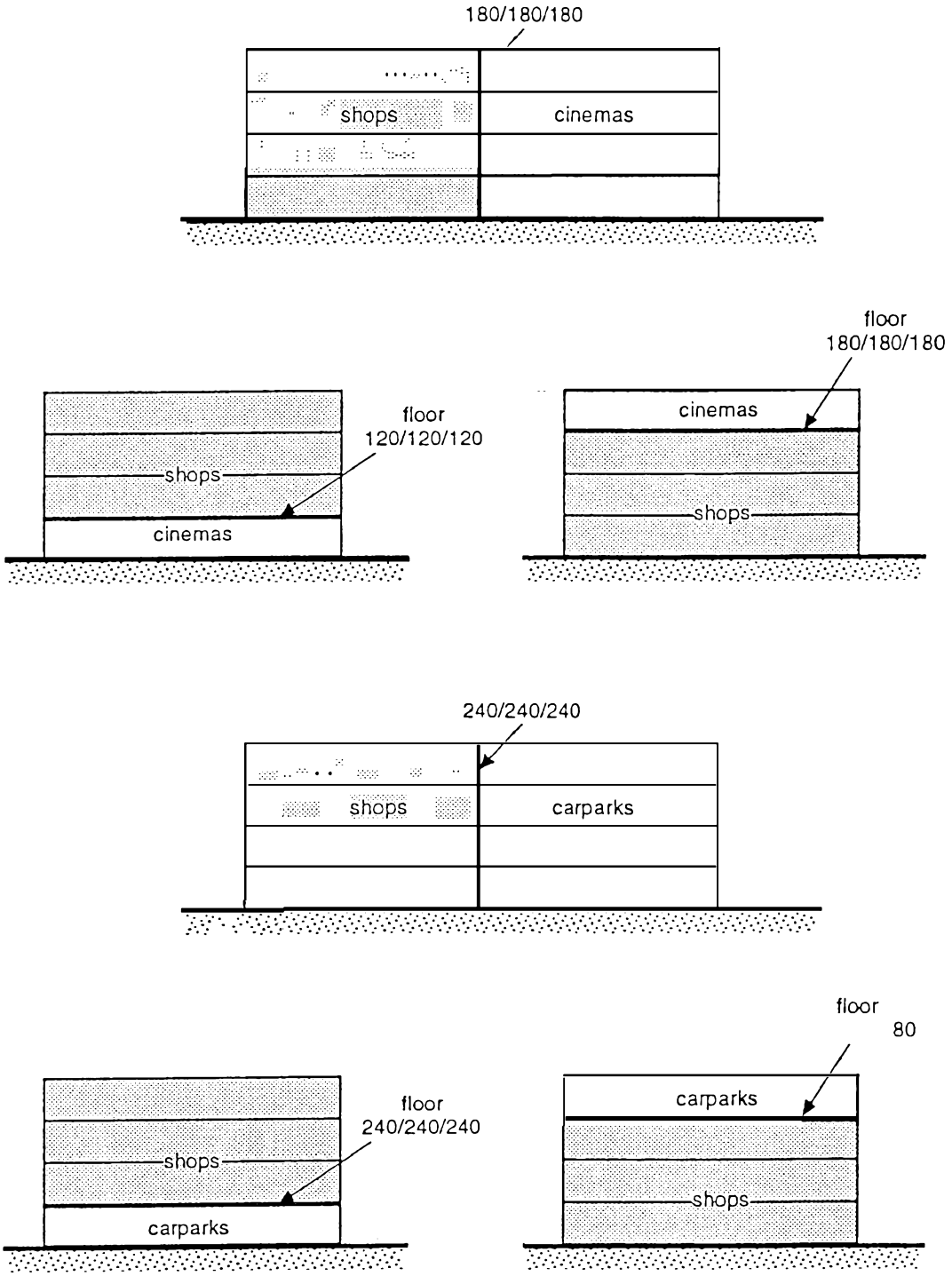

FIGURE 3.3 SEPARATION OF PARTS OF

3.3 FIRE RESISTANCE REQUIREMENTS FOR SUPPORTING PARTS

As will have been noted from the previous sections, various members (such as floors in Type B construction) are not required to have a fire-resistance. However, such members will often provide support to other members (such as internal columns) that are required to have an FRL.

The BCA (Spec Cl . 1, cl 2.2) requires a part of a building that gives necessary direct vertical or lateral support to another part (required to have an FRL), to itself, have an FRL. The supporting part must:

- have an FRL in respect of structural adequacy that is the greater of-
  - that required for the part it supports; or
  - that required for the part itself; and
- be non-combustible if the part it supports is required to be non-combustible.

4. MATERIALS OF CONSTRUCTION

The BCA requires various building elements to be non-combustible (as determined in accordance with AS 1530.1[3]). These requirements are summarised below:

- *External* walls---For Types A and B construction, external walls must be non-combustible, whereas for Type C construction, the external walls may be of combustible construction-
- *Fire and common walls*—For Types A and B construction, fire and common walls are required to be non-combustible. Loadbearing fire walls must be of masonry or concrete. Fire walls and common walls in Type C construction may be of combustible construction-
- *Internal walls*—For Types A and B construction, loadbearing internal walls are required to be constructed of concrete or masonry-thereby implying that they must be non-combustible. Non-loadbearing internal walls are permitted to be of combustible construction and are not required to extend up to the floor above.
- Floors-The BCA also does not require floors in buildings of Types B and C construction to have an FRL or be non-combustible. Buildings of Type A construction are required to have floors which have an FRL but may still be of combustible construction-

The BCA (cl C1.10) also requires materials and assemblies installed in a building to resist the spread of fire and limit the generation of smoke-even though such elements may be permitted to be "combustible". Thus all materials, components, linings and surface finishes used in the building construction must satisfy the specific requirements of BCA (Spec C1.10). The BCA refers to AS 1530.2 [4], which deals with flammability and AS 1530.3 [5], which is concerned with spread of flame and the degree of smoke developed following ignition of a material.

The BCA (Spec Cl.0 cl 2) requires that any material or component used in the building must:

(a) in the case of a sarking-type material (i.e. a material such as a reflective foil or other flexible membrane of the type normally used for a purpose of water proofing, vapour proofing or thermal reflectance), have a *Flammability Index* of not more than 5; or

(b) in the case of other materials, have:

  (i) a *Spread-cf-Flame Index* not more than 9; and

  (ii) a *Smoke-Developed Index* not more than *8* if the *Spread-cf-Flame Index* is more than 5; or

(c) be completely covered on all faces by concrete or masonry not less than *50* mm thick; or

(d) in the case of a composite member or assembly (e.g. a wall construction with inner combustible material sandwiched between outer non-combustible skins), be constructed so that when assembled as proposed in the building:

(i) any material which does not comply with (a) or (b) is protected on all sides and edges from exposure to the air; and

(ii) the member or assembly, when tested in accordance with Spec A2.4 (Early Fire Hazard Test for Assemblies), has a Smoke-Developed Index and a Spread-of-Flame Index not exceeding those prescribed in (b); and

(iii) the member or assembly retains the protection in position so that it prevents ignition of the material and continues to screen it from access to free air for a period of not less that 10 minutes.

Floor coverings[4], wall linings and finishes, ductwork, ceiling materials including ceiling tiles and insulation, and facade construction, are examples of components that must comply with the above requirements. The control of the fire hazard indices does *not* however, apply to contents and furniture.

The BCA (Spec C1.10) also limits construction materials for use in fire isolated exits and exempts certain materials from compliance to the spread-of-flame, smoke-developed or flammability indices. These materials are "deemed-to-comply" and are as shown below.

3CA **Spec** C1.10

and materials

The requirements in this Specification for a *Spread-of-Flame Index, Smoke-Developed Index* or *Flammability*

(a) timber-framed *windows;* or

(b) solid

(c) doors; or

(d) like; or

(e) for-

(i) roof roof insulating material,

(ii) continuous adhesives; or

(iii) damp-proof courses, flashing, moisture barriers,

(f)

(g) rooflight of polyester if-

(i) the roof in is of a single *required* to be of Type C

(ii) is used as part of the roof

(iii) it is by of the

(iv) it is than 1.5 m from another rooflight of

(v) each rooflight is than 14 m^2 in area; and

(vi) of 70 m^2 of roof surface is not 14 m^2; or

(h) of of air-handling systems; or

(i) diffuser plates of emergency *exit* signs

(j) of fire.

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are approval authorities as of the

5 EXIT REQUIREMENTS

The requirements of the BCA that relate to the number of required exits, exit travel distances, fire isolated exits, exit dimensions, horizontal exits and non-required exits are summarised in this chapter.

5.1 EXITS

The BCA (cl A1.1) defines a exit as:

"a) Any, or any combination of the following if they provide egress to a road or open space-

* An internal or external stairway.
* A ramp complying with Section D.
* A fire-isolated passageway.
* A doorway opening to a road or open space

b) A horizontal exit or a fire-isolated passageway leading to a horizontal exit."

A *horizontal exit* is defined in the BCA (cl Al. 1) as:

"a required doorway between 2 parts of a building separated from each other by a fire wall with an FRL as required by Spec C 1 .1."

Escalators, travelators and passenger lifts are not defined as exits by the BCA

5.2 NUMBER OF REQUIRED EXITS

The number of exits required (i.e. *required exits)* in a building, in addition to any horizontal exit, are stated in the BCA (cl 01.2). Those relevant to shopping centres are summarised in the table below.

TABLE 3

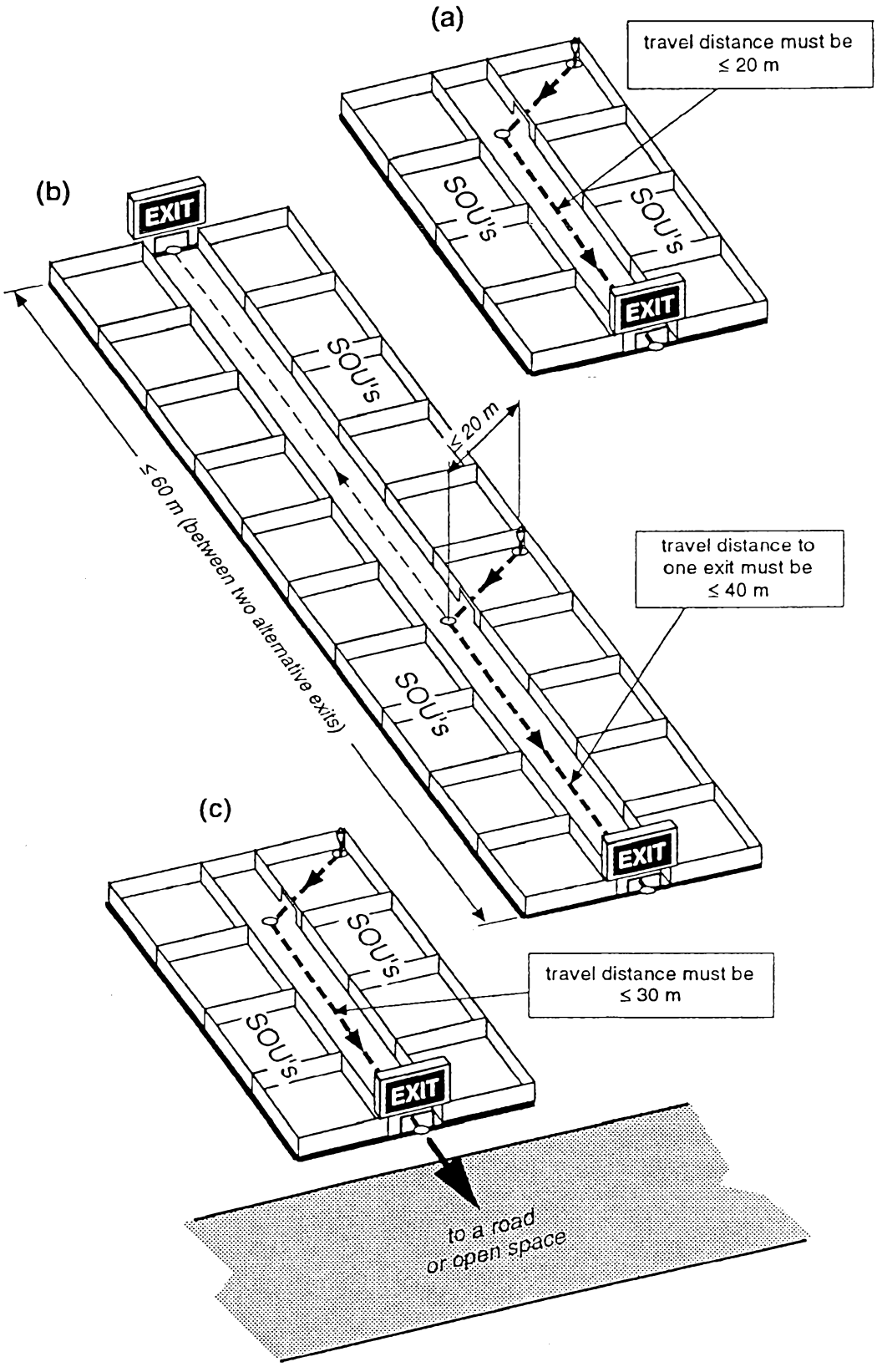
building effective height (m)	*number of required exit for each storey*	*number of required exit for each basement level*
< 25	≥ 1	≥ 2 †
≥ 25	22	≥ 2 †

† if
- area of storey < of >1.5 m, unless
- distance of travel and point on the floor to a single exit < 20 m.

5.3 EXIT TRAVEL DISTANCES

In addition, the BCA (cl D1.4(c)) requires the distance of travel to an exit comply with the following:

- no point on a floor must be more than 20 m from an exit (Figure 5.1(a)); or
- no point on a floor must be more than 20 m from a point from which travel in different directions to 2 exits is available, in which case the maximum distance to one of those exits must not exceed 40 m (Figure 5.1(b)); and



not to scale

FIGURE 5.1 EXIT TRAVEL DISTANCE

- the distance to a single exit serving a storey at the level of access to a road or open space may be increased to 30 m (Figure 5.1(c)).

It is noted that the travel distance requirements are independent of any sprinkler or smoke control system installed in a building.

When alternative exits are utilised to comply with the above travel distance requirements, they must then be considered as required exits, and comply with specific requirements for required exits. Alternative exits must be located such that they are evenly distributed within the building and not closer than 9 m or greater than 60 m apart.

Required exits must be fire-isolated when they connect or pass through more 3 consecutive storeys in a sprinklered building. Where fire-isolated exits are required, an external stairway may be utilised in lieu of a fine-isolated stairway if the building is less than 25 m in effective height. The external stairway is required to be non-combustible and located with specific constraints in relation to openings in the external wall in proximity to the stairway (Figure 5.2).

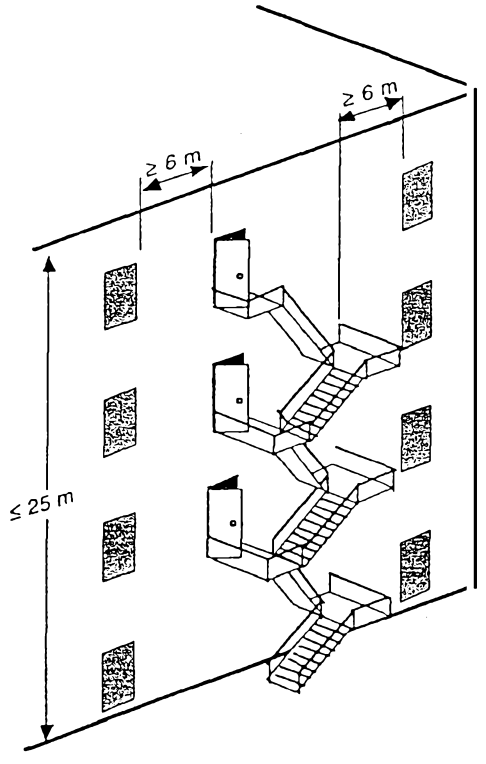
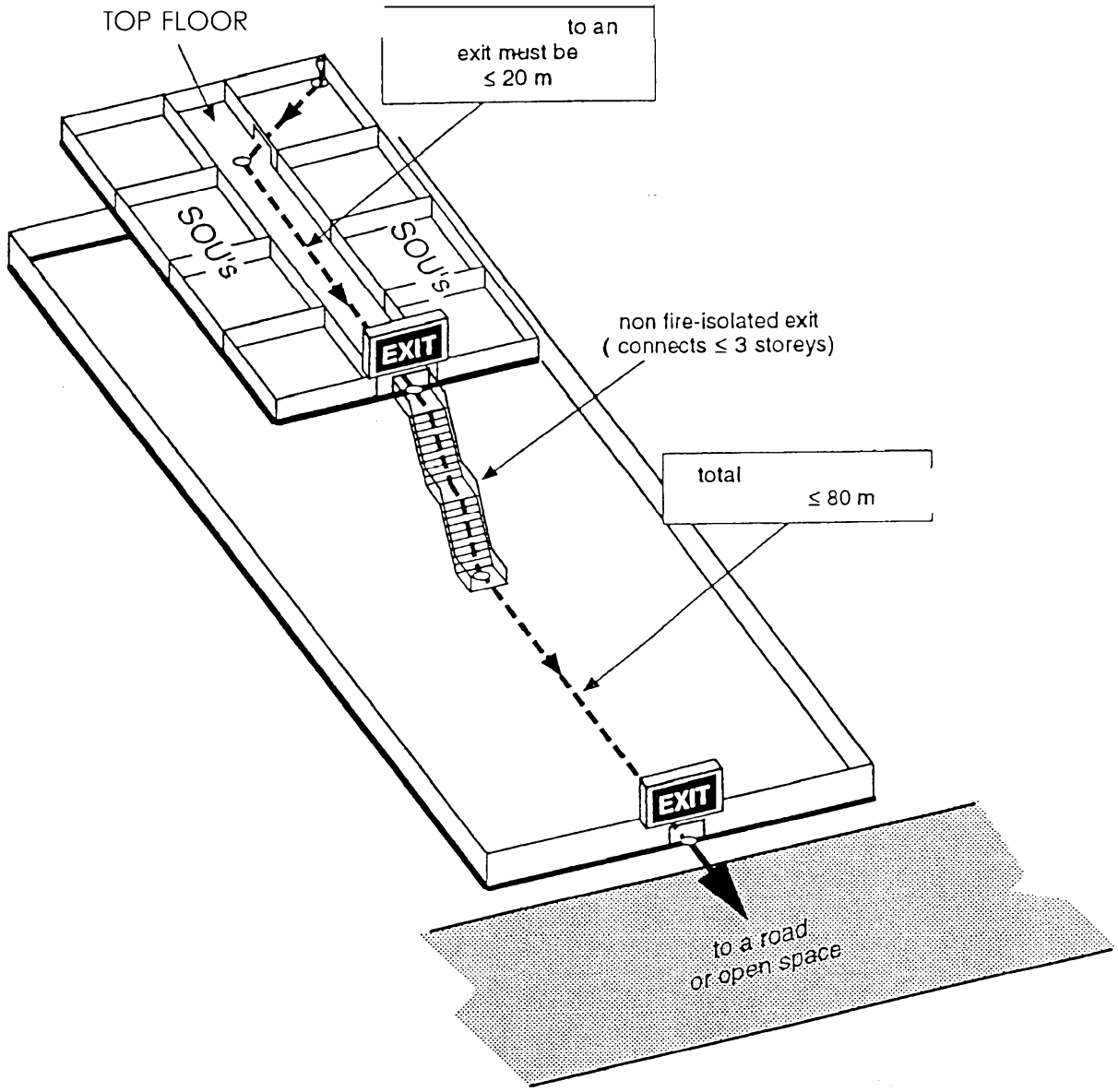


FIGURE 5.2 EXTERNAL STAIRWAY

The travel distance from a point on a floor to a road or open space by way of a required exit that is not fire-isolated (connects only 2 or 3 storeys) must not exceed 80 m. The required non fire-isolated exit is allowed to discharge inside the building, 20 m or 40 m (under certain criteria) from a doorway providing egress to a road or open space. The 80 m maximum travel distance is an additional requirement to the 20 or 40 m limit to an exit/alternative exit. These requirements are illustrated in Figure 5.3.



not to scale

FIGURE 5.3 TRAVEL DISTANCE TO ROAD OR OPEN SPACE

Excessive travel distances to exits may also be overcome by providing fire-isolated passageways that connect with fire-isolated stairways or ramps or connect with a road or open space. Alternatively compliance with excessive travel distance may also be met by providing extra exits that directly connect with a road or open space.

5.4 FIRE ISOLATED EXITS

The BCA (cl D1.7) contains specific requirements pertaining to doors opening into required fire-isolated stairways or passageways.

A doorway from a room must not open directly into a stairway, passageway or ramp that is required to be fire-isolated unless it is from-

- a public lobby, corridor, hallway, or the like; or
- a sole-occupancy unit occupying all of a storey; or
- a sanitary compartment, airlock or the like.

This precludes gaining access to fire-isolated passageways from the rear of individual shops (Figure 5.4(a)).

Additionally, the BCA (cl D1.7(d)) specifies that if more than 2 access doorways, not from a sanitary compartment or the like, open to a required fire-isolated exit in the same storey-

- a smoke lobby in accordance with the BCA (cl D2.6) must be provided (Figure 5.4(b)); or
- the exit must be pressurised in accordance with AS 1668.1 (Figure 5.4(c)).

The BCA (cl D1.7(b)) also sets out the discharge requirements for fire-isolated stairways or ramps. They must independently egress from each storey served and discharge directly, or by way of their own fire-isolated passageways:

- to a road or open space; or
- to a point-
  - in a storey or space, within the confines of the building, that is used only for pedestrian movement, car parking or the like and is enclosed for no more than 1/3 of its perimeter; and
  - from which an unimpeded path of travel, not further than 20 m, is available to a road or open space; or
- into a covered area that-
  - adjoins a road or open space; and
  - is open for at least 1/3 of its perimeter; and
  - has an unobstructed clear height throughout, including the perimeter openings, of not less than 3 m; and
  - provides an unimpeded path of travel from the point of discharge to the road or open space of not more than 6 m.

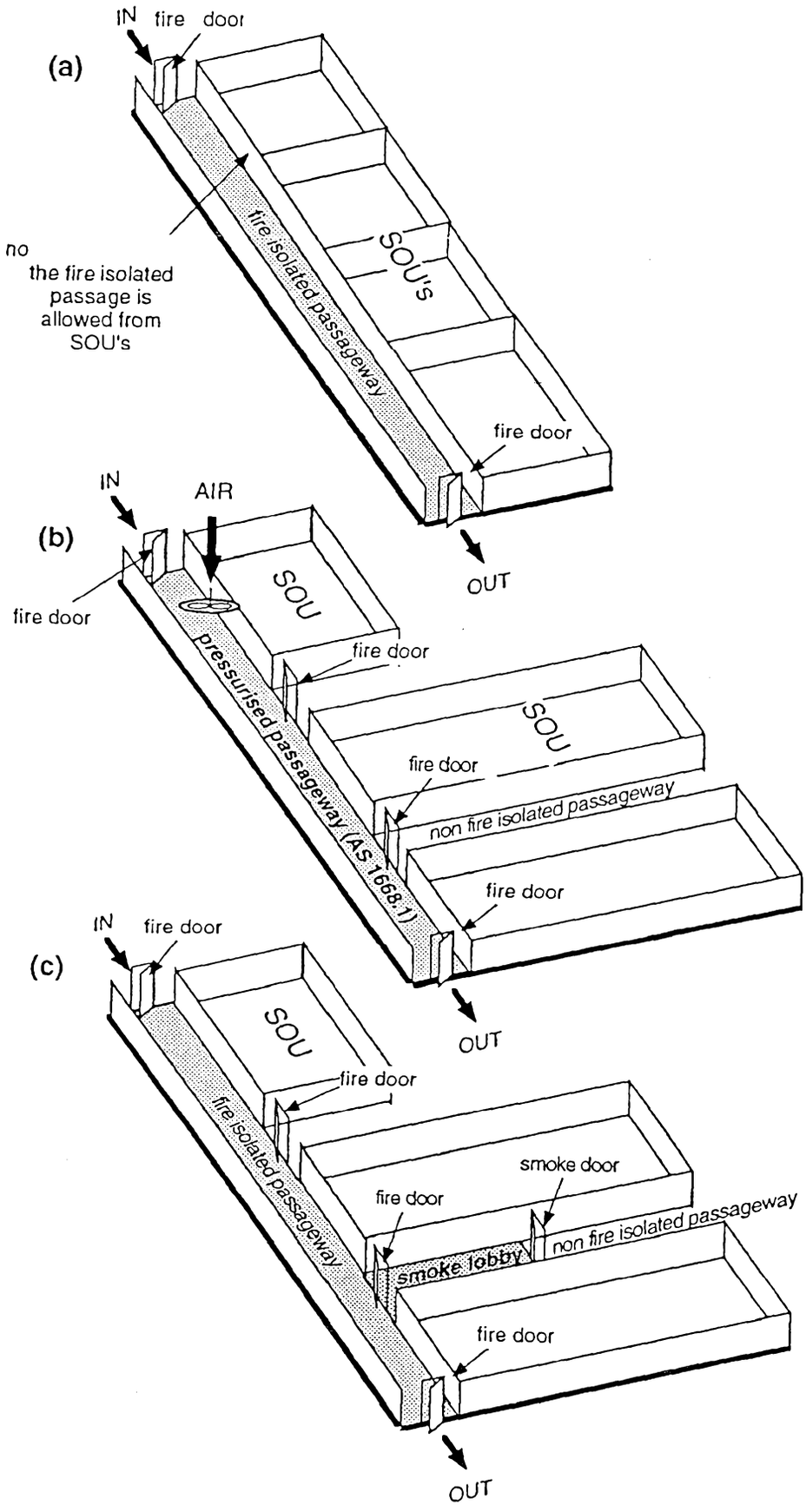


FIGURE 5.4 FIRE ISOLATED EXITS

5.5 REQUIRED EXIT DIMENSIONS

Shopping centres and cinema complexes contain large numbers of occupants. These buildings are required to provide sufficient exit widths to evacuate the number of people accommodated. The required exits per storey must comprise an aggregate egress width calculated as a proportion of the number of occupants to be accommodated.

The BCA (cl D1.13) states how the population of a building (and therefore a storey) is to be determined. The BCA (Table D 1.13) or another approved method of assessment may be used to determine the population. Table D1.13 gives the floor area per person for various building uses. For example:

type of use:	floor area per person (m')
· cafe, restaurant	1
· gymnasium	3
· shop-space for sale of goods (at a level entered direct from the open air or any lower level)	3
· shop-space for sale of goods (any other level)	5
· showroom, covered mall or arcade	5
· theatre	1.2 or seating capacity

The total population, for the purpose of calculating exit widths, is found by using the above numbers in association with the various use floor areas. The BCA (cl D1. 13) makes it clear, that for the purpose of these calculations, the spaces associated with lifts, stairs, ramps, escalators, corridors, hallways, lobbies and the like can be ignored. Nevertheless, for the floor area of a mall or atrium and the balconies associated with them, a population density of 5 m^2 per person is required to be considered.

For a typical shopping centre (the storeys of which will accommodate more than 200 persons) the BCA (cl D1.6(d)) requires the aggregate exit width or path of travel to an exit except for doorways to be calculated as:

- 2 m plus 500 mm for every 60 persons (or part) in excess of 200 persons if egress involves a change in floor level by a stairway or ramp with a gradient steeper than 1 in 12; or
- in any other case, 2 m plus 500 mm for every 75 persons (or part) in excess of 200.

The doorway width must be the width of each exit provided, as determined above but may be reduced by 250 mm. The unobstructed height throughout an exit must not be less than 2 m, or 1980 mm in the case of doors.

5.6 HORIZONTAL EXITS

In the case of a storey or fire compartment not being able to provide a sufficient exit width, or travel distance to an exit within the limits, then a "horizontal exit" may be utilised. A horizontal exit may be provided between fire

separated areas that are not SOU's. For example, a horizontal exit may be provided between the mall area within a shopping centre and a fire separated department store. It is noted that the horizontal exit in this case may only considered "one way" - provided for occupants within a department store egressing to the mall but not for the occupants in the mall to egress into the department store. The horizontal exit concept considers a doorway in a fire wall between fire compartments as being an appropriate exit if the doorway is a self closing or automatic fire door as specified by BCA (cl C3.7) and does not comprise more than 50 % of the required exits from any part of the divided storey. Both sides of the horizontal exit must be able to accommodate 0.5 m^2 per person accommodated on that storey in each of the compartments- Figure 5.5 illustrates one usage of a horizontal exit and it is noted that the 0.5 m^2 per person is only required to be provided to the mall side.

5.7 NON-REQUIRED EXITS

Escalators and travelators are common in shopping centres and department stores. The escalators, travelators and *non-required non-fire-isolated stairways* are regulated by the BCA (cl D1.12). The intent of this clause is to limit the number of storeys that can be connected in order to limit smoke and fire migration between the connecting floors. Escalators, travelators and non-required non-fire-isolated stairways may connect:

- not more than 2 storeys or 3 storeys in a sprinklered building where storeys are consecutive and one of the storeys provides direct egress to a road or open space; or
- any number of storeys provided compliance with BCA Spec D1.12, which sets out forms of construction in order to limit potential fire and smoke spread via an void space.

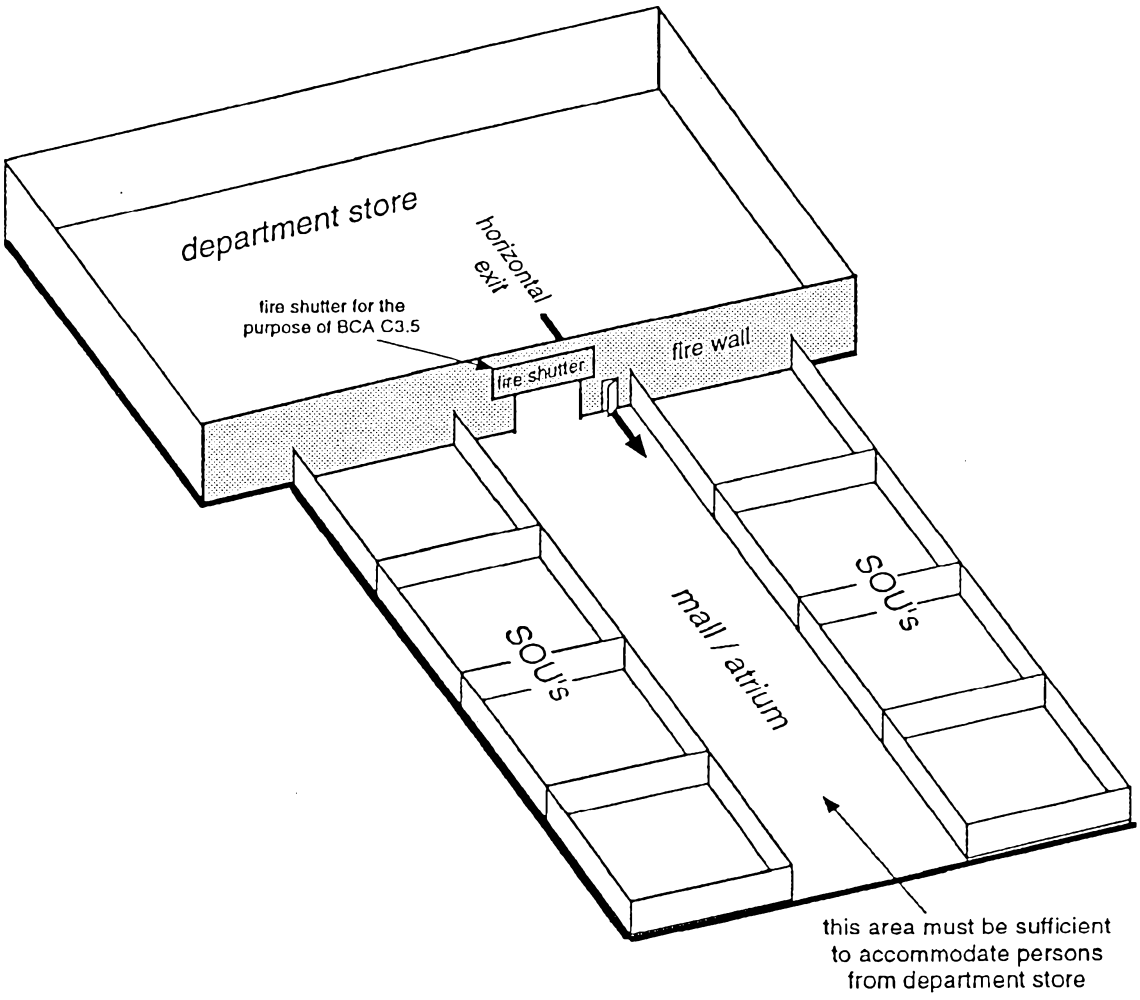


FIGURE 5.5 HORIZONTAL EXIT

6 SPRINKLER SYSTEM REQUIREMENTS

A sprinkler system is required in building fire compartments with a floor area greater than 3500 m^2 or in buildings required by the large isolated building requirements. In such cases the BCA requires the sprinkler system to be designed to control the development and spread of fire in a building.

A sprinkler system may be designed to BCA Spec El.5 or to any other standard that meets the above mentioned level of performance. According to the BCA (Spec E2.2), a Grade III water supply is permitted if the building is less than 25m. If the building is greater than 25 m the water supply must be either a Grade I or Grade II supply. According to AS 2 118 up to 1000 sprinkler heads can be controlled from one sprinkler stop valve. An external booster connection must be provided to allow boosting of the system pressure by the fire brigade should this be needed. The BCA (via AS 2118) requires all stop valves to be electronically monitored to guard against unauthorised operation and for the valves to located within a secure room.

Shopping centres often incorporate various classes of building. A summary of some of the sprinkler requirements for various classes of building are detailed in the Table 4 and have been obtained from AS 2118. It should be noted that the requirements for sprinklers in ceiling, roof, floor, and concealed spaces have also been given.

In Class 6 buildings where the distance between ceiling and floor is generally greater than 800 mm and where this space typically only occupies water pipes, electric wiring, air conditioning ducts or non-combustible materials, then the sprinkler system required throughout this space may be an extra light hazard system (4.6 m maximum spacing, max area of coverage 21 m^2).

AS 2118 (cl 5.4.3) requires that roofs be sprinklered. This also applies to the roofs of shopping malls.

TABLE 4 SPRINKLER SYSTEM REQUIREMENTS

Location	*Hazard Class*	*Assumed Area of Operation (m^2)*	*Design Density of Discharge (mm/min)*	*Sprinkler Nom. Dia. (mm)*	*Max. Spacing (m)*	*Max Coverage Area (m^2)*
Carparks	Ordinary,	144	5	15	4	12
Cinemas	Ordinary,	216	5	15	4	12
Offices	Extra Light	84	2.25	10	4.6	9
Shops and department stores	Ordinary, Group III	216	5	15	4	12
Between roof spaces:						
d≥400				10 to 15	4 ‡	12 §
d<400				10	7†	42
Between floor and Ceiling spaces:						
d≥800				10 to 15	4 ‡	12 §
200<d<800				10	7†	42

Notes: d = depth in mm

‡ 4.6 m—where pipes, trunking of

§ 21 m^2 —where the concealed spaces pipes, trunking of

† ≤ 15 m in and draught stops.

7 SMOKE HAZARD MANAGEMENT

7.1 AIR-HANDLING AND SMOKE MANAGEMENT SYSTEMS

The two types of mechanical air handling systems that can be installed in a shopping centre building are a *central air handling system* or an *individual air handling system.* A central air handling system is one which re-cycles air to more than one fire compartment whereas am individual air handling system only re-cycles air within one fire compartment. If a shopping centre is constructed as one fire compartment, which is often the case, then the system will be classified as an individual air handling unit.

Smoke management may be achieved through the limitation of supply air to the enclosure where the fire is located, and the simultaneous operation of mechanical smoke exhaust or ventilation system, upon the activation of a detection system. An air-handling system may be an integrated smoke exhaust system and achieve the same result by operating in "smoke" mode.

7.2 REQUIREMENTS

7.2.1 GENERAL

Various clauses in the BCA require smoke management to be considered-for example; cl C2.3 (large isolated buildings), cl E2.2 and cl G3.8 (atriums). Each clause specifies different methods of compliance and some requirements appear to overlap. For example, cl C2.3 refers to a smoke exhaust system in accordance with Spec E2.2 but makes no reference to cl E2.2 (and therefore does not refer to Table E2.2) which sets out a number of specific requirements. The most conservative of the various requirements must be satisfied.

As stated in Section 2.3 of this report, a smoke exhaust or venting system is required for large isolated buildings with a building total floor area greater than 18,000 m^2, or with a building volume greater than 108,000 m^3. Where the ceiling height of a fire compartment is less than 12 m, a smoke venting system to Spec E2.4 or a smoke exhaust system to Spec E2.2 must be provided. A ceiling height greater 12 m requires a smoke exhaust system to Spec E2.2.

The BCA (cl E2.2) requires that a building (open-deck car-parks and certain other buildings excluded) has a smoke hazard management system such that the following requirements are met:

(a) In the event of a fire in a building, the conditions in any escape route must be maintained for a height of not less than 2.1 m above the floor level so that-

- the temperature will not endanger human life; and
- the level of visibility will enable the escape route to be determined; and
- the Ievel of toxicity will not endanger human life, for the period of time the occupants would take to evacuate that part of the building.

(b) The period of time to evacuate must take account of the nature of the building and mobility of the occupants.

(c) For the purposes of this Part, escape route means the continuous path of travel (including exits, fire-isolated passageways, fire-isolated ramps, public corridors and the like) from any part of a building.

The wording of the above requirements suggest, that if it can be demonstrated by calculation that the above performance will be achieved with a particular design, then that design is an acceptable solution. In this case however, the burden of proof is with the designer.

The remainder of Spec E2.2 is aimed at providing "deemed-to-comply" solutions for the purpose of satisfying (a).

- *Buildings with Central Air-handling Systems-A* Central Air-handling System in a Class 6 building must operate as a smoke control system in conjunction with other systems installed to satisfy Table E2.2. Alternatively, it can be arranged so that under fire conditions it does not compromise other smoke management systems as required by Table E2.2.

  In addition to the above requirement these buildings are deemed to satisfy the performance requirements of BCA cl E2.2(a) if they comply with:

  (a) other requirements of the BCA (considered in other sections); and

  (b) deemed-to-satisfy provisions of BCA Table E2.2; and

  (c) in the case of a buildings containing parts of different classifications:

    (i) each separate classification complies with the relevant provisions of Table E2.2 determined as if all storeys below, excluding basements, are of that same classification; or

    (ii) the whole building complies with the most stringent of those provisions: and

    (iii) an audible warning is initiated on the activation of an automatic smoke control system and stair pressurisation system if one is installed.

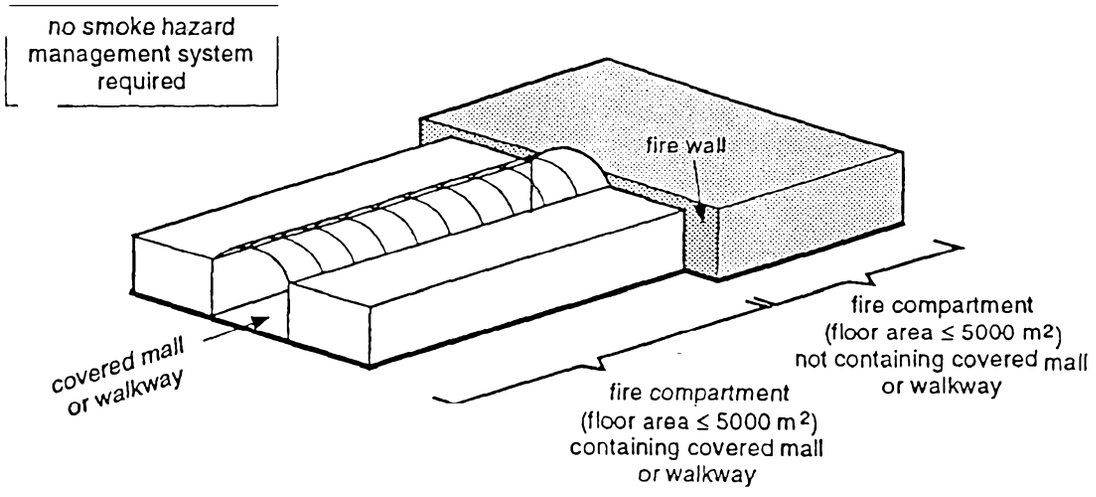
- *Buildings with Individual Air-handling* Systems-Buildings with these air-handling systems are deemed to satisfy the performance requirements of cl E2.2(a) if they comply with (a)-(c) above, as for buildings with Central Air-handling Systems.

The provisions of Table E2.2 are now considered.

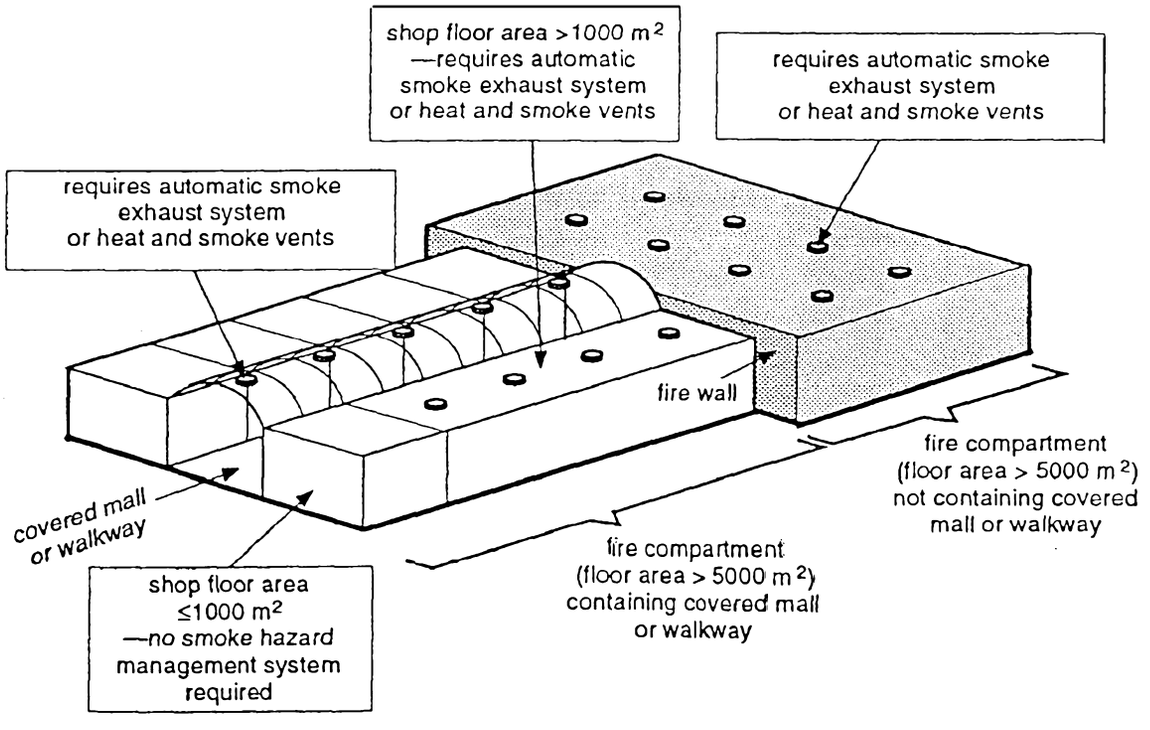
7.2.2 DEEMED-TO-SATISFY PROVISIONS—TABLE E2.2

- *Shops and Department Stores :*

  - *single storey* buildings-Figure 7.1 relates to single storey sprinklered buildings. It will be noted that neither the mall nor the department store are required to have smoke extraction or exhaust unless the floor area of the fire compartment exceeds 5000 m^2. For single storey sprinklered shops which do not open into a common mall there are no requirements for smoke exhaust or venting.



a) Fire Compartment floor area ≤ 5000 m²



b) Fire Compartment floor area > 5000 m²

FIGURE 7.1 SPRINKLERED SINGLE STOREY BUILDINGS

- *two storey buildings* -The situations for two-storey sprinklered buildings are illustrated by Figure 7.2. Provided the total floor area of the fire compartment is less than 3500 m^2, there are no requirements for smoke exhaust or venting. If the floor area exceeds this limit then exhaust or venting is required for the mall, and non-compartmentalised shops with a floor area greater than 1000 m^2, are required to have a smoke exhaust system or smoke venting if the shop is single storey. If the shop is compartmentalised, and opens into a mall, a smoke exhaust system is required only if the floor area of that shop exceeds 3500 m^2.

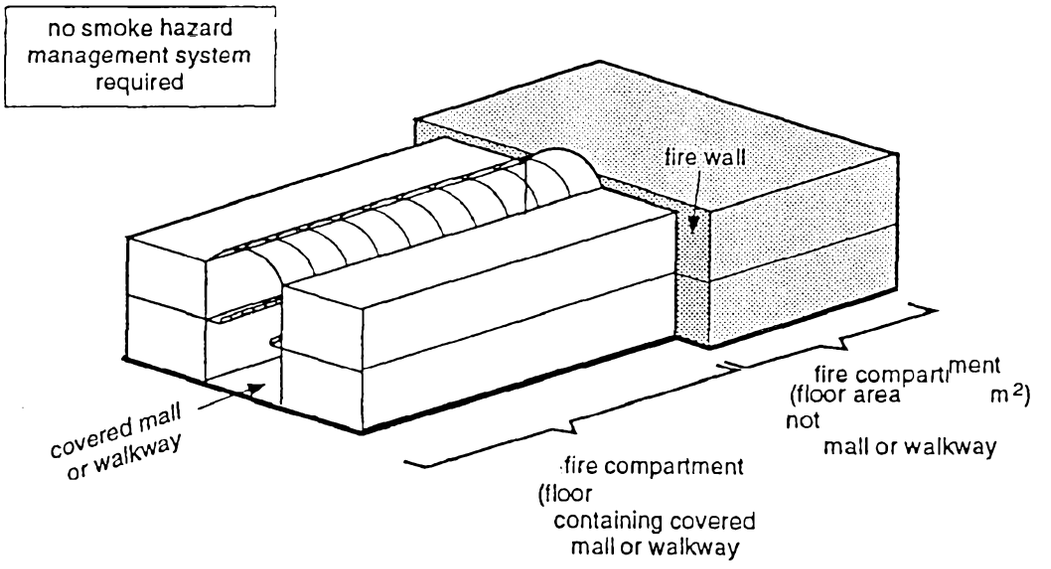
  In the case of a two-storey building which does not open into a common mall, and which has open access (escalators etc.) between the storeys, the BCA will regard the building as being one fire compartment irrespective of whether the floors have a fire-resistance level or not. In this case, a smoke exhaust system capable of exhausting smoke from any floor must be provided.

- *three storey buildings* -The above requirements also apply to three-storey buildings (Figure 7.3), however in this case, a smoke exhaust system is required for any shop with a floor area of greater than 1000 m^2—irrespective of whether that shop is compartmentalised. Again, due to access requirements between the floors, the BCA will regard these buildings as single fire compartments.

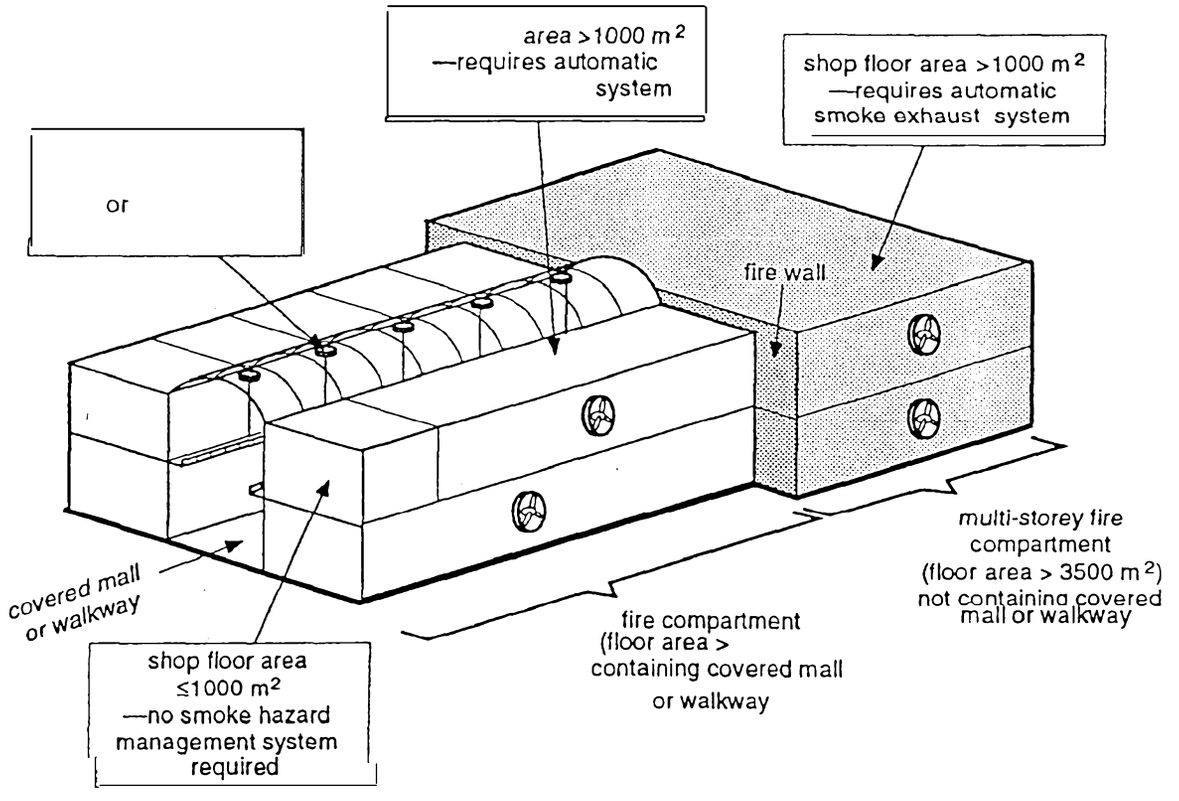
- *four storey* buildings-Four-storey buildings, which do not open into a common mall or covered walkway, must have a smoke exhaust system as required for three storey buildings. Such buildings, which incorporate a mall or a covered walkway are classified as atrium buildings, and must satisfy additional requirements which will be considered further in Section 8.

- *Carparks*—When carparks are provided with a mechanical ventilation system in accordance with AS 1668.2 [7] then they must be designed to satisfy, cl 7.6 of AS 1668.1 [8]. Figure 7.8 illustrates carpark exhaust requirements.

- Cinemas-According to Table E2.2, a smoke exhaust system in accordance with Spec E2.2 will be required when fire compartments are greater than 2000 m^2. It is noted that each individual cinema cubicle are constructed as individual fire compartments due to sound transmission insulation criteria and therefore nullifies any requirement. It is also noted that it is only in the case of a cinema within a single storey building and having a fire compartment not more than 5000 m^2 that sprinklers are allowed as an adequate means of a smoke management.



a) Fire Compartment floor area ≤ 3500 m²



b) Fire Compartment floor area > 3500 m²

FIGURE 7.2 SPRINKLERED **TWO STOREY BUILDINGS**

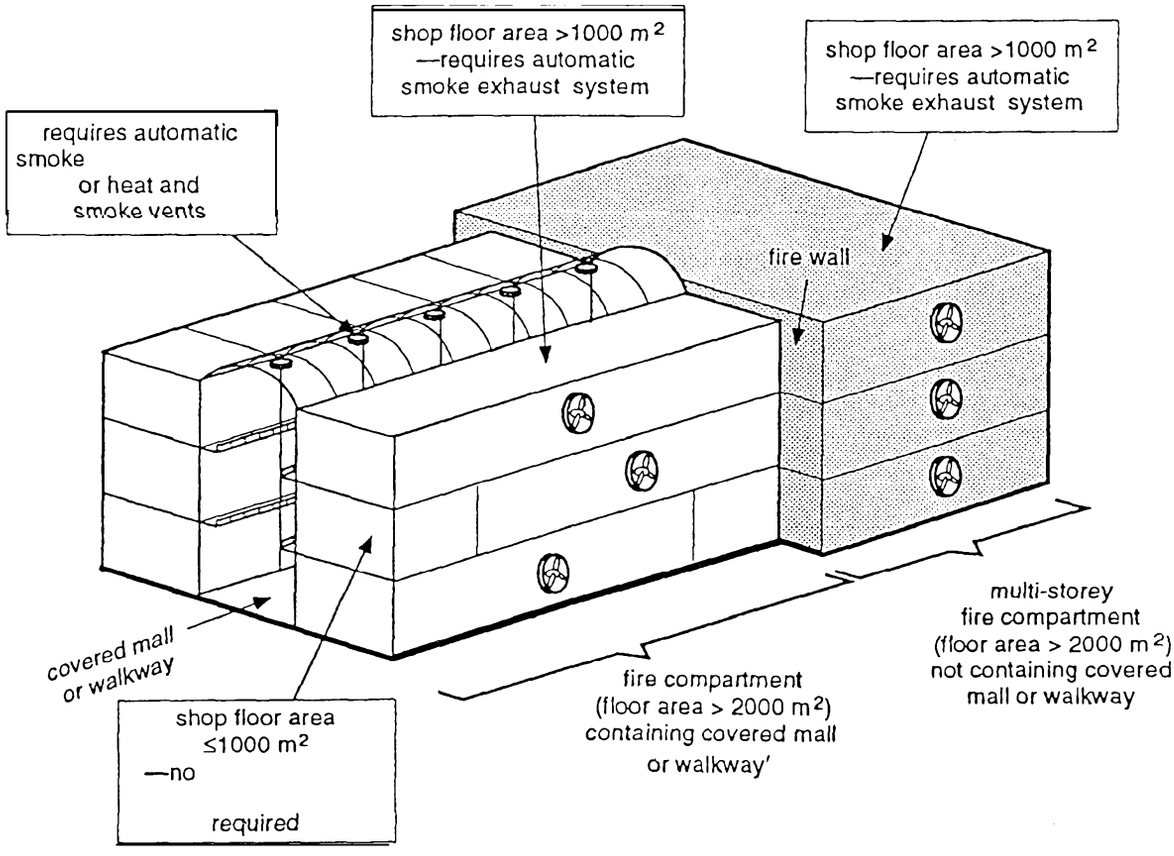


FIGURE 7.3 SPRINKLERED THREE STOREY BUILDING

7.2.3 SMOKE HAZARD MANAGEMENT SYSTEMS

(i) Smoke and Heat Venting-Clause E2.4

The requirements for smoke and heat venting are illustrated diagrammatically in Figure 7.4. These systems must comply with AS 2665 [9] and other requirements located in cl E2.4. Draught curtains must be provided at regular intervals to divide the roof into compartments. Roof vents within the same compartment must open simultaneously in the event of a fire.

The opening of vents may be initiated by a number of mechanisms as depicted in Figure 7.4.

(ii) Smoke Exhaust Systems-Spec E2.2

Smoke exhaust systems operate by extracting smoke from "reservoirs". Satisfactory performance is achieved if the bottom of the smoke layer is kept greater than 2.1 m above the highest floor level.

This performance requirement is deemed to be achieved if the requirements illustrated in Figure 7.5(a) are achieved. For sprinklered buildings the design capacity is determined on the basis of a sprinkled fire although no indication is given of the duration of the fire-except that the exhaust fans must continue to operate for 60 minutes at an air temperature of 200°C.

The smoke exhaust system can be activated, as illustrated in Figure 7.5(b). It is noted that the smoke detectors must activate the fans in the appropriate reservoir and not in all reservoirs unless smoke is detected. Since smoke exhaust is required to be activated by other alarm devices and sprinklers (when located on the same grid pattern), it is not clear whether similar discrimination is intended for the activation of the exhaust fans.

According to cl 2.5 of the specification, individual air-handling systems that supply air at a rate greater than 500 l/s and which do not form part of the smoke exhaust system, must shut down on the activation of the smoke exhaust system.

Smoke detectors installed to activate the smoke exhaust system must be connected to

(a) an EWIS if required by Part E4 of the BCA; or

(b) a system of loudspeakers or other audible alarm warning devices complying with cl 2.2.3 of AS 2220.2 [10] located on each storey.

An EWIS is only required for atriums by Specification G3.8 and for cinemas by clause E2.4 —Cinemas[5].

- *Single storey jire* compartments-Specific requirements are given in Spec E2.2 cl 2.9 regarding the details of detection and smoke reservoirs to be provided at the ceiling level in a single storey enclosure or fire compartment. The requirements are as shown in Figure 7.5 but with the addition that the maximum area and minimum depth of a smoke reservoir is 2000 m^2 and 500 mm, respectively.

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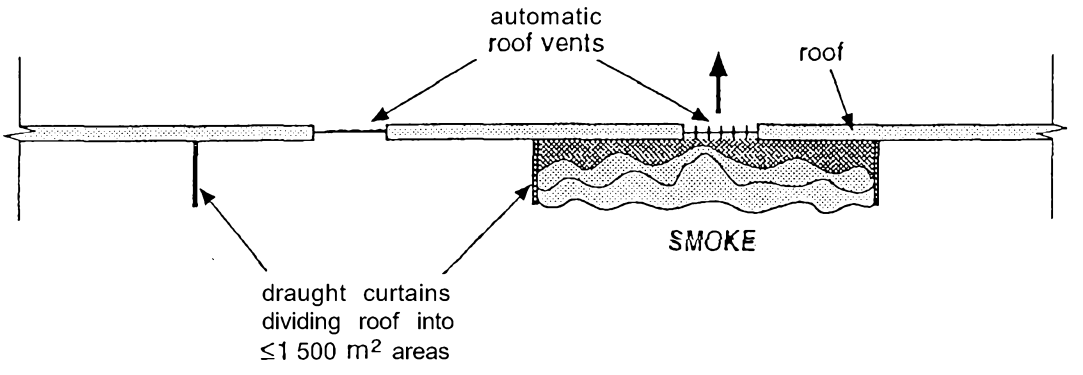
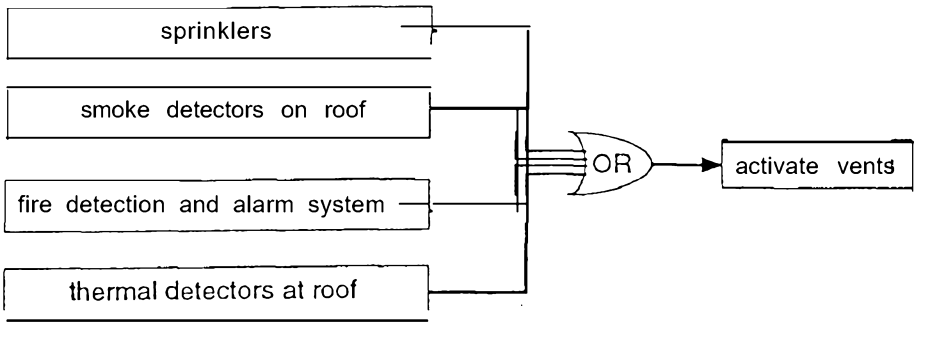
any a 25 metres in effective height to be provided with an EWIS.

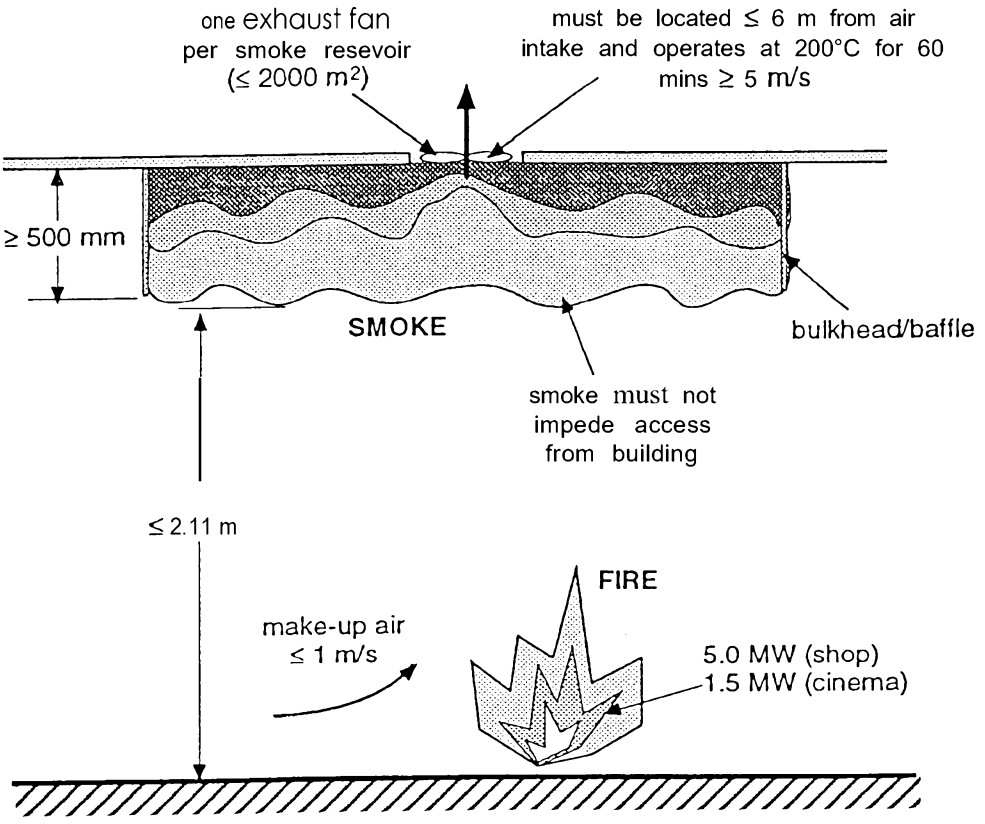


a) roof vents and draught curtains

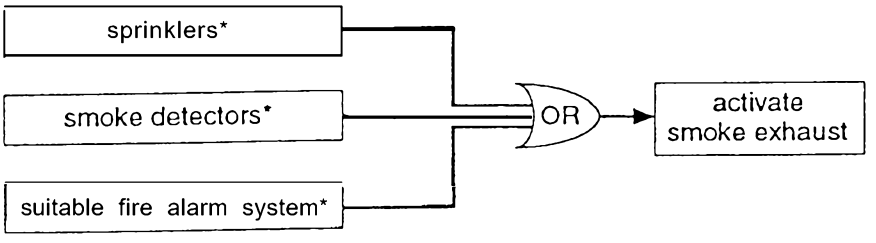


b) means of activation

FIGURE 7.4 HEAT VENTS



a) Requirements for Smoke Exhaust Systems



*detectors located within reservoir

b) Means of Activation

FIGURE 7.5 SMOKE EXHAUST SYSTEM

These requirements will also apply to a shop that is required to have a smoke exhaust system, and that is located within a multi-level shopping centre, provided that the shop has been compartmentalised vertically and horizontally.

- *Multi-storey fire* compartments--There may be no compartmentation within a multi-level shopping centre, and in this case, cl 2.10 gives a number of specific requirements with regard to detection, reservoir size, bulkheads or baffle around openings between storeys, and operation of the smoke exhaust system. These requirements are illustrated in Figure 7.6.
- *Enclosed common walkways and* malls-In the case of shopping malls, the mall area must also have an appropriate smoke exhaust system. This system is activated by smoke detection within the mall (BCA Spec E2.2 cl 3(d)) and consists of smoke exhaust fans and smoke reservoirs at roof or ceiling level. The details are shown in Figure 7.7.

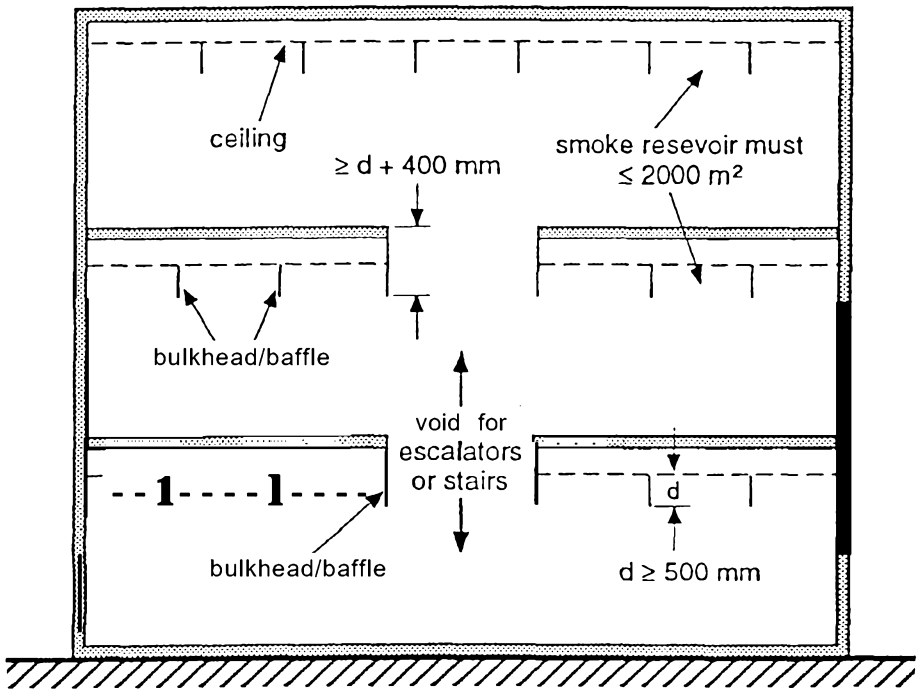
(iii) AS 1668.1 Requirements

AS 1668.1 is referred to within Part E2 and then within Spec E2.2. A summary of the various references to this standard in relation to Class 6 buildings, carparks, and cinemas, is given below.

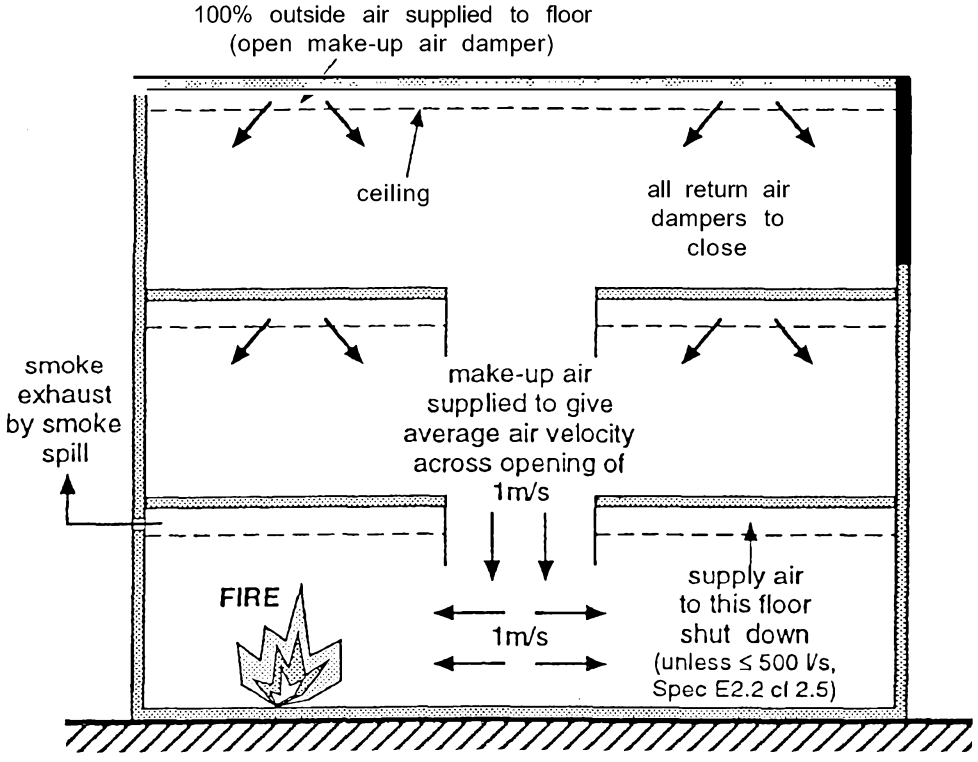
(a) cl E2.2(b) requires central air-handling systems which form part of the smoke control system to be designed in accordance with AS 1668.1 (Section 5)

(b) Spec E2.2 refers to AS 1668.1 in cl 2.3 (c)(ii) (smoke exhaust control details), cl 2.3(d) (power supply wiring), and cl 2.5(b) (smoke detection).

(c) Table E2.2 requires carparks provided with a mechanical ventilation system designed in accordance with AS 1668.2 to comply with cl 7.6 of AS 1668.1. This clause covers smoke detection and the operation of exhaust and air supply systems in the event of a fire. The specific requirements are summarised in Figure 7.8.

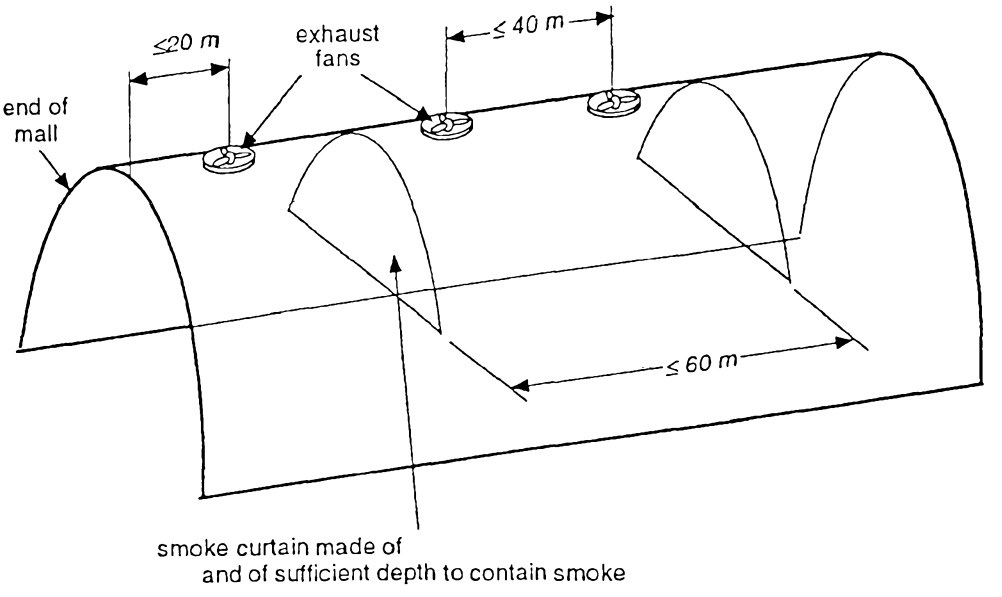


a) Smoke Resevoir Requirements



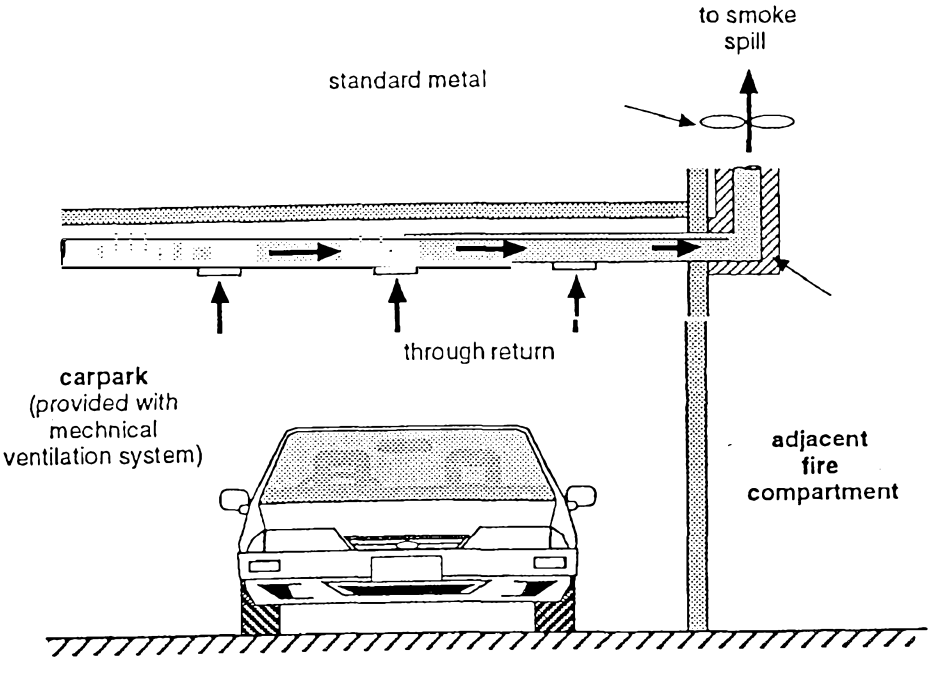
b) Exhaust and Supply in Fire Mode

FIGURE 7.6 MULTI-STOREY FIRE COMPARTMENTS



NB: fans must not of malls

FIGURE 7.7 EXHAUST REQUIREMENTS FOR MALLS



electical not be fire rated

FIGURE 7.8 SMOKE CONTROL FOR CARPARKS

8 ATRIUMS

8.1 GENERAL REQUIREMENTS

The BCA (cl Al. 1) defines an *atrium* as :

"a space within a building that connects 2 or more storeys, and-

* is wholly or substantially enclosed at the top by a floor or roof (including a glazed roof structure); and
* includes any adjacent part of the building not separated by bounding construction in accordance with Part G3; but
* does not include a stairwell, rampwell or the space within a shaft."

It should be noted that the above definition does not include escalator voids-but it is reasonable to consider these as being similar to a stairwell, particularly since it is not allowed to vent smoke via an escalator void.

A building containing an atrium must comply with the requirements of **Part G3** of the BCA. However, the BCA (cl G3.1) makes it clear that it does not apply to an atrium that:

- connects only 2 storeys; or
- connects only 3 storeys if-
  - each storey is provided with a sprinkler system throughout; and
  - one of those storeys is situated at a level at which there is direct egress to a road or open space.

It follows therefore, that within the context of this project on low-rise sprinklered buildings, Part G3 only applies to atriums which connect at least four storeys (Figure 8.1). It is convenient to consider that an atrium contains a "well". Thus an *atrium well* is defined by the BCA as:

"a space in an atrium bounded by the perimeter of the openings in the floors or by the perimeter of the floors and the external walls."

The atrium well has no maximum size limitation or shape restrictions except that the width throughout the well must be able to contain an imaginary 6 m diameter cylinder (BCA cl G3.2). This requirement applies to all voids between floors where four or more floors are connected, and where the voids are not for the purpose of stairs, escalators, rampwell, or the space within a vertical shaft.

An atrium (well) typically requires separation from the remainder of the building by bounding wall construction, with a setback of not greater than 3.5 m from the perimeter of the atrium well. Boundary wall construction is required by the BCA (cl G3.3) at all levels, with the exception of 3 consecutive storeys if (Figure 8.1):

(a) one of these storeys is at a level at which direct egress to a road or open space is provided; and

(b) the sum of the floor areas of those storeys that are contained within the atrium is not more than the maximum area that is permitted in Table c2.2.

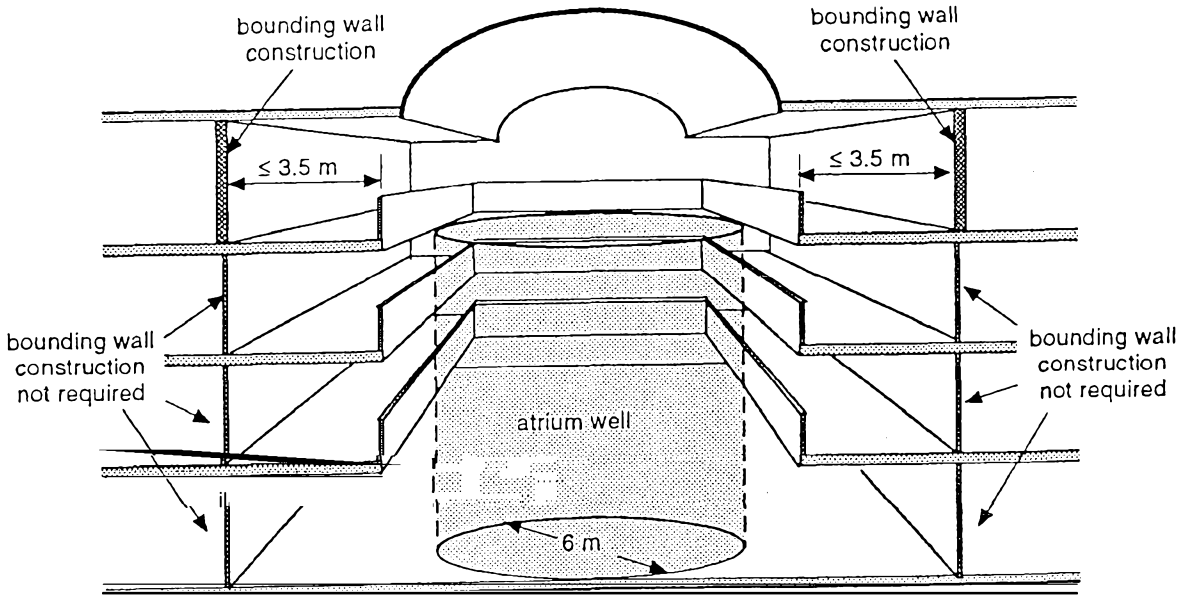


FIGURE 8.1 ATRIUM WELL

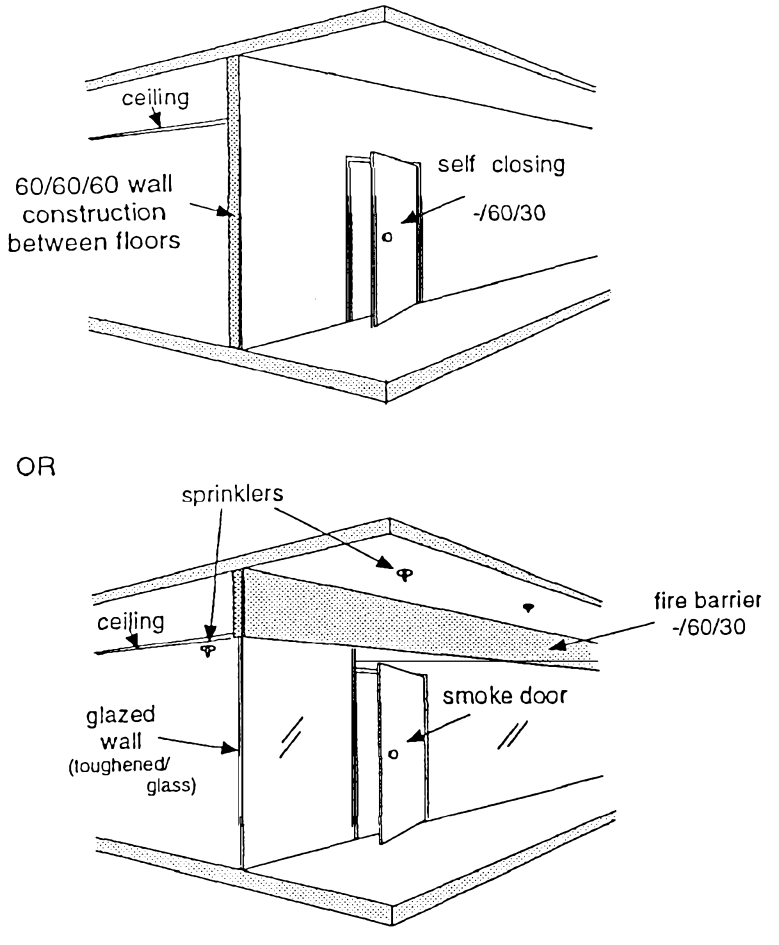


FIGURE 8.2 BOUNDING WALL CONSTRUCTION

Condition (a) is normally achieved within shopping centre atria; however, item **(b)** requires extensive compartmentation of the floor levels or the construction of bounding walls within 3.5 m of the atrium well. A literal interpretation of item (b) refers to Table C2.2 and therefore disallows the use of the provisions for large isolated buildings cl C2.3.

8.2 BOUNDING WALL CONSTRUCTION

According to the BCA (cl G3.4) a variety of construction techniques can be used for bounding walls. The various options are illustrated by Figure 8.2. This bounding wall construction is apparently required to prevent spread of a fire from the atrium to the surrounding floor but is not considered to separate the adjacent storey into a separate fire compartment. That is, these walls are not regarded as fire walls but rather walls which will offer some fire-separating function. The presence of these walls defines the extent of the atrium (Figure 8.3).

8.3 ROOF SEPARATION

According cl G3.6 of the BCA, the roof structure and membrane must have an FRL of 180/60/30 or be protected by a sprinkler system. The sprinkler system is to be designed in accordance with E1.5. Clause 5.4.3 of AS 2118[6] requires roofs to be sprinklered. Clause G3.8 also specifies roof sprinkler protection to be provided to

8.4 EGRESS

The BCA (cl G3.7) requires that *all* areas within an atrium must have access to at least two exits. The spacing and details of exits must comply with Section D.

8.5 FIRE AND SMOKE CONTROL

The BCA (cl G3.8) states that "suitable provision for sprinkler systems, smoke control, fire detection and alarm systems, and emergency warning and intercommunication systems must be provided in a building containing an atrium".

A mechanical air-handling system (unless where varied by in a building containing an atrium must be in accordance with AS 1668.1

Compliance with Spec G3.8 of the BCA and AS 1668.1 is considered to satisfy the above performance requirement.

(a) *Rocf protection-* According Spec G3.8, cl 2.2, if the roof of an atrium does not have an FRL it must be sprinkler protected if the distances between various parts of the atrium and the roof exceed the limit shown in Figure 8.4.

(b) Floor protection-Spec G3.8, cl 2.3 requires protection of the floor of the atrium by overhead and fast response sidewall sprinklers. The overhead sprinklers are in addition to those on the roof of the atrium.

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[6]It appears that of sprinklers on roofs is to cool the roof membrane to prevent may cause malfunctioning of the

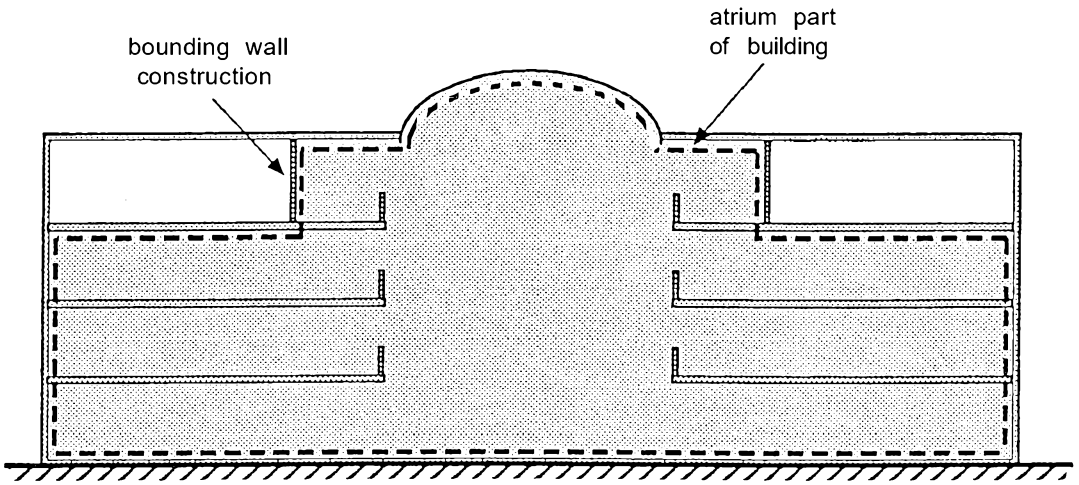

FIGURE 8.3 ATRIUM PART OF BUILDING

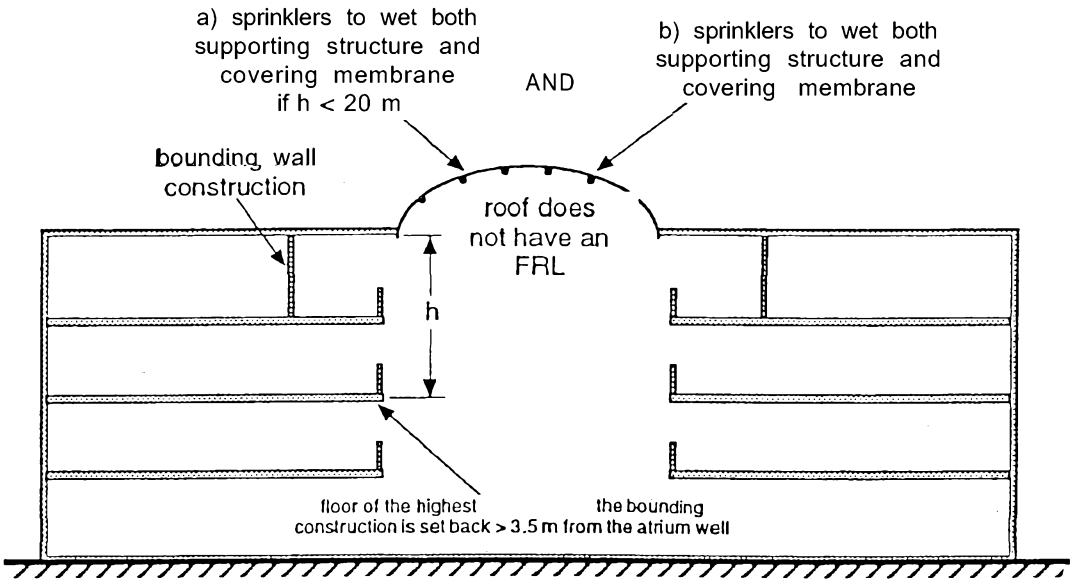

FIGURE 8.4 ATRIUM ROOF PROTECTION

(c) *Sprinkler protection to glazed walls*- Spec G3.8, cl 2.4 sets out the requirements for sprinkler protection of bounding wall construction and glazed walls or doors. These requirements, along with those for water discharge rate and water supply, are illustrated in Figure 8.5.

(d) *Stop valves for atrium sprinklers*—Spec *G3.8,* cl 2.5. All sprinkler valves must be monitored and independent valves provided for the roof sprinklers and for sprinklers used for wall wetting of glazing associated with bounding wall construction.

(e) *Smoke control* system-Spec G3.8, cl 3.2 specifies deemed to comply requirements for the operation of air-handling and smoke control systems in these buildings.

3CA Spec 3.8

3.2 Operation of *atrium* systems

Mechanical *atrium* to that luring

(a) atmosphere is maintained in all paths of *required exits* during the period of

(b) smoke exhaust *atrium* are only *atrium;* and

(c) central do the *atrium*

(d) central *atrium*-

(i) cycle

(ii) stop supply air to the fire affected *storey* or *fire compartment*; and

(iii) continue to fully affected *storey* or *fire compartment* from other *storeys* or *fire compartments* 75%; and

(iv) continue to supply *air* to *fire compartments* or *storeys* other than the fire affected *storey* or *fire compartment;* and

(e) fans or exhaust *the atrium*

(f) floor a single *fire compartment* or *storey*-

(i) in affected *storey* or *fire compartment;* and

(ii) commences full relief fire affected *storey* or *fire compartment;* and

(iii) continue to to *fire compartments or storeys* affected *storey* or *fire compartment.*

It will be noted that both central and *unitary* (or individual) air-handling systems are considered. There appears to be significant conflict with the above requirements and those of clauses 3.3, 3.4 and 3.5.

Spec G3.8, cl 3.4 specifies the design fires to be used for various situations. It also gives recommended exhaust fan capacities, and cl 3.5 specifies some additional (upward) air flow requirements to be achieved in the atrium well.

Spec G3.8, cl 3.7 does not allow the use of smoke or heat vents in an atrium when a Class 6 part of the building adjoins the atrium. Table E2.2 allow the

use of either smoke exhaust or smoke and heat vents in malls or walkways when required.

According to cl 7 required fire-isolated exits in a building containing an atrium must be protected from the entry of smoke by means of stair pressurisation.

(f) *Smoke* detection-cls 4.1 to 4.3 give specific requirements for smoke detection. Automatic fire detection and alarm systems must comply with AS 1670 [11] except when specific requirements are given by Spec G3.8 cls *4.2* and 4.3.

(g) *Alarm* systems--Alarm systems required for a building with an atrium include a break-glass fire alarm at each door to a tire-isolated stairway, ramp, and passage. Where a sampling type smoke detector is provided for an atrium, a staged alarm must be given. Smoke detectors and other alarms must result in a call to the fire brigade and activate the EWIS.

(h) *Emergency warning and intercommunication system (EWIS)*—All buildings containing atria must have an emergency warning and intercommunication system. EWIS are described further in Section 10 of this report.

(i) *Standby power* — According to cl 6, if a required path of travel to an exit is within an atrium, a suitable alternative power supply must be provided to operate required safety systems, including sprinkler systems and hydrant pumps, air handling systems, alarms, warning and communication systems, and emergency lighting circuits. If this standby supply is within the building, it must be within an enclosure having an FRL of 120/120/120.

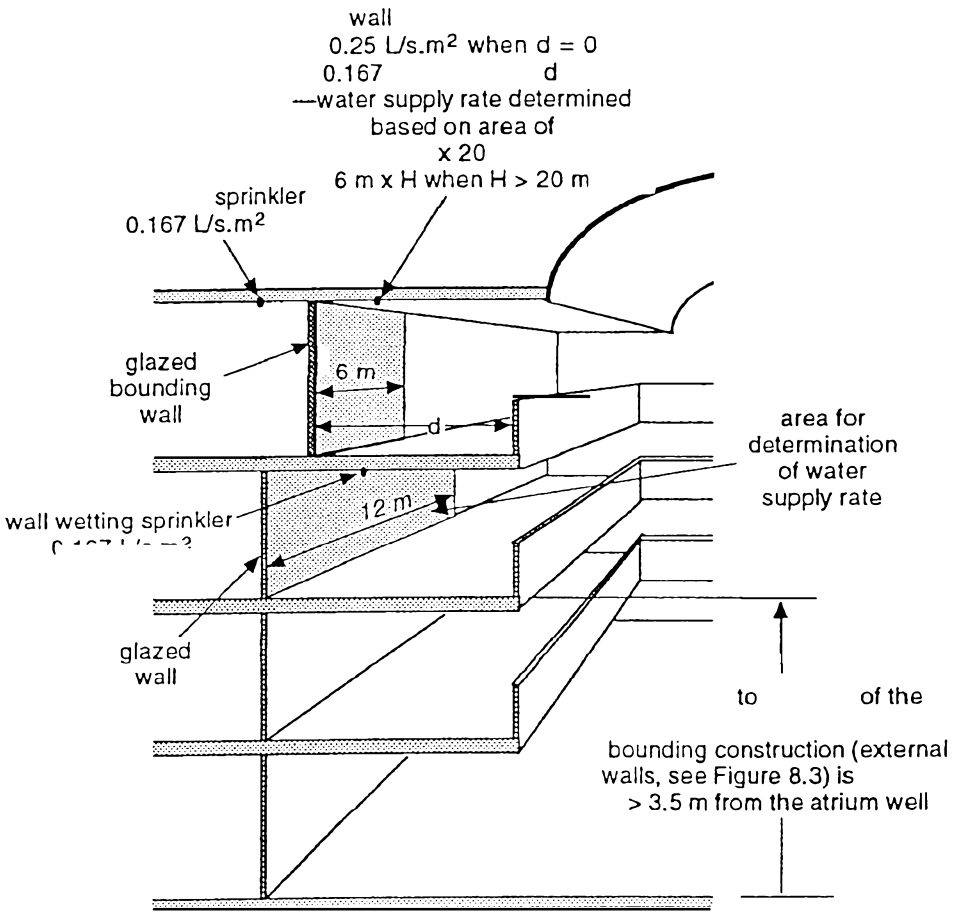

FIGURE 8.5 SPRINKLER REQUIREMENTS FOR GLAZED WALLS

9 FIRE FIGHTING

9.1 OCCUPANT FIRE FIGHTING

Occupant fire fighting includes the use of portable fire extinguishers or hose reels. Hose reels are required to be installed in a building when internal hydrants are installed or when a building fire compartment exceeds 500 m^2. Internal hydrants form part of the brigade fire fighting equipment. The BCA (cl El.4 (b)) and AS 2441 [12] specifies the provisions relating to location, type of onsite pumpsets, water supply and operating flows and pressures of hose reels.

The BCA also requires portable fire extinguishers to be provided for occupant fire fighting, but water type extinguishers are not required when hose reels are provided. Portable fire extinguishers are installed in accordance with AS 2444 [13].

9.2 BRIGADE FIRE FIGHTING

9.2.1 HYDRANTS

Fire hydrants are required to be installed in buildings having a total floor area greater than 500 m^2 and when an operational fire service is available to attend the building fire. The BCA (El.3 (b)) and AS 2419 [14] specifies the location of internal hydrants, types and location of on-site pumpsets and water supply criteria.

9.2.2 CENTRES

The BCA (cl E1.8) requires a "fire control centre" in accordance with Spec El.8 if the building is more than 25 m or if it has a total floor area of 18000 m^2. The latter will usually be the case of shopping centre buildings.

Spec El.8 specifies the requirements for fire control centres. It states that these centres are to:

- provide an area from which fire fighting operations and other emergencies can be directed; and
- contain controls, panels etc. associated with the required fire services in the building; and
- not be used for any other activities.

Extensive details of the requirements for these rooms are given in Spec E1.8.

10 EMERGENCY WARNING AND EVACUATION

The BCA (Spec G3.8, cl G3.8 and E2.4), requires an Early Warning and Intercommunication System (EWIS) to be provided in shopping centres containing an atrium or in cinema complexes. These systems must be installed in accordance with AS 2220.1 [15].

An EWIS is a combined system of an Emergency Warning System (EWS) and an Emergency Intercommunication System (EIS). The main function of the integrated system (EWIS) is to generate an alert and evacuation signal, facilitate verbal access to evacuation zones and to provide verbal intercommunication between the base system and strategic call points within a building (Warden Intercommunication Point-WIP).

An EWIS can be activated upon activation of any alarm system in the building or an emergency alarm initiating device-break glass alarm. The EWIS is connected to the Fire Indicator Panel, which is required in buildings greater than 18,000 m^2. The EWIS hardware can be used as a paging system or to provide background music.

11 SIGNATURE PAGE

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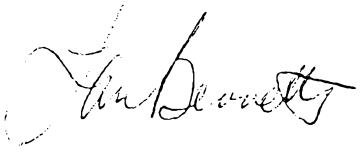

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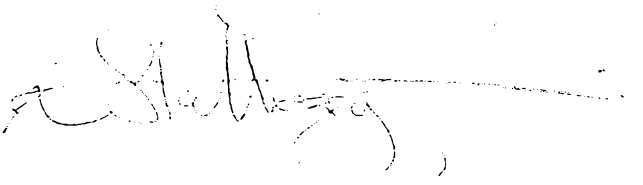

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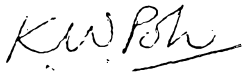

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