MECHANICAL VENTILATION AND SMOKE CONTROL SYSTEMS

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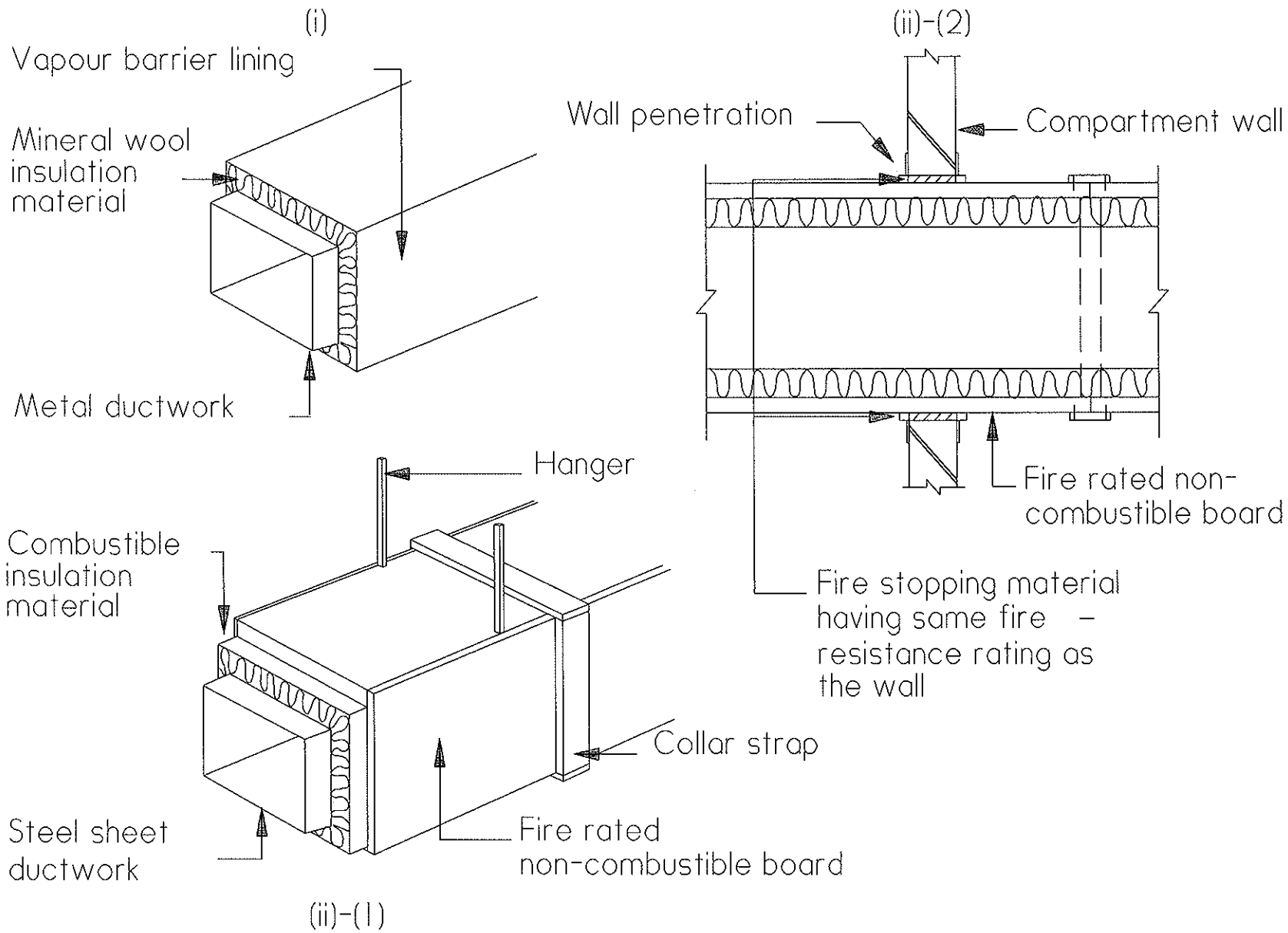
7.1 - AIR-CONDITIONING & MECHANICAL VENTILATION SYSTEMS

7.1.1

General			
(a)	Where air-conditioning system is provided in lieu of mechanical ventilation system during emergency, all the requirements **specified in this Code** for the **mechanical ventilation system shall apply to the air-conditioning system**.		
(b)	**Ducts** for air-conditioning and mechanical ventilation systems shall be constructed in compliance with the following requirements:		Construction of ductwork
	(i)	All air-conditioning or other ventilation **ducts** including framing thereof, shall be constructed of steel, aluminium, glass-fibre batt or mineral-wool batt or other approved material.	
	(ii)	All air-conditioning or other ventilation ducts shall be **adequately supported**.	
	(iii)	Duct **covering and lining** should be **non-combustible**. However, if it is necessary to use combustible material, it shall:-	Duct linings & coverings

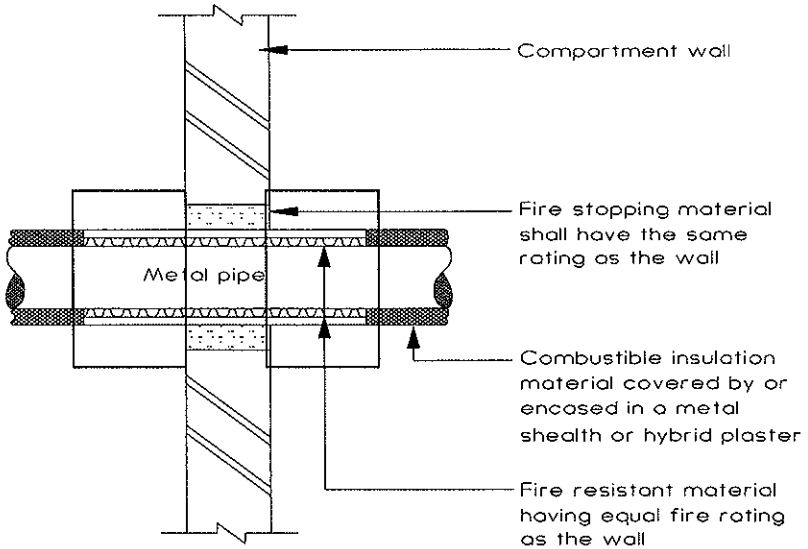
	*	when tested in accordance with methods specified in this Code, **have a surface flame spread rating of not lower than Class 1**, but in areas of building where **Class 0 flame spreading rating is required for the ceiling construction** under this Code, a **Class 0 rating for the covering and lining materials shall be required**;	
	*	when involved in fire generate a **minimum amount of smoke and toxic gases**; and	
	*	be at **least 1.0 m away** from **a fire damper.**	
(iv)	Materials and installation of all flexible joints and connections shall be in accordance with SS **CP 13** Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings.		Flexible joint and connection


(i)
Vapour barrier lining
Mineral wool insulation material
Metal ductwork
(ii)-(2)
Wall penetration
Compartment wall
Fire rated non-combustible board
Fire stopping material having same fire - resistance rating as the wall
Hanger
Combustible insulation material
Collar strap
Steel sheet ductwork
Fire rated non-combustible board
(ii)-(1)

(c)	**Insulation for pipework** associated with the air-conditioning and mechanical ventilation systems shall comply with the following requirements:		Pipework insulation
	(i)	Insulation material for pipework together with vapour barrier lining and adhesives shall when tested in accordance with the methods specified in this Code, have a surface flame spread of **not lower than Class 1** but in areas of buildings where Class 0 flame spread is required for the ceiling construction under this Code, a Class 0 rating for the insulation material shall be required.	
	(ii)	Notwithstanding the requirements of sub-clause (c)(i), the use of **plastic and foam rubber insulation materials of a lower classification <u>may be permissible</u>** if:	Plastic and foam rubber insulation

*	the material is the **self-extinguishing type** acceptable to the Relevant Authority;
*	the insulation material is covered by or encased in a metal sheath or hybrid plaster or other non-combustible cladding materials acceptable to the Relevant Authority.
provided that any opening in the element of structure or other part of a building penetrated by the **pipework shall be effectively fire-stopped by replacement of the insulation material at the junction of penetration with fire resistant material having equal fire rating**. Fire rated proprietary pipework system may be used if it is tested in the manner acceptable to the Relevant Authority.	

Metal pipes with combustible insulation



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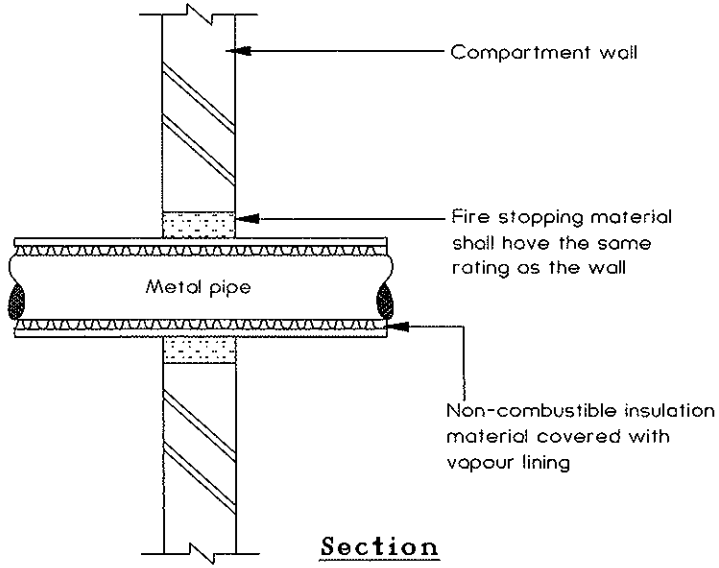
Metal pipes with non-combustible insulation



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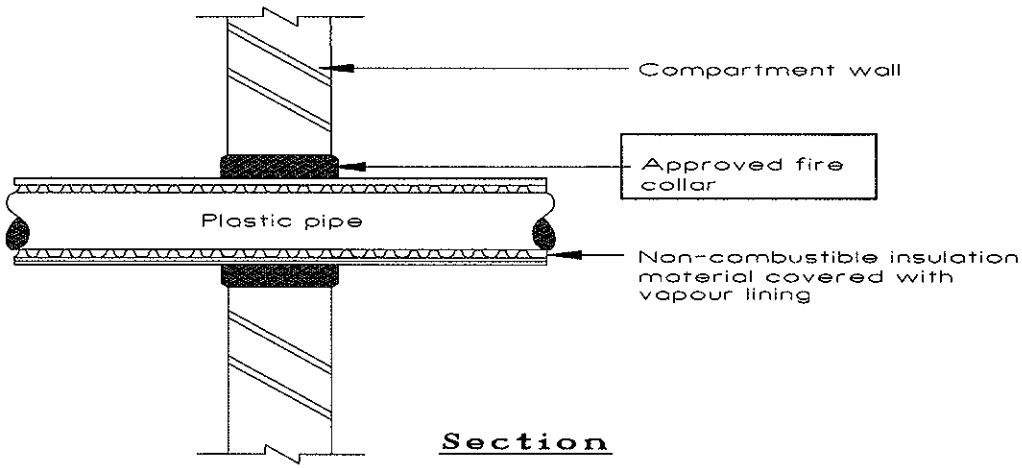
Plastic pipes with non-combustible insulation



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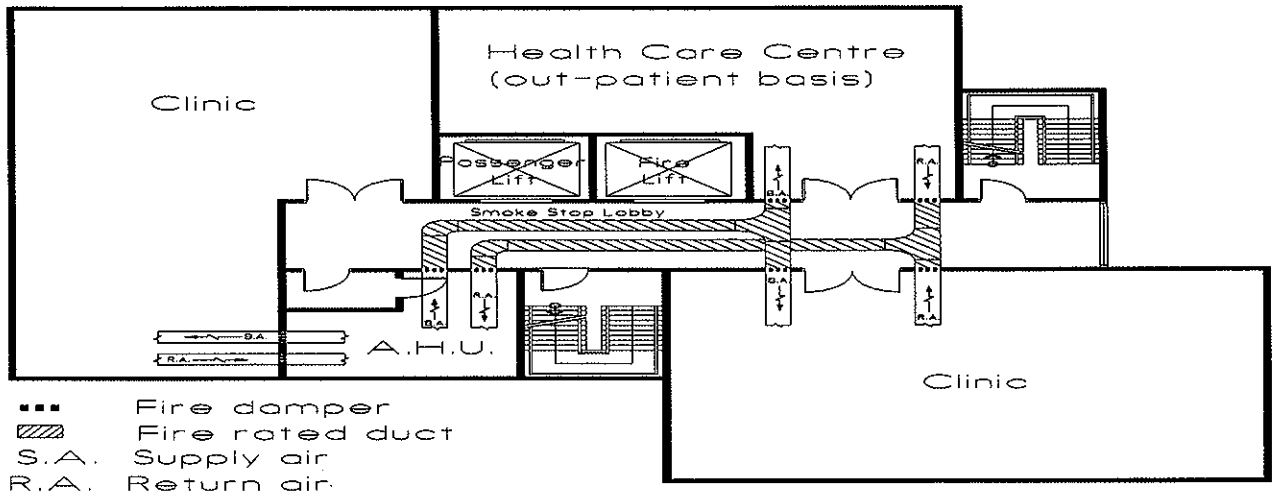
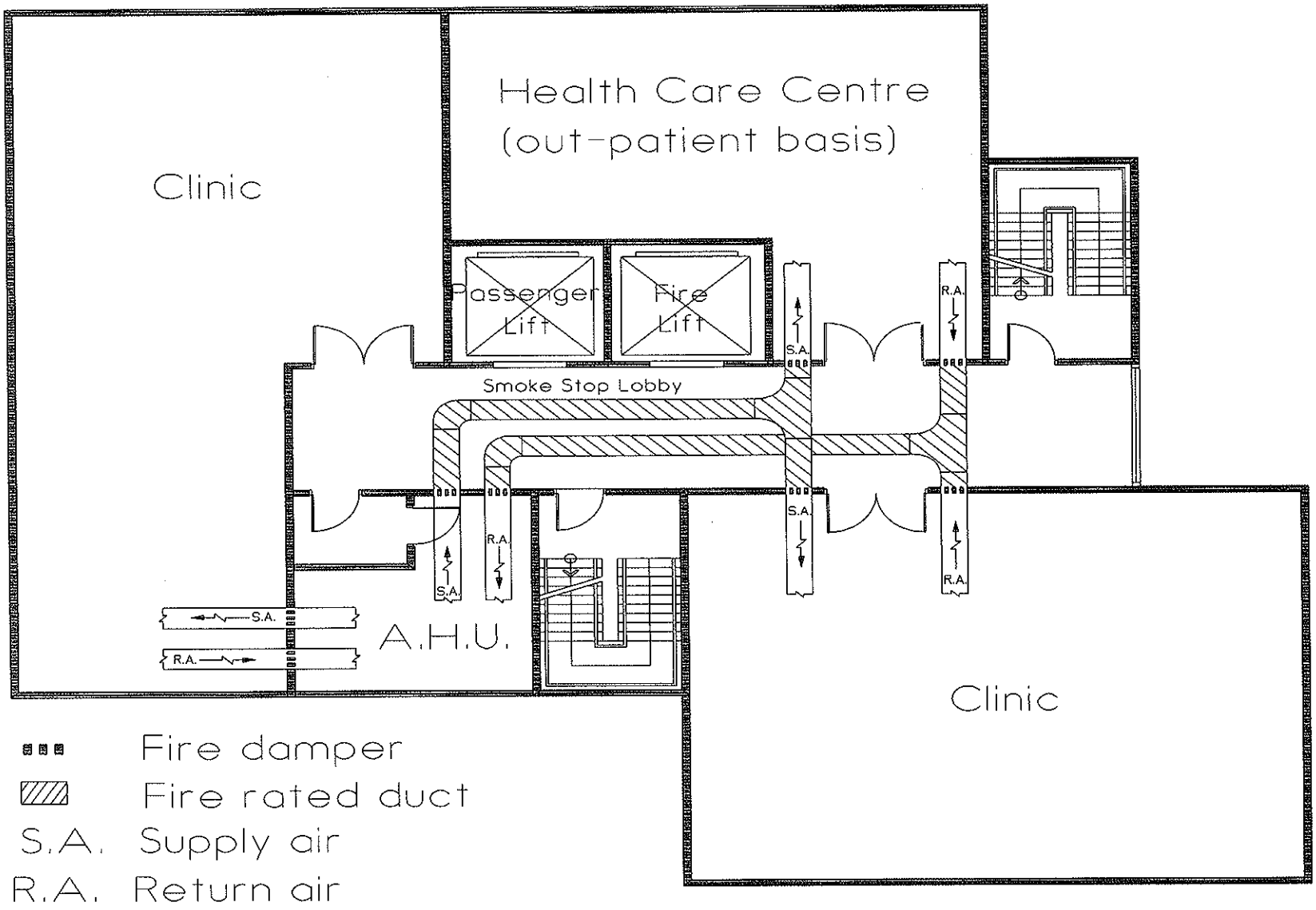
(d)	Enclosure of ducts shall comply with the requirements in sub-clause 3.8.9(a).
(e)	Ventilation ducts should not pass through smoke-stop or fire fighting lobby. Where unavoidable, **the part of the ventilation duct within the lobby shall be enclosed in construction with fire resistance rating at least equal to that of the elements of structure**. Such construction shall be in **masonry**. **If other form of fire resisting construction is used**, **fire damper** shall be fitted where the duct penetrates the lobby enclosure.

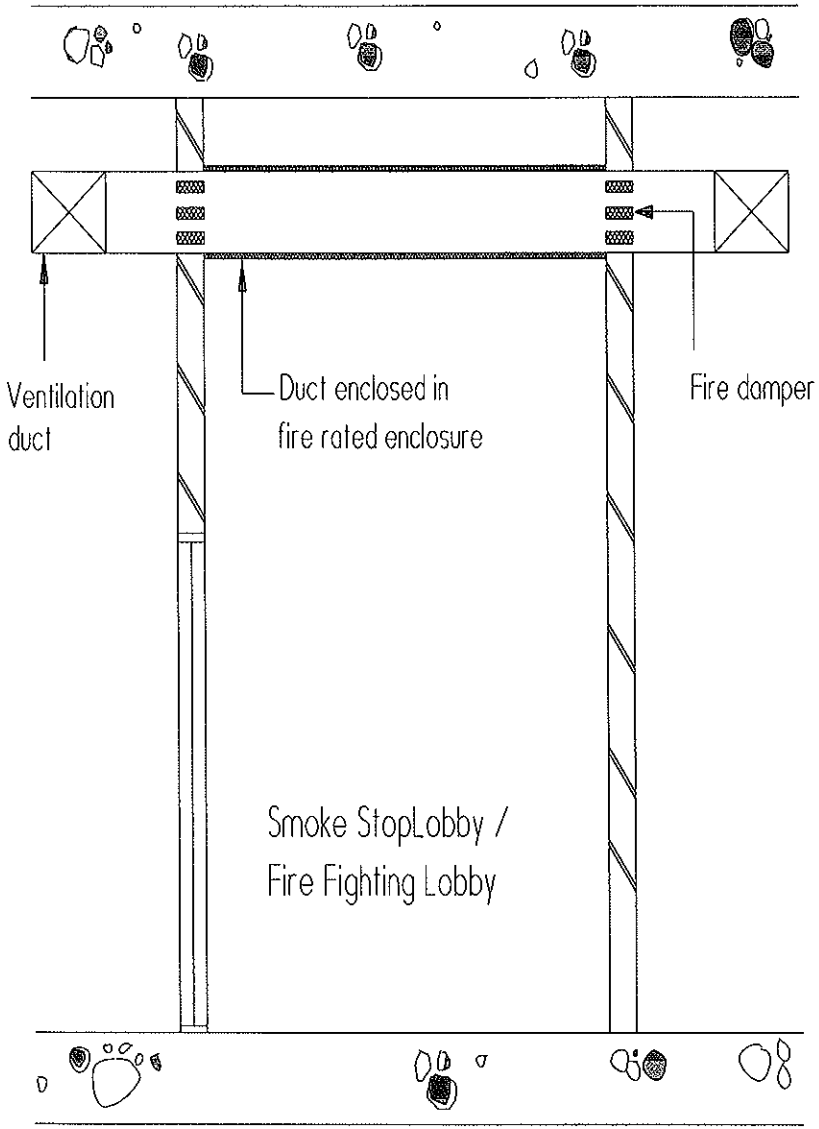
Duct enclosure

Ductwork through smoke-stop or fire fighting lobbies





Ventilation ducts are routed along protected lobby



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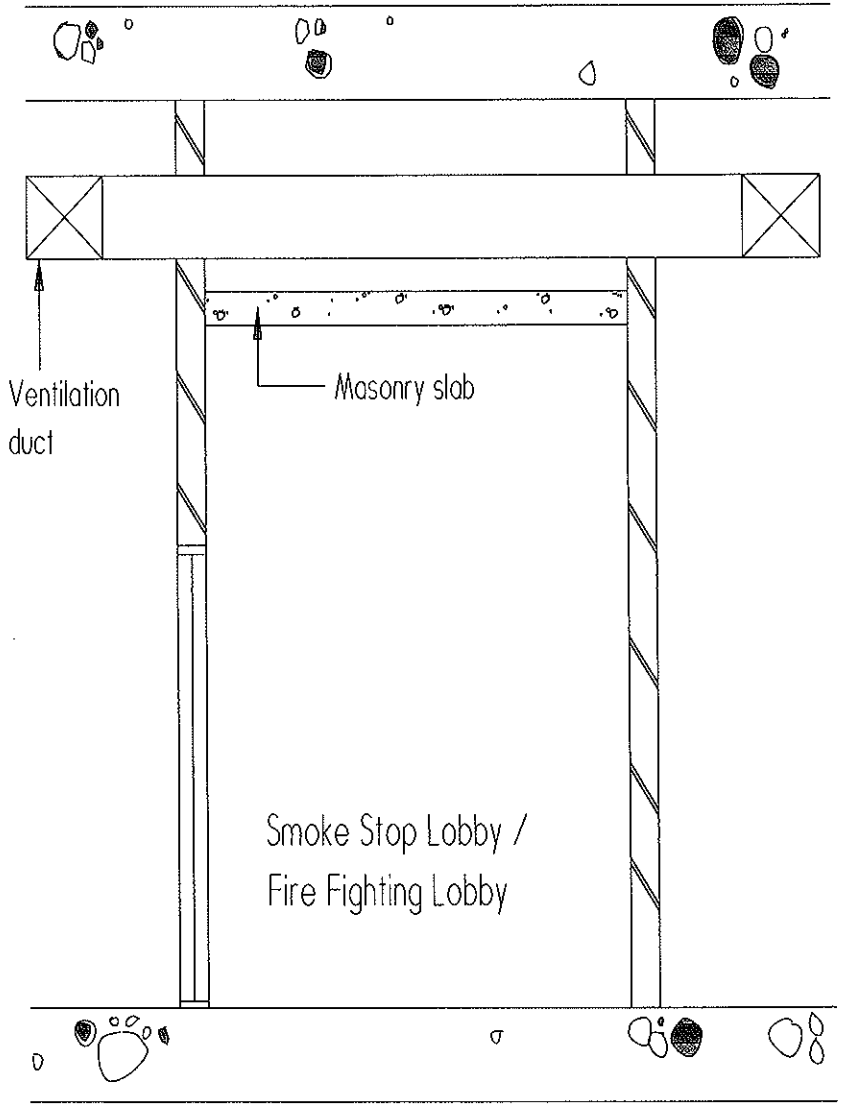

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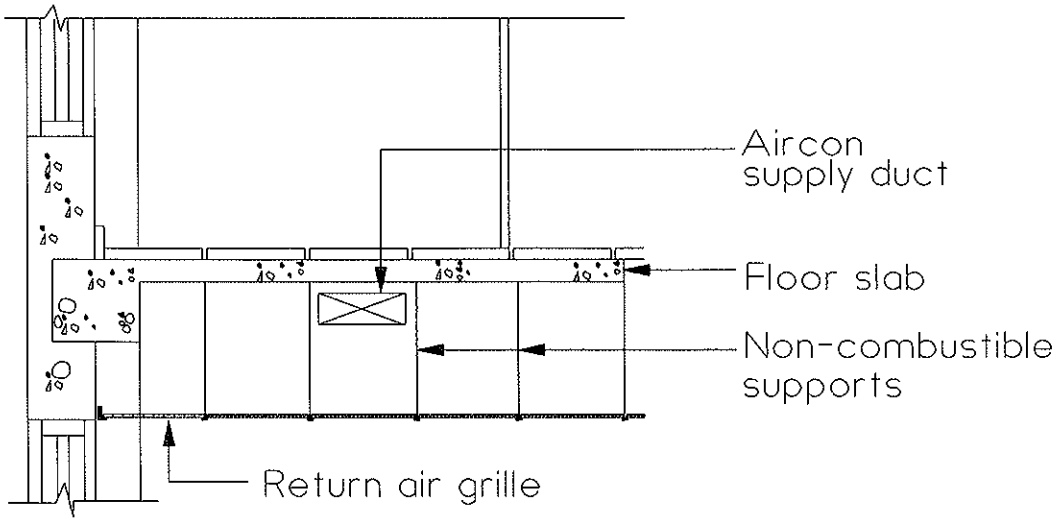
Plenum

(f)	A **concealed space between the ceiling and floor above it, ceiling and roof, or raised floor and structural floor of a building** may be used as a **plenum** provided that-			
	(i)	The **concealed space** contains only:		
		*	mineral-insulated metal-sheathed cable, aluminium-sheathed cable, copper-sheathed cable, rigid metal conduit, enclosed metal trunking, flexible metal conduit, liquid-tight flexible metal conduit in lengths not more than 2 m, or metal-clad cables;	
		*	electric equipment that is permitted within the concealed spaces of such structures if the wiring materials, including fixtures, are suitable for the expected ambient temperature to which they will be subjected;	
		*	other ventilation ducts complying with sub-cl. (b);	
		*	communication cables for computers, television, telephone and inter-communication system;	
		*	fire protection installations;	
		*	pipes of non-combustible material conveying non-flammable liquids.	
	(ii)	The supports for the ceiling membrane are of non-combustible material.		

Return air plenum in ceiling space



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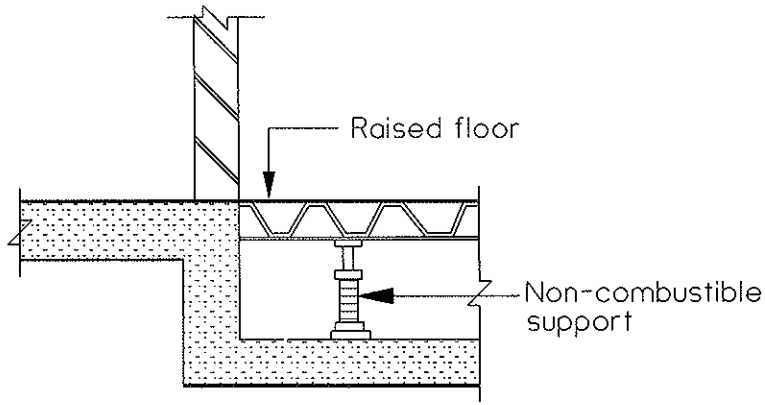
Return air plenum in concealed space below rised floor



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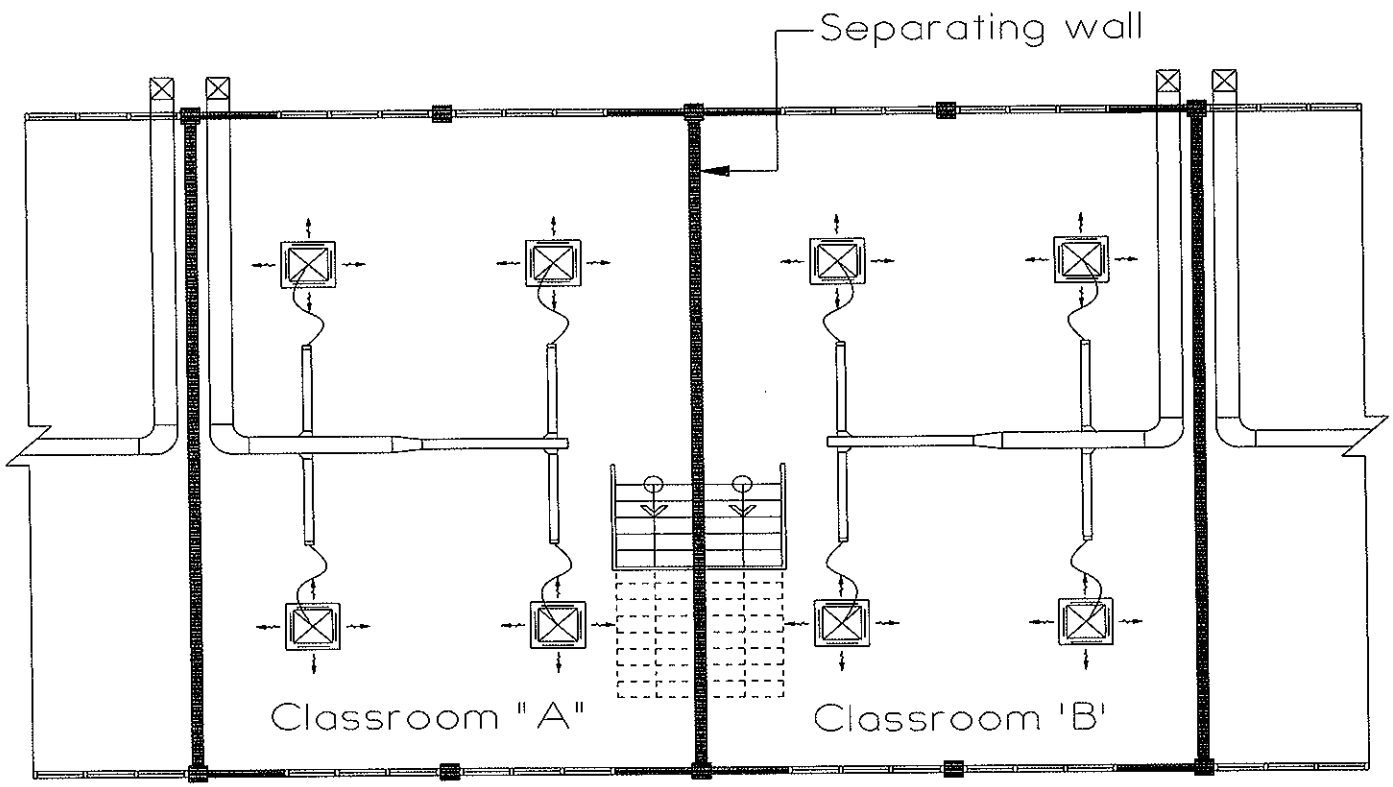
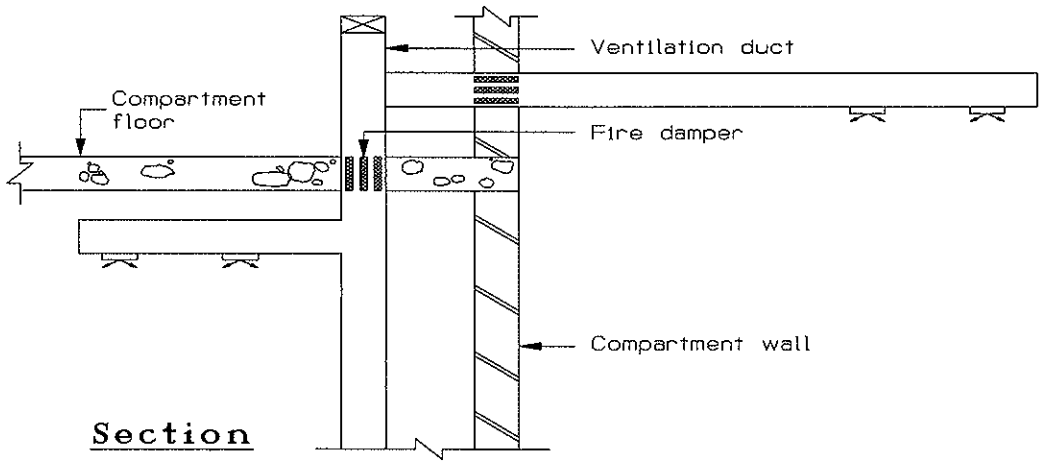
(g)	No air conditioning or ventilation **ducts shall penetrate separating walls.**

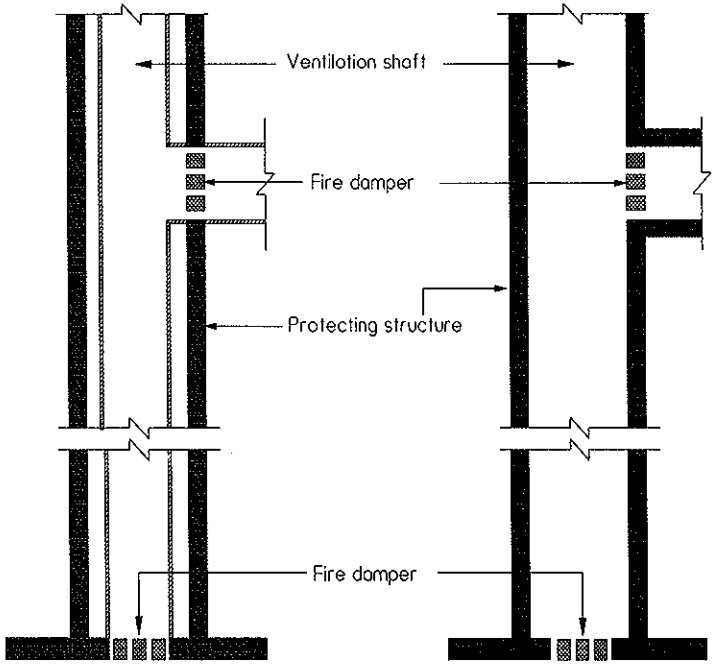
Separating walls



2nd Storey Floor Plan

(h)	**Fire Dampers**			
	(i)	Ventilation ducts which pass directly through a compartment wall or compartment floor shall comply with the following -		Provision of fire dampers
		*	where the **ventilation duct does not form a protected shaft or is not contained within a protecting structure**, the duct **shall be fitted with a fire damper** where it passes through the compartment wall or compartment floor;	
		*	where the ventilation duct forms a protected shaft or is contained within a protecting structure, **the duct shall be fitted with fire dampers at the inlets to the shaft and outlets from it.**	





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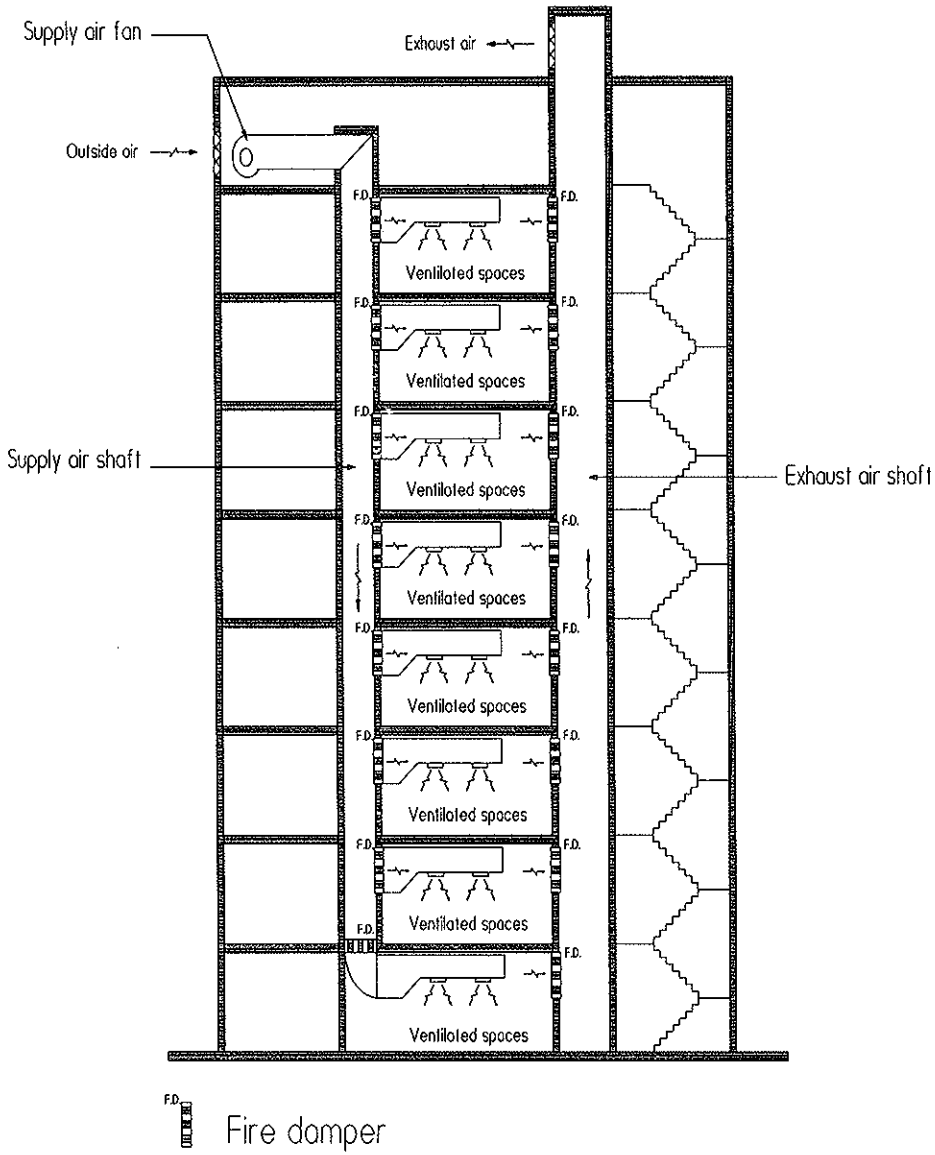
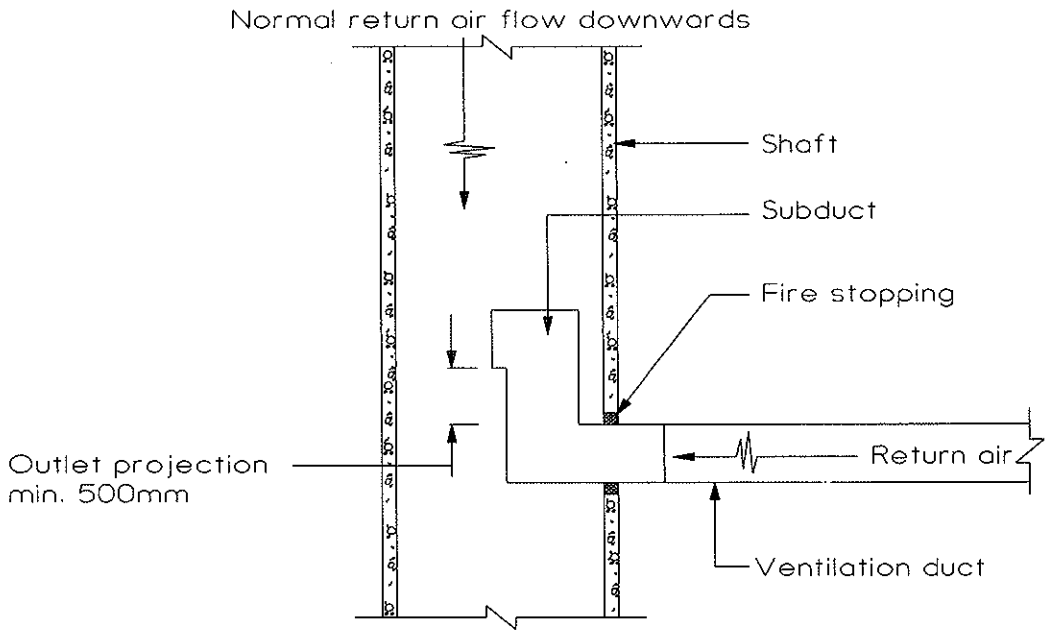


F.D. Fire damper

Fire dampers are provided to inlets of exhaust air shafts and outlets of supply air shaft

(ii)	Conditions under which **fire dampers are not required to be fitted in openings of compartment walls and floors** shall be in accordance with SS **CP 13** Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings.	Provision of fire dampers not required

Normal direction of air flow downwards



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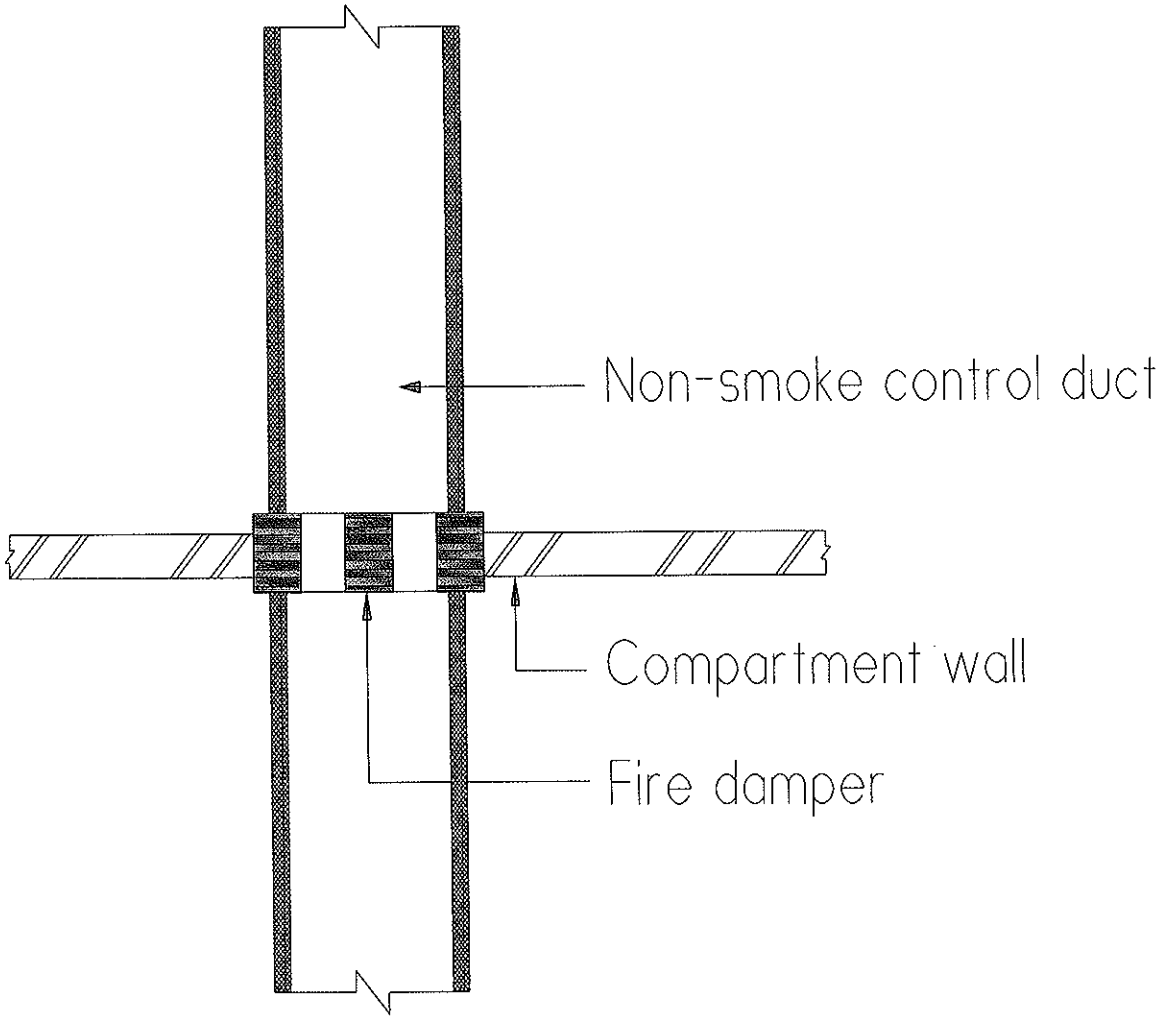
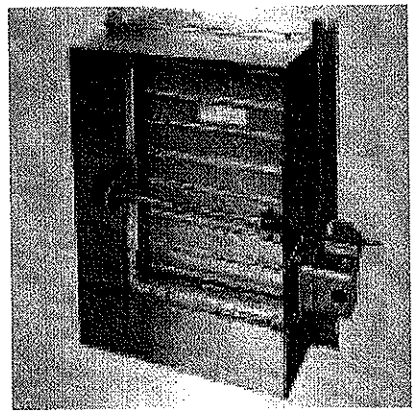
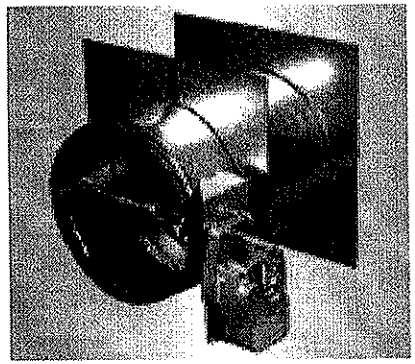




1220 Series Steel Airfoil Blade



1290FS Series

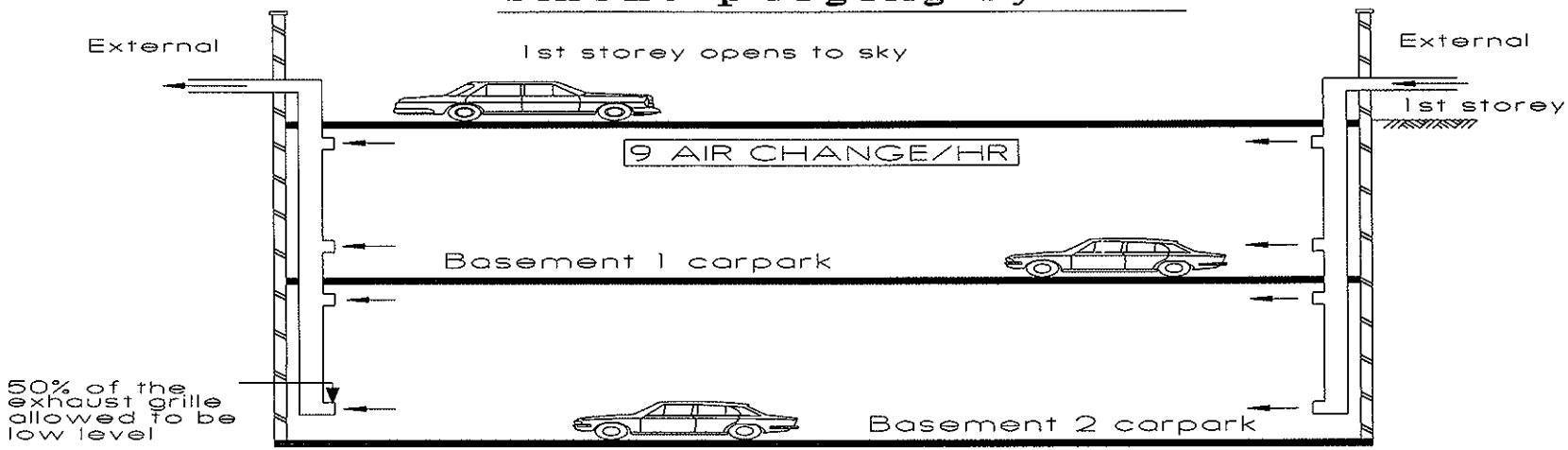
True Round Design

Air duct penetrating a compartment wall being fitted with a fire damper

(iii)	Fire dampers **shall not be fitted** in the following locations:	
	*	openings in walls of a **smoke extract shaft or return air shaft which also serves as a smoke extract shaft**;
	*	openings in walls of a protected shaft when the openings have **a kitchen exhaust duct passing through** it; or
	*	**anywhere in an air pressurising system**;
	*	where explicitly prohibited in this Code.

Prohibition of fire dampers

Smoke purging system



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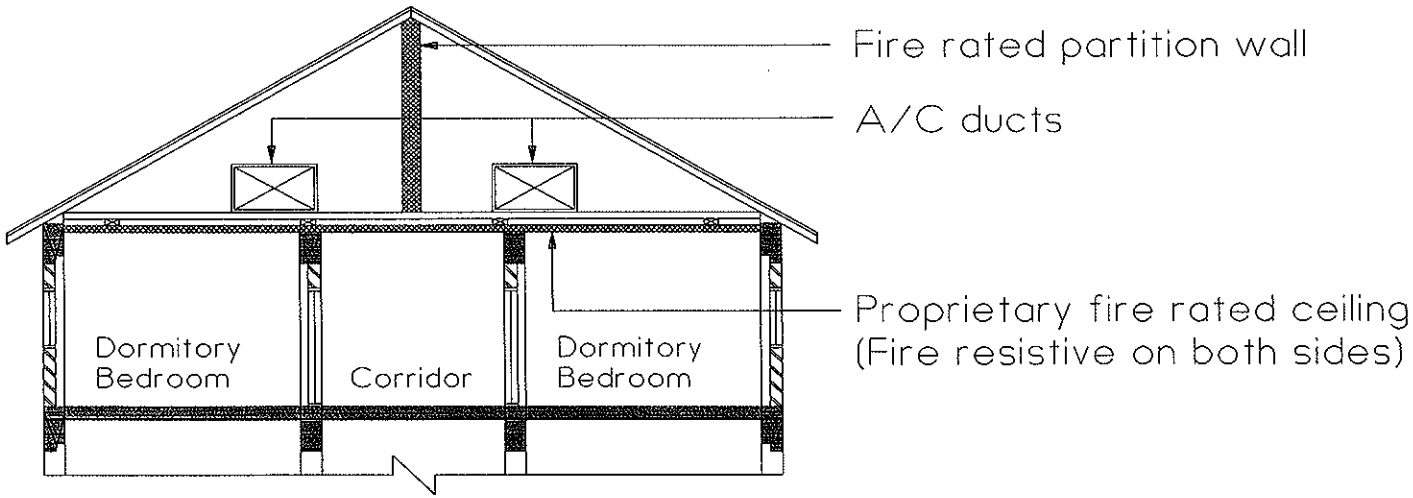
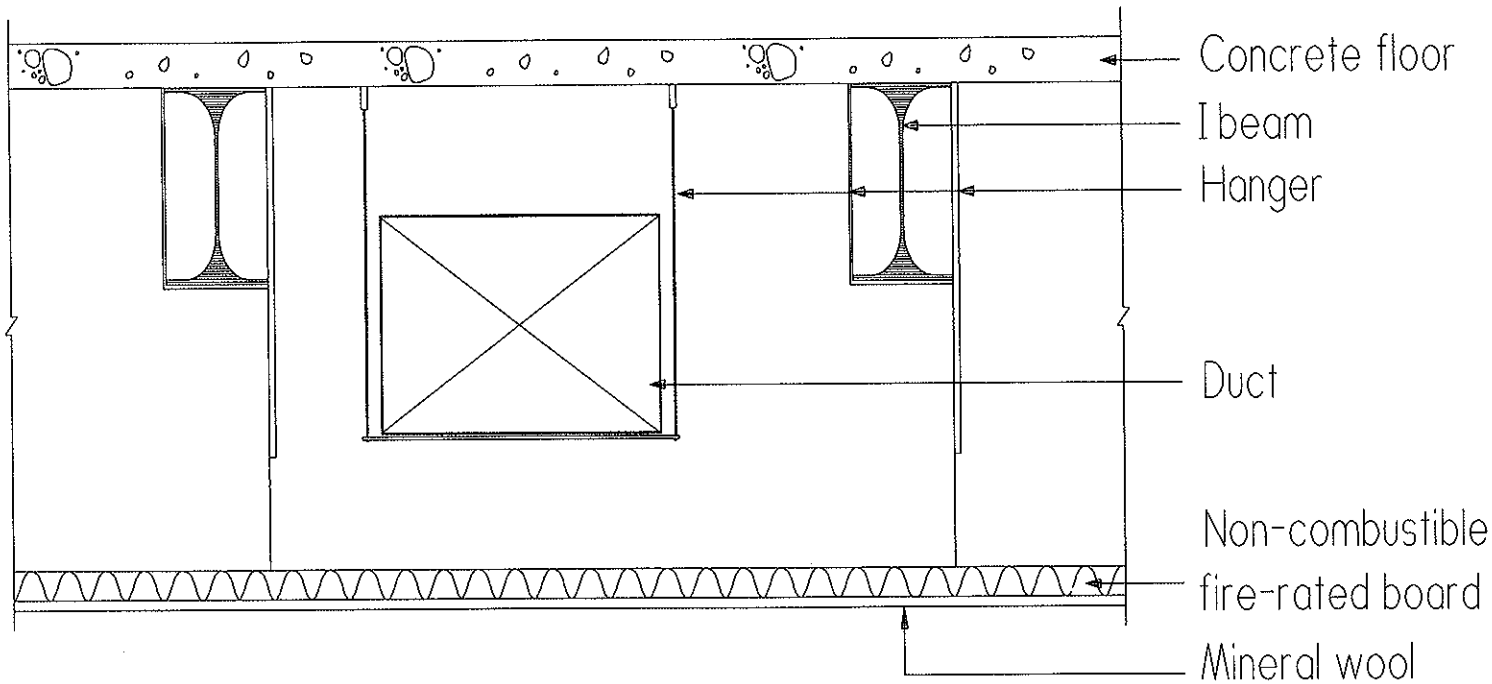
(iv)	Where a **fire damper is required by this Code to be installed in the airconditioning and mechanical ventilation system**, its type, details of installation, connection of accessories, inspection door, etc. shall be in accordance with SS CP 13 Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings. Construction of the fire damper shall comply with requirements in **SS CP 333 Specifications of Fire Dampers.**

(i)	**Fire Resisting Floor-ceiling and Roof-ceiling**	
	(i)	The space above a suspended ceiling which forms part of a fire-rated floor ceiling or roof-ceiling construction **shall not contain ducting** unless ducting was incorporated in a prototype that qualified for the required fire-resistance rating, in which case the ducting shall be identical to that incorporated in the tested prototype.

Fire resisting floor-ceiling and roof-ceiling

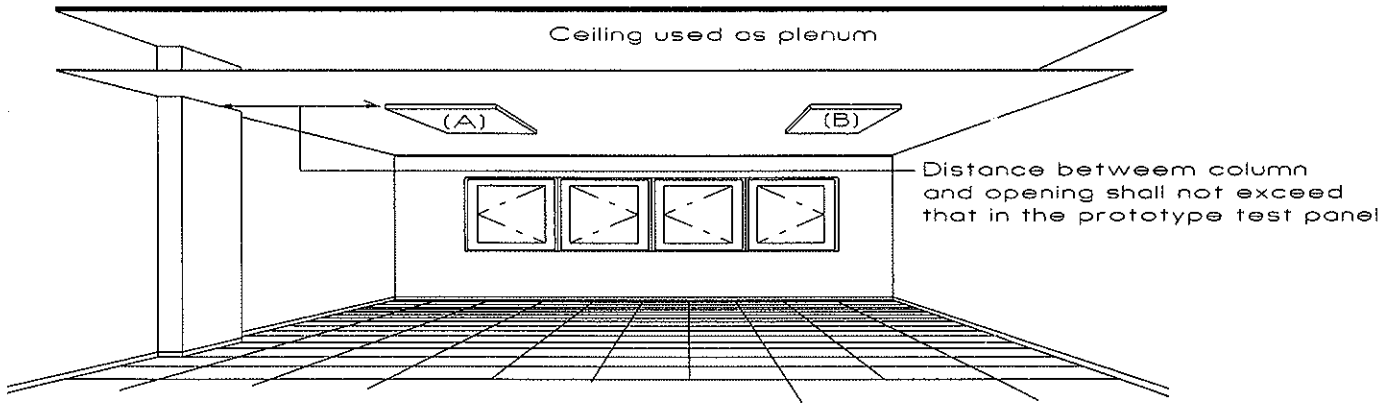


Ducting above fire rated ceiling or roof ceiling construction

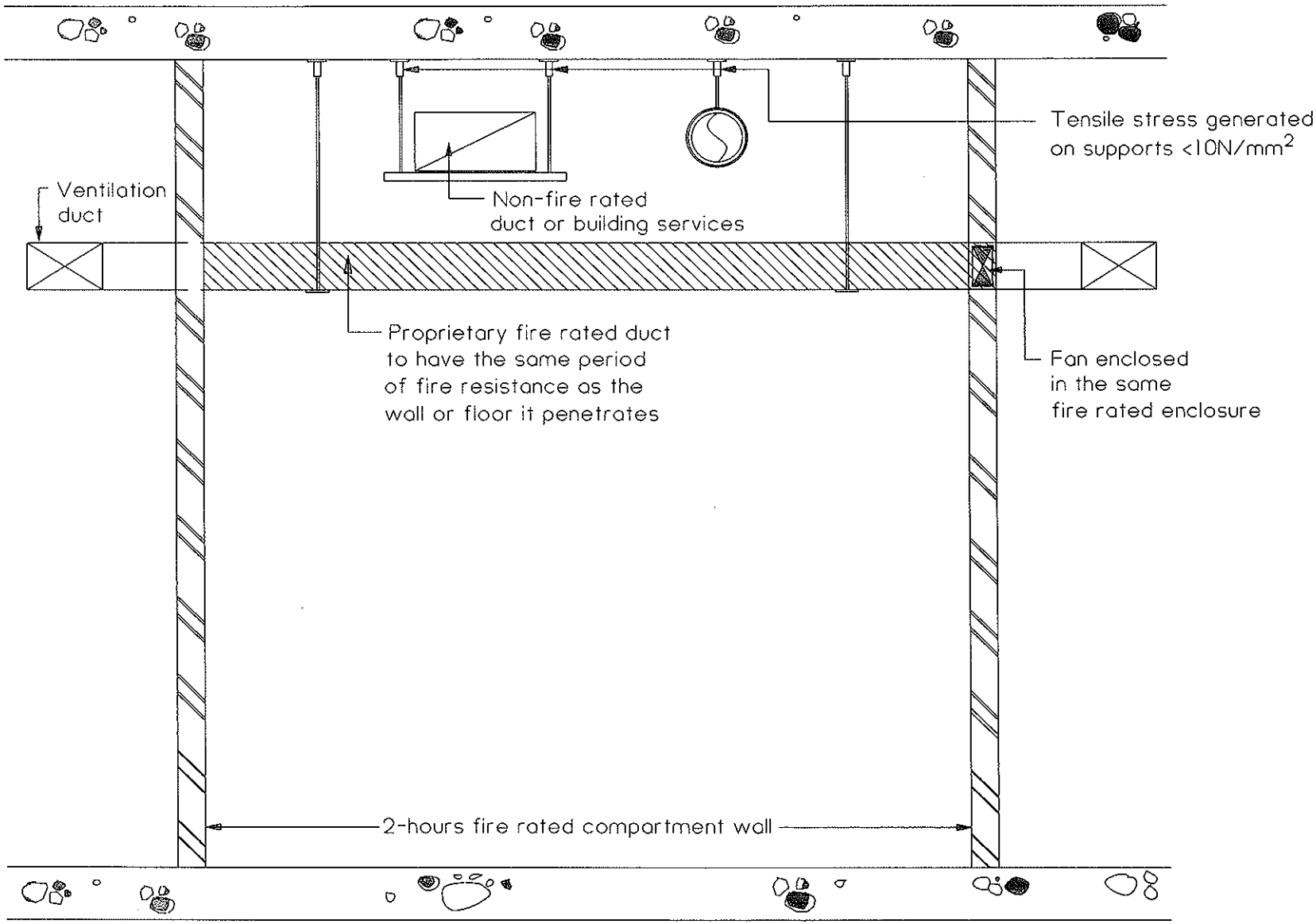


Mechanical ventilation ducts are not permitted to be located in the concealed space of fire rated floor ceiling or roof ceiling assembly, unless such ducts are included in the prototype that was tested for the required fire resistance rating*. The type of ducting within such ceiling or roof spaces as well as details of openings in such ceiling shall be identical to that incorporated in the tested prototype.*

(ii)	**Openings in the ceiling**, including openings to enable the ceiling to be **used as a plenum**, shall be **protected by fire dampers** identical to those used in the tested prototype and such openings in the ceiling shall be so arranged that -	
	*	No opening is greater in area than that corresponding in the prototype test panel;
	*	The aggregate area of the openings per unit ceiling area does not exceed that of the prototype test panel; and
	*	The proximity of any opening to any structural member is not less than that in the prototype test panel.



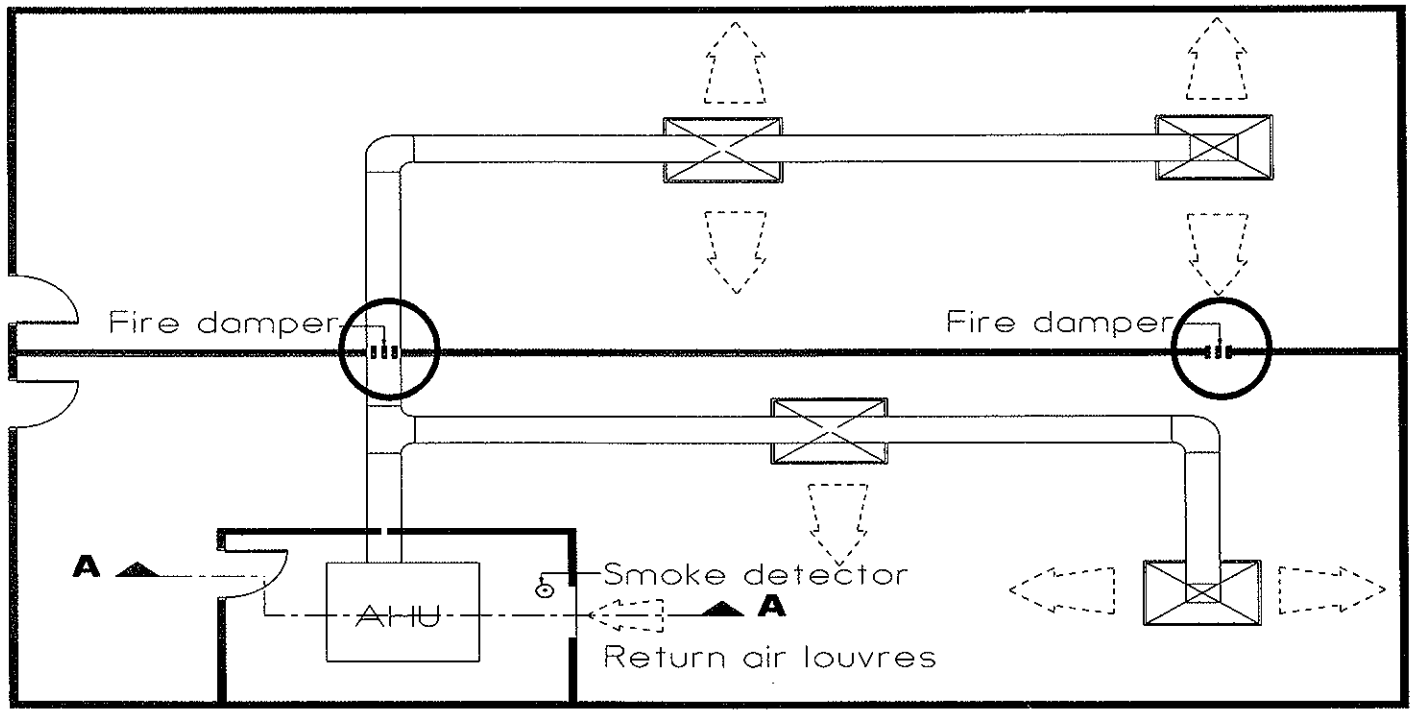
(j)	(i)	Where proprietary **fire rated materials are used to construct the fire rated duct**, the fire rating of the fire rated duct shall have the same period of fire resistance as the wall or floor it penetrates.	Fire rated duct
	(ii)	Proprietary **fire rated duct shall be tested to BS 476 Pt 24 or** equivalent and its usage be approved by the Relevant Authority	
	(iii)	Running of non-fire rated duct and/or other building services above the proprietary fire rated duct ~~should~~ must be avoided. **When unavoidable due to physical constraints, the supports to such non-fire rated duct and/or other building services running above the proprietary fire rated duct shall be strengthened such that the tensile stress generated on the supports shall not exceed 10N/mm^2** and the non-fire rated duct and/or building services shall also be adequately protected to prevent collapse in a fire which will otherwise affect the stability of the proprietary fire rated duct below.	
	(iv)	**Fans forming part of a fire rated duct shall also be enclosed in the same fire rated enclosure.**	


Tensile stress generated
on supports <10N/mm2
Ventilation
duct
Non-fire rated
duct or building services
Proprietary fire rated duct
to have the same period
of fire resistance as the
wall or floor it penetrates
Fan enclosed
in the same
fire rated enclosure
2-hours fire rated compartment wall

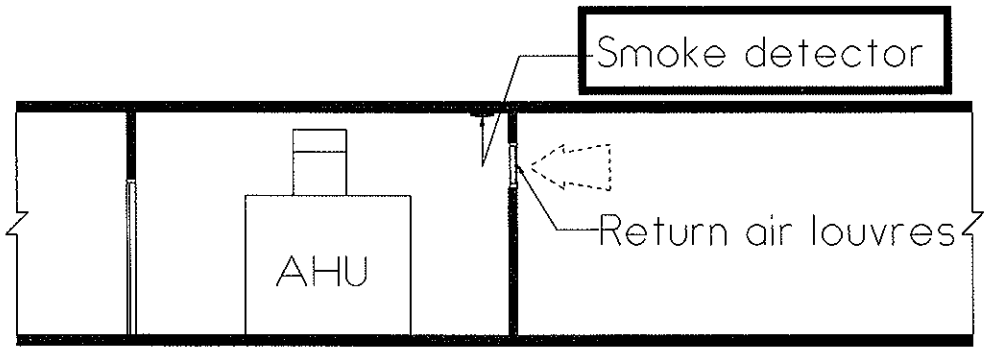
Section

7.1.2

Air handling unit room			
(a)	Rooms having no other usage than housing air handling equipment or package units, and their associated electrical controls are not regarded as areas of high risk. However, in situations where the **air handling equipment serves more than one compartment**, **fire dampers shall be provided in air ducts at penetrations through the compartment walls and floors** to comply with the requirements in Cl. 7.1.1(h).		Air handling unit rooms
(b)	Smoke detectors of approved type shall be incorporated in the **return air stream** immediately adjacent to:		Smoke detectors
	(i)	air handling units serving **more than one storey** or compartment; or	
	(ii)	a single unit in excess of **15000 m³/h**; or	
	(iii)	any AHU as may be required by the Relevant Authority.	
(c)	The function of smoke detectors where required by this Code is to **initiate action to shut down the AHU automatically when the smoke density in the return-air system has become unacceptable for recycling**. Details of the requirements shall be in accordance with SS CP 13 Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings.		



An AHU serving 2 fire compartments



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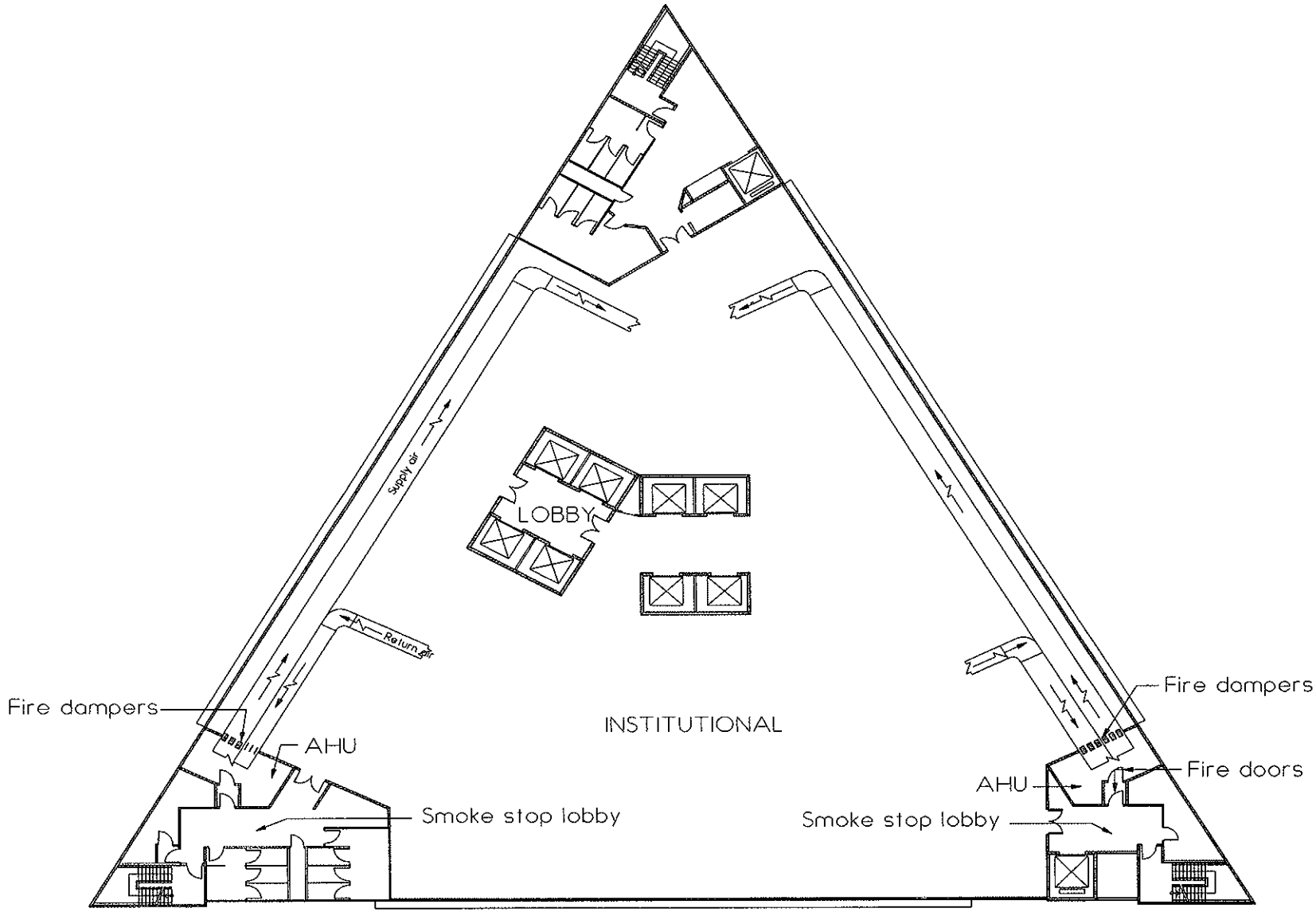
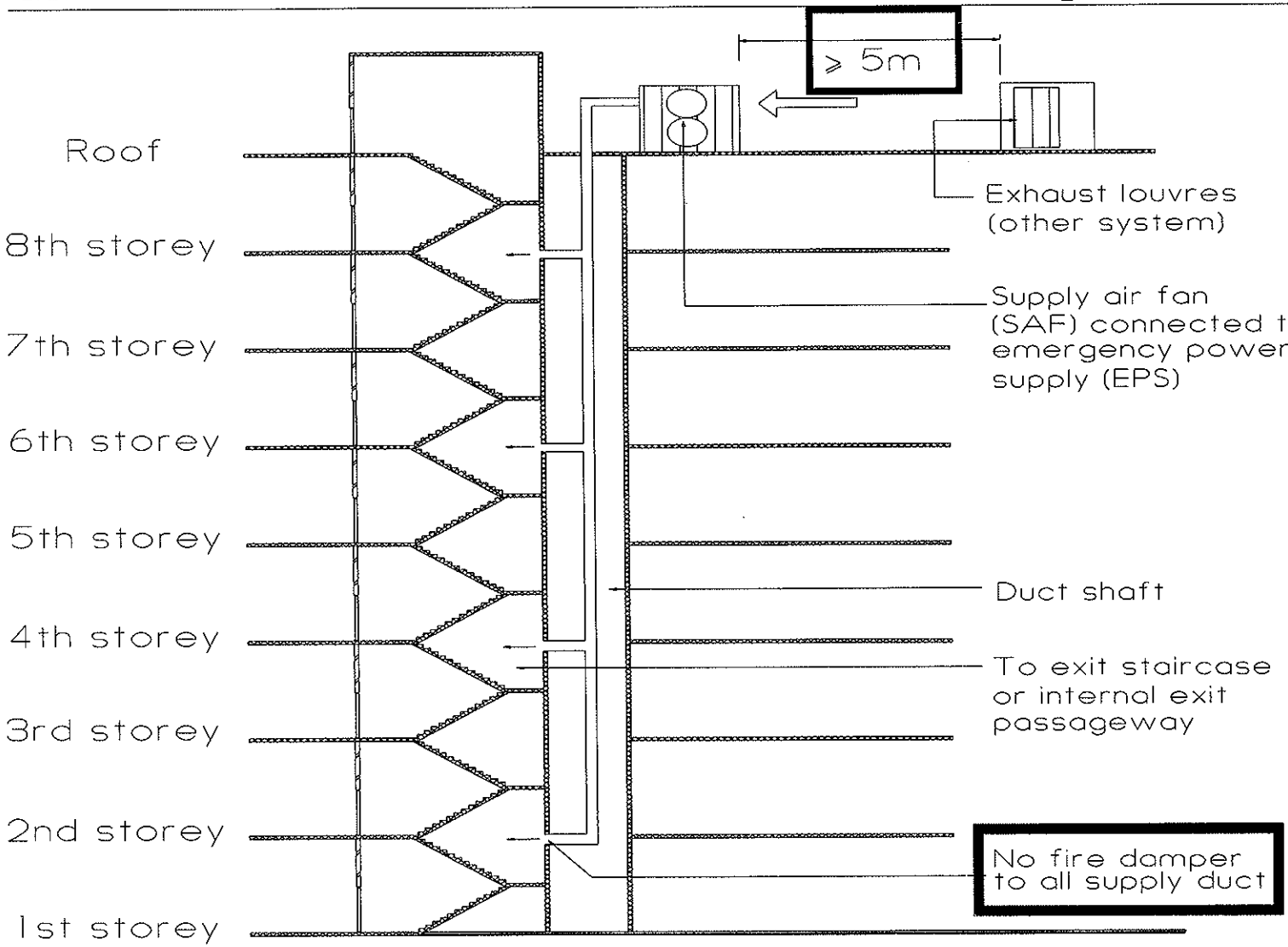


Ventilation ducts are routed from The AHU Rooms directly into the office space

7.1.3

Exits			
(a)	Protected shaft of exits, smoke-stop lobbies, including its concealed space shall not be used for supply, exhaust or return air plenum of air handling systems.		Exits
(b)	Mechanical ventilation system for each exit staircase and internal exit passageway, if provided, shall be an **independent system of supply mode only** exclusive to the particular staircase, and it shall comply with the following requirements:		Exit staircase and internal exit passage-way
	(i)	Supply air for the system shall be drawn directly from the external, with intake point not **less than 5 m** from any exhaust discharge openings.	
	(ii)	For exit staircase serving **more than 4 storeys**, supply air shall be conveyed via a vertical duct extending throughout the staircase height and discharging from outlets distributed at **alternate floor**.	
	(iii)	Where the supply air duct serving the exit staircase has to penetrate the staircase enclosure, the **portion of the duct where it traverses outside the staircase shall be enclosed in masonry construction or drywall** complying with Cl.3.8.7(c) of at least the same fire resistance as the elements of structure and it shall not be fitted with fire dampers.	

M/V to exit staircase and internal exit passageway



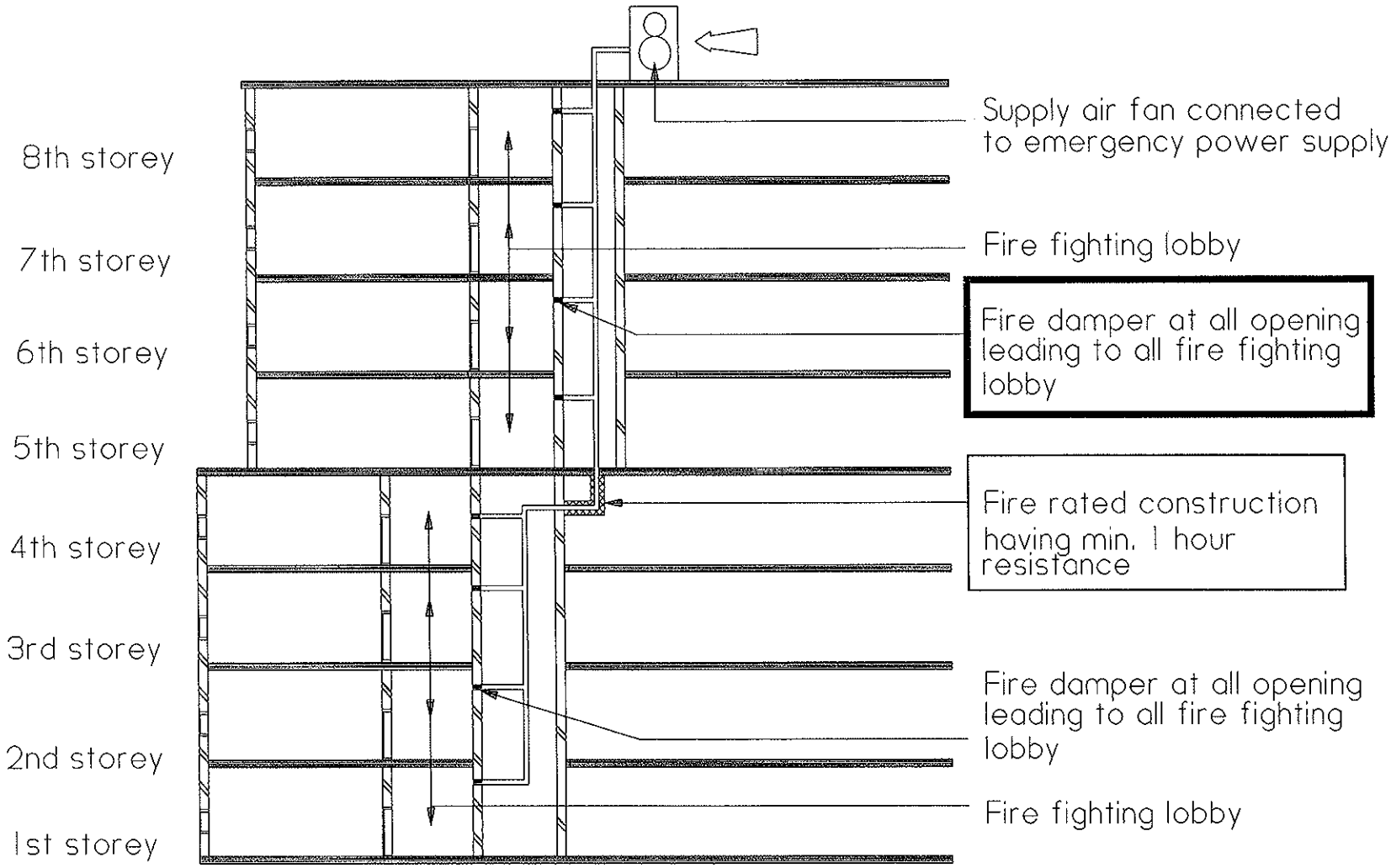
Section

7.1.4

Mechanical ventilation system for **smoke-stop lobbies and fire fighting lobbies shall be a system exclusive to these lobbies**, and it shall comply with the following requirements:	
(a)	The ventilation system shall be of **supply mode only of <u>not less than 10 air changes per hour</u>**.
(b)	Supply air shall be drawn directly from the external with intake point <u>not **less than 5m**</u> from any exhaust discharge or openings for natural ventilation.
(c)	Any part of the **<u>supply duct running outside the smoke-stop or fire fighting lobby which it serves shall either be enclosed or constructed to give a fire resistance rating of at least 1 hr</u>**. The Relevant Authority may at its discretion require a higher fire resistance rating if the duct passes through an area of high fire risk.
(d)	The mechanical ventilation system shall be <u>automatically activated by the building fire alarm system</u>. In addition, a **<u>remote manual start-stop switch shall be made available to firemen at the fire command centre</u>**, or at the fire indicating board where there is no fire command centre. <u>Visual indication of the operation status</u> of the mechanical ventilation system shall be provided.

Mechanically ventilated smoke-stop lobby and fire fighting lobby

Mechanical ventilation of smoke stop/fire fighting lobbies



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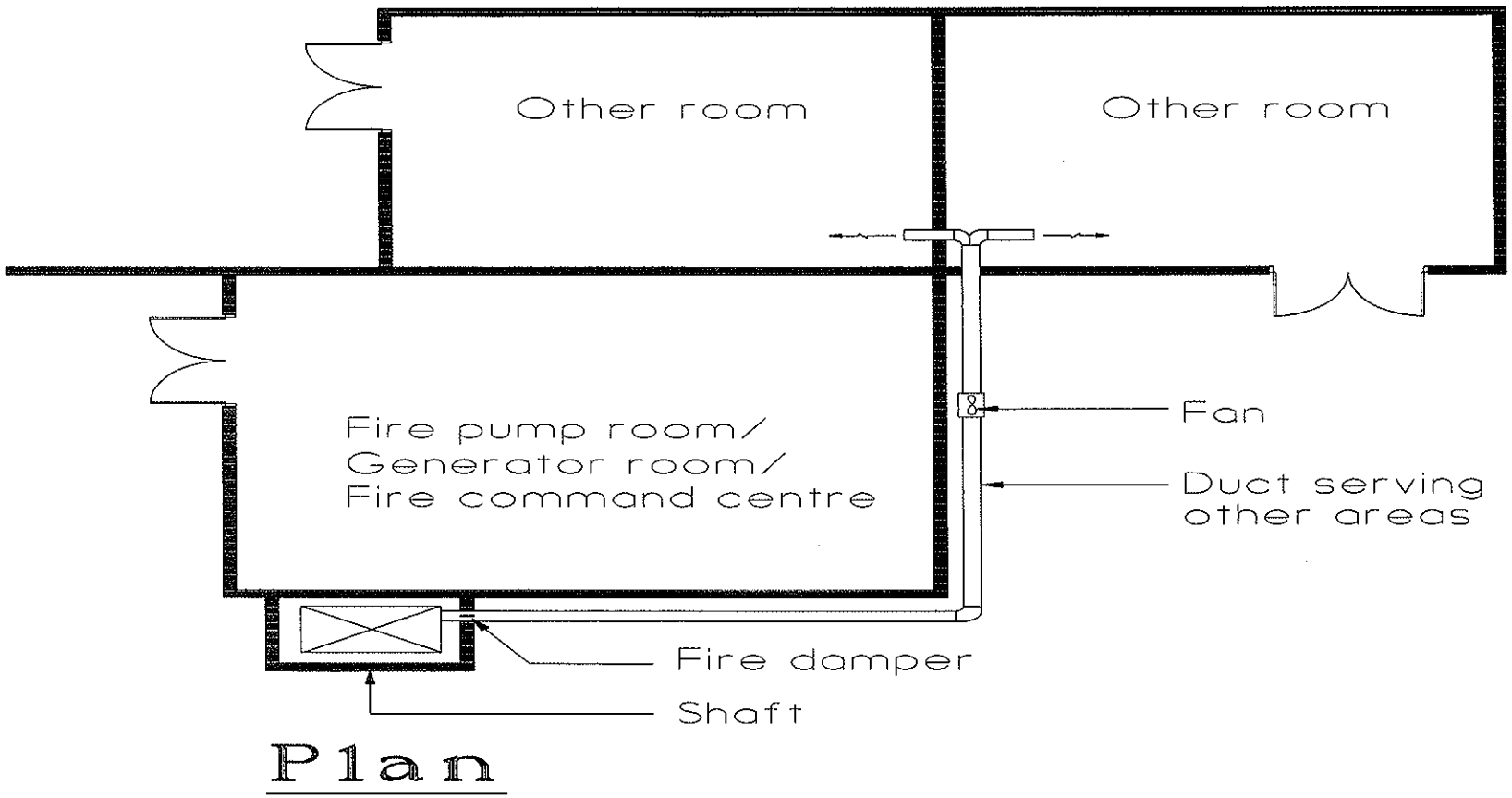
7.1.5	Where mechanical ventilation is installed to provide air for the operation of the following equipment, such system shall be **independent** of each other and any other system serving other parts of the building:	Engine driven fire pump and generator
	-engine driven fire pump; **-emergency generator;**	
(a)	Supply air shall be drawn directly from the external and its intake point shall not be less than 5 m from any exhaust discharge openings. Exhaust discharge shall also be direct to the external and shall not be less than 5 m from any air intake openings.	
(b)	Where the corresponding ducts run outside the room they shall either be enclosed in a structure or be constructed to give at least the same fire rating as the room which they serve or that of the room through which they traverse, whichever is higher. The rating shall apply to fire exposure from both internal and external of the duct or structure. Where the duct risers are required to be enclosed in a protected shaft constructed of masonry or drywall complying with Cl.3.8.9(a), they shall be compartmented from the rest of the shaft space containing other ducts or services installations.	
(c)	No fire damper shall be fitted in either supply or exhaust duct required under this clause.	
(d)	Duct serving areas other than rooms housing equipment stated in this clause shall not pass through such rooms.	

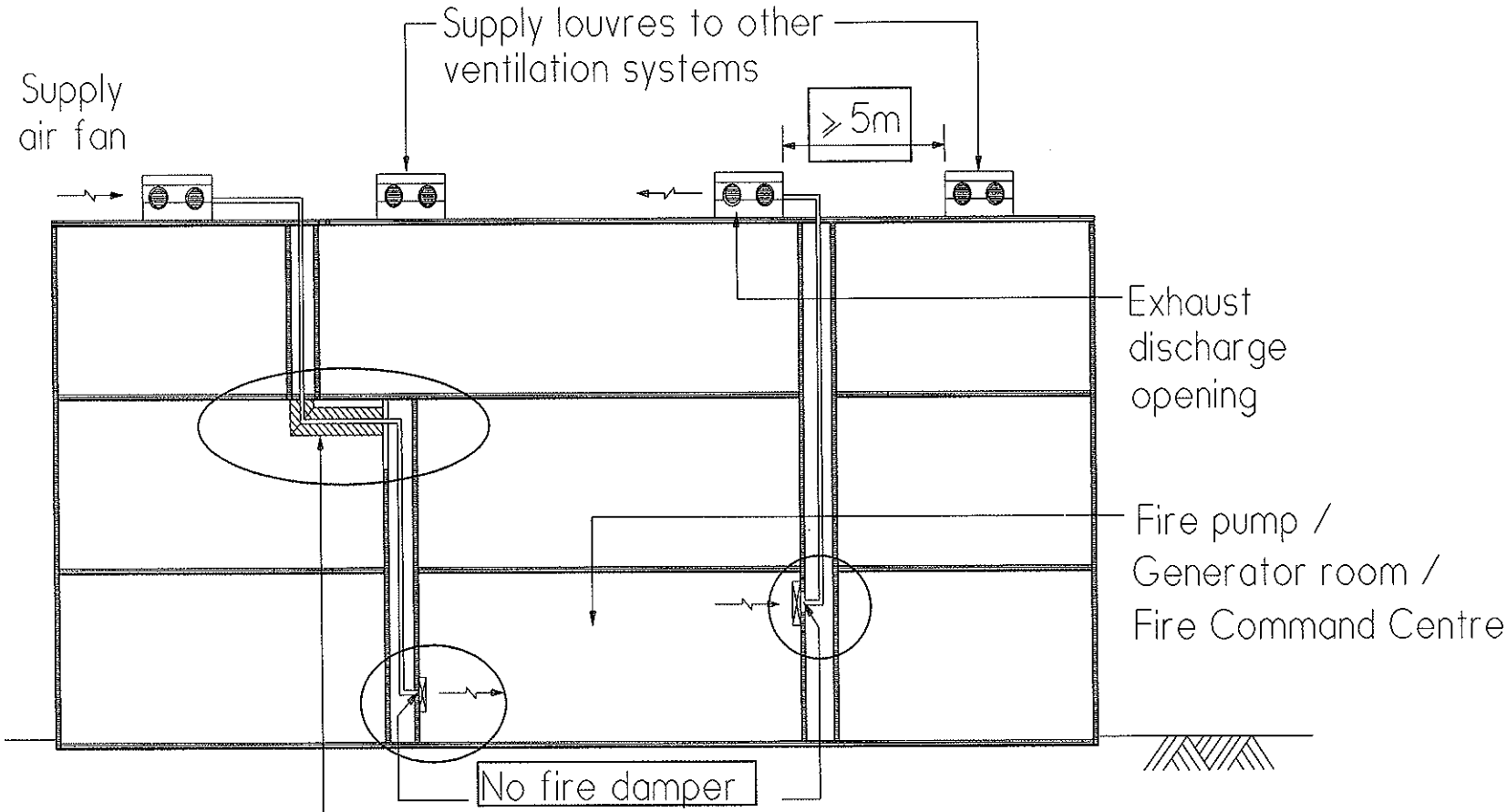
7.1.6

Where mechanical ventilation is required for the fire command centre, such system shall be **independent** of each other and any other system serving other parts of the building. It shall also comply with the following requirements:	
(a)	Supply air shall be drawn directly from the external and its intake point shall not be **less than 5 m from any exhaust discharge openings**. Exhaust discharge shall also be direct to the external and shall not be **less than 5 m from any air intake openings.**
(b)	Where the corresponding ducts run outside the fire command centre, they shall either be enclosed in a structure or be constructed to give **at least the same fire rating as the room which they serve** or that of the room through which they traverse, whichever is higher. Where the duct risers are required to be enclosed in a protected shaft constructed of masonry or drywall complying with Cl.3.8.9(a), they shall be compartmented from the rest of the shaft space containing other ducts or services installations.
(c)	**No fire damper** shall be fitted in either supply or exhaust duct required under this Clause.
(d)	**Duct serving areas** other than the fire command centre **shall not pass** through the room.

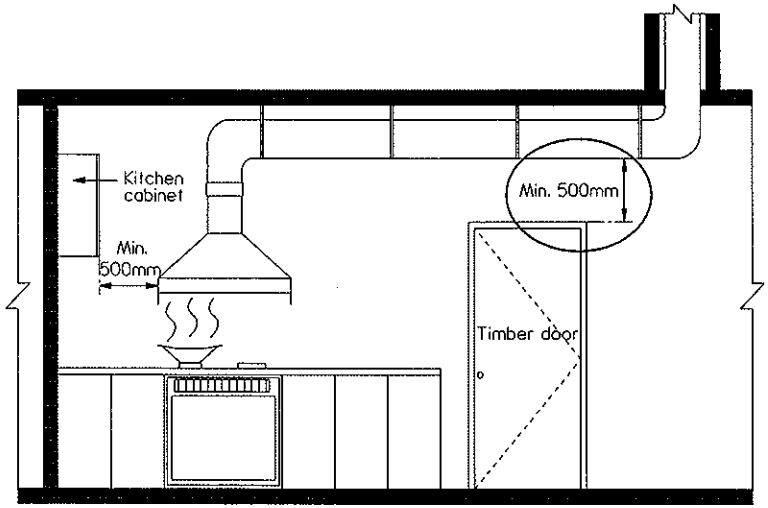
Fire command centre

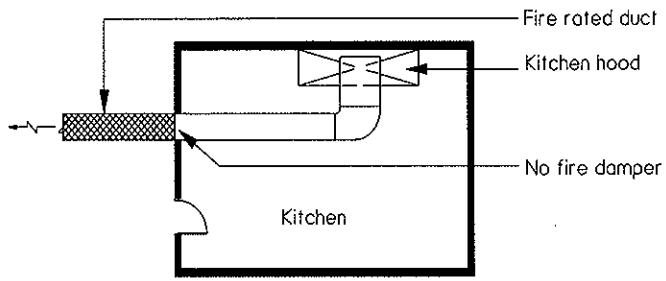


Ducts serving other areas shall not pass through the fire pump room, generator room and fire command centre. The above diagram shows that the ventilation duct is diverted to avoid traversing the aforesaid rooms.


Supply louvres to other ventilation systems
Supply air fan
≥ 5m
Exhaust discharge opening
Fire pump / Generator room / Fire Command Centre
No fire damper
Fire rated construction having the same fire resistance rating as the room it serves, or that of the room through which the duct traverses, whichever is higher. The rating shall apply to fire exposure from internal and external of the duct or structure.

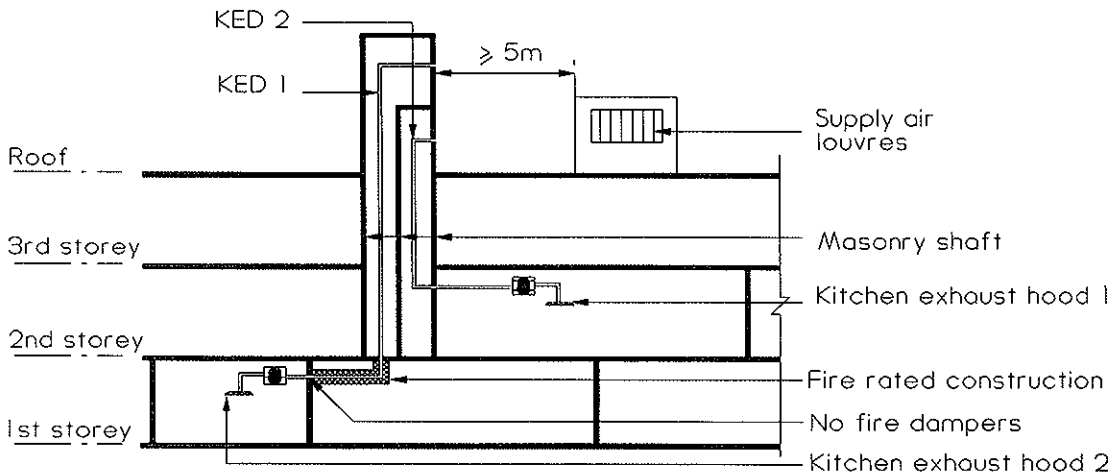
Section





Plan

Kitchen Exhaust Ducts



Section

7.1.7

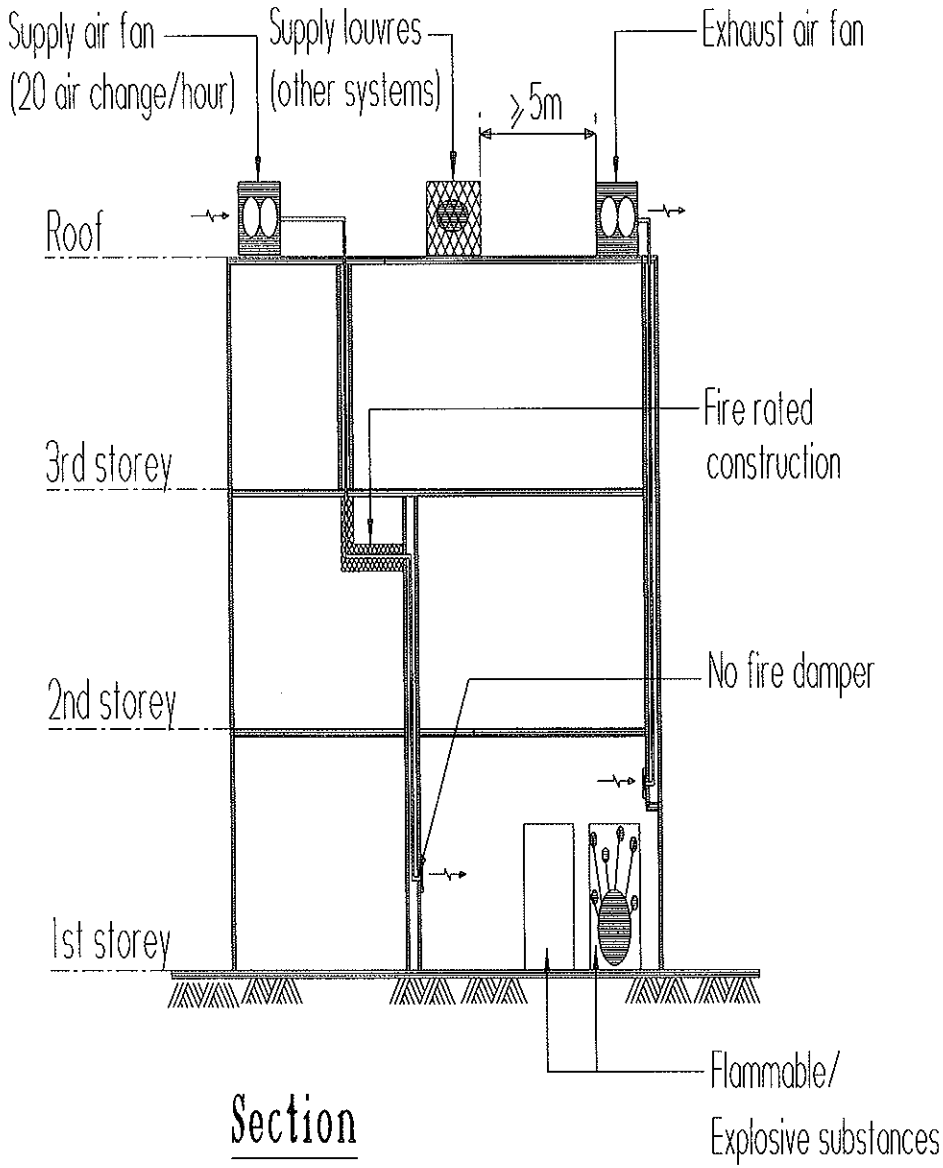
Kitchen		
(a)	Mechanical exhaust system for the cooking area of a kitchen in a hotel, restaurant, coffee house or the like shall be **independent** of those serving other parts of the building. It shall also comply with the following requirements:	
	(i)	The hood and ducts for the exhaust shall have a clearance of 500 mm from unprotected combustible materials;
	(ii)	The exhaust shall be discharged directly to the external and shall not be less than 5 m from any air intake openings;
	(iii)	The exhaust duct where it runs outside the kitchen shall either be enclosed in a structure or be constructed to give at least the same fire rating as the kitchen or that of the room through which it traverses, whichever is higher. The rating shall apply to fire exposure from both internal and external of the duct or structure. Where the duct riser is required to be enclosed in a protected shaft constructed of masonry or drywall complying with Cl.3.8.9(a), it shall be compartmented from the rest of the shaft space containing other ducts or services installations; and
	(iv)	**No fire damper** shall be fitted in kitchen exhaust ducts.

Kitchen

7.1.8

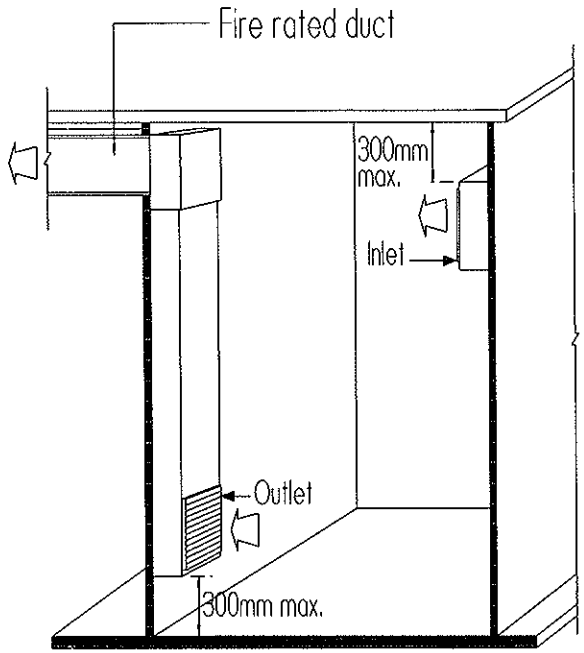
Rooms involving use of Flammable and Explosive Substances		
(a)	Mechanical ventilation system where required for rooms which involve the use of flammable and explosive substances shall be **independent** from those serving other parts of the building. It shall comply with the following requirements:	
	(i)	Ventilation system shall consist of exhaust and supply part with a **rate of 20 air-change per hour** or any other rates acceptable to the Relevant Authority. The exhaust shall be direct to the external and shall not be less than 5 m from any air intake openings;
	(ii)	Where such ducts run outside the room they shall either be enclosed in a structure or be constructed to give **at least the same fire rating** as the room which they serve or that of the room through which they traverse, whichever is higher. The rating shall apply to fire exposure from both internal and external of the duct or structure. Where the duct risers are required to be enclosed in a protected shaft constructed of masonry or drywall complying with Cl.3.8.9(a), they shall be compartmented from the rest of the shaft space containing other ducts or services installations;
	(iii)	**No fire damper** shall be fitted in either supply or exhaust duct required under this Clause; and
	(iv)	**Ducts serving other areas shall not pass through rooms** involving use of flammable and explosive substances.

Rooms involving use of flammable & explosive substances

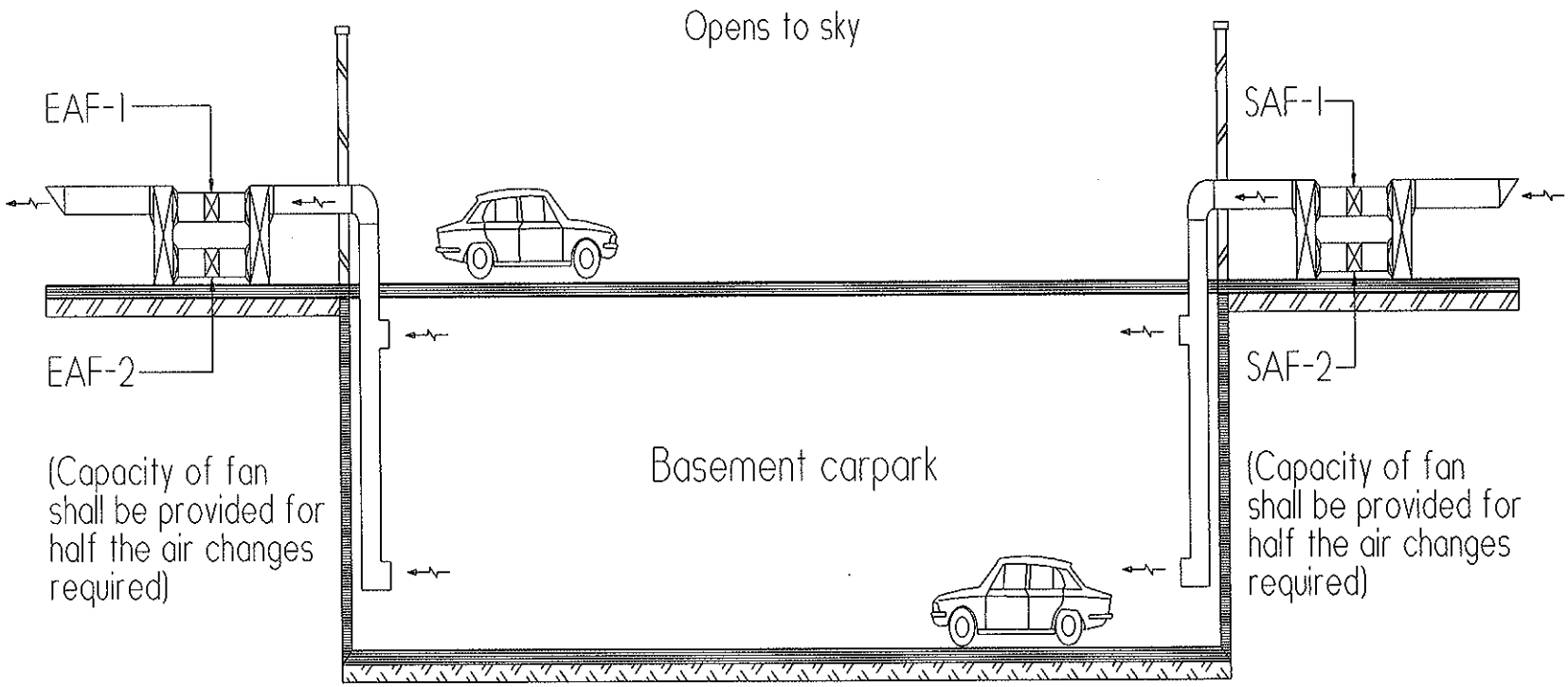


Section

Room with flammable vapour being removed is heavier than air



7.1.9	Where mechanical ventilation system is required for car parking areas in basements with total floor area **exceeding ~~1900~~ 2800 sq m**, a smoke purging system which is independent of any systems serving other parts of the building shall be provided to give a purging rate of not **less than 9 air-change per hour**.		Basement car park
	(a)	The smoke purging system shall be **activated automatically by the building fire alarm system**. In addition, a **remote manual start-stop switch shall be located at fire command centre, or at main fire alarm panel on first storey** (where there is no fire command centre in the building). **Visual indication of the operation status of the smoke purging system** shall also be provided with this remote control.	
	(b)	Supply air shall be drawn directly from the external and its intake shall not **be less than 5 m from any exhaust discharge** openings. Outlets for the supply air shall be adequately distributed over the car park area.	
	(c)	Where there is natural ventilation for such basement car park based upon **openings equal to not less than ~~2%~~ 2.6% of the floor area of such storey**, such natural ventilation may be considered as a satisfactory substitute for the supply part of the smoke purging system for that storey.	
	(d)	Exhaust air shall be discharged directly to the external and shall not be less than 5m from any air intake openings.	
	(e)	Where **ducts are used for the basement car park smoke** purging system, they shall comply with the requirements of **SS CP 13 Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings**.	



Section

Failure of EAF-1 will cuts down SAF-1

Failure of EAF-2 will cuts down SAF-2

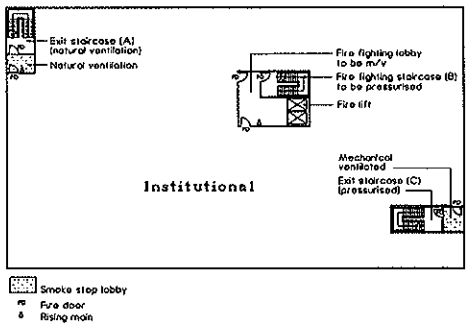
EAF: Exhaust air fan

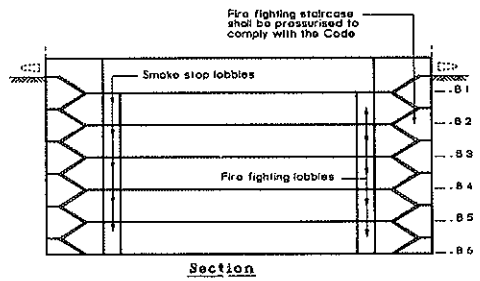
SAF: Supply air fan

7.2 - PRESSURISATION FOR EXIT STAIRCASES

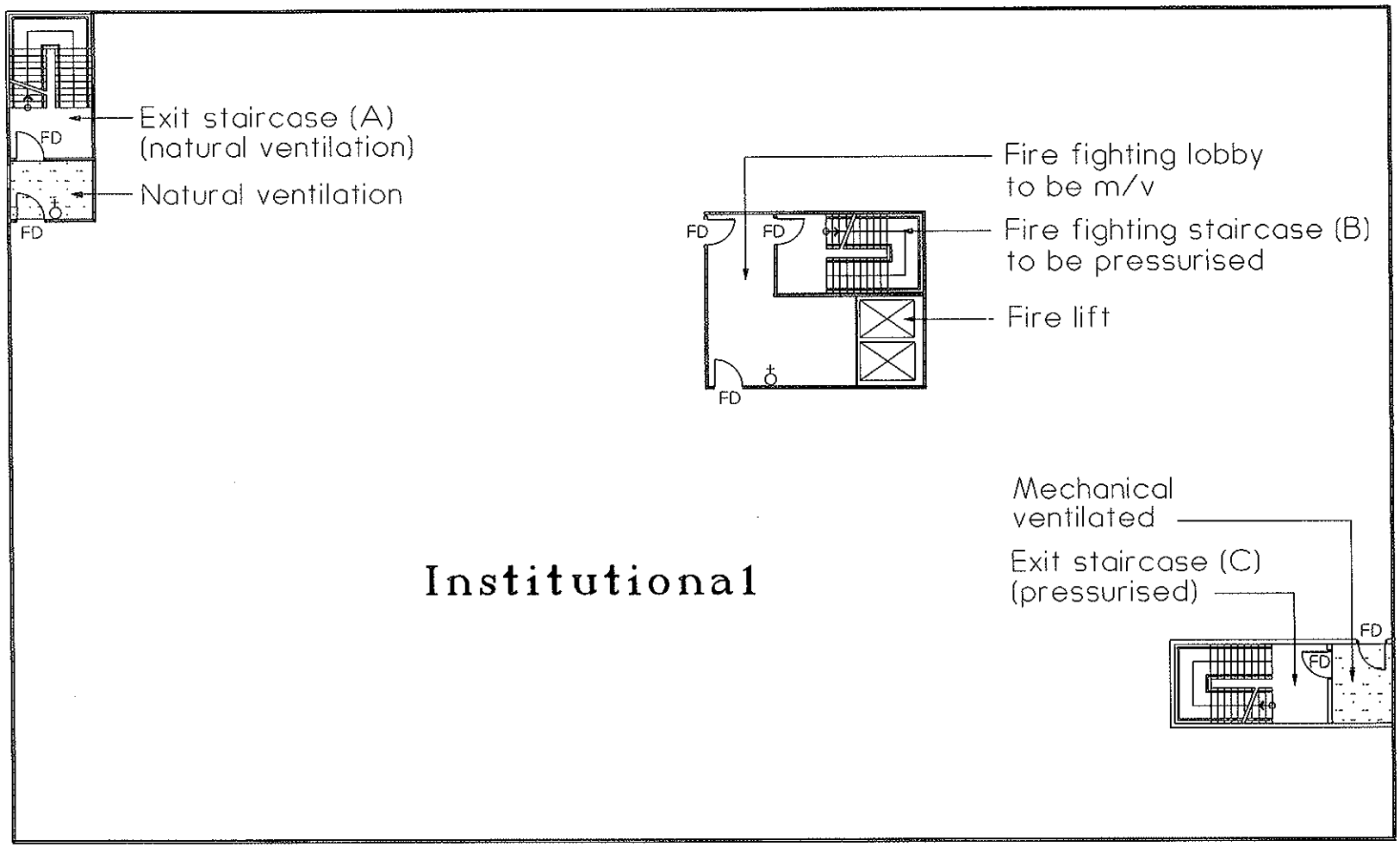
7.2.1

General		
(a)	In any building of which the **habitable height exceeds 24 m**, **any internal exit staircases** without provision for **natural ventilation** shall be pressurised to comply with the requirements in this Code.	General
(b)	In a building comprising more than **4 basement storeys**, **exit staircase connected to fire fighting lobby** in basement storeys shall be pressurised to comply with the requirements in this Code.	Basement
(c)	**Pressurisation** ~~may~~ must be extended to **smoke-stop lobby** provided the pressurisation level complies with Cl. 7.2.2(b).	Smoke-stop lobby





Clause 7.2.1(a)

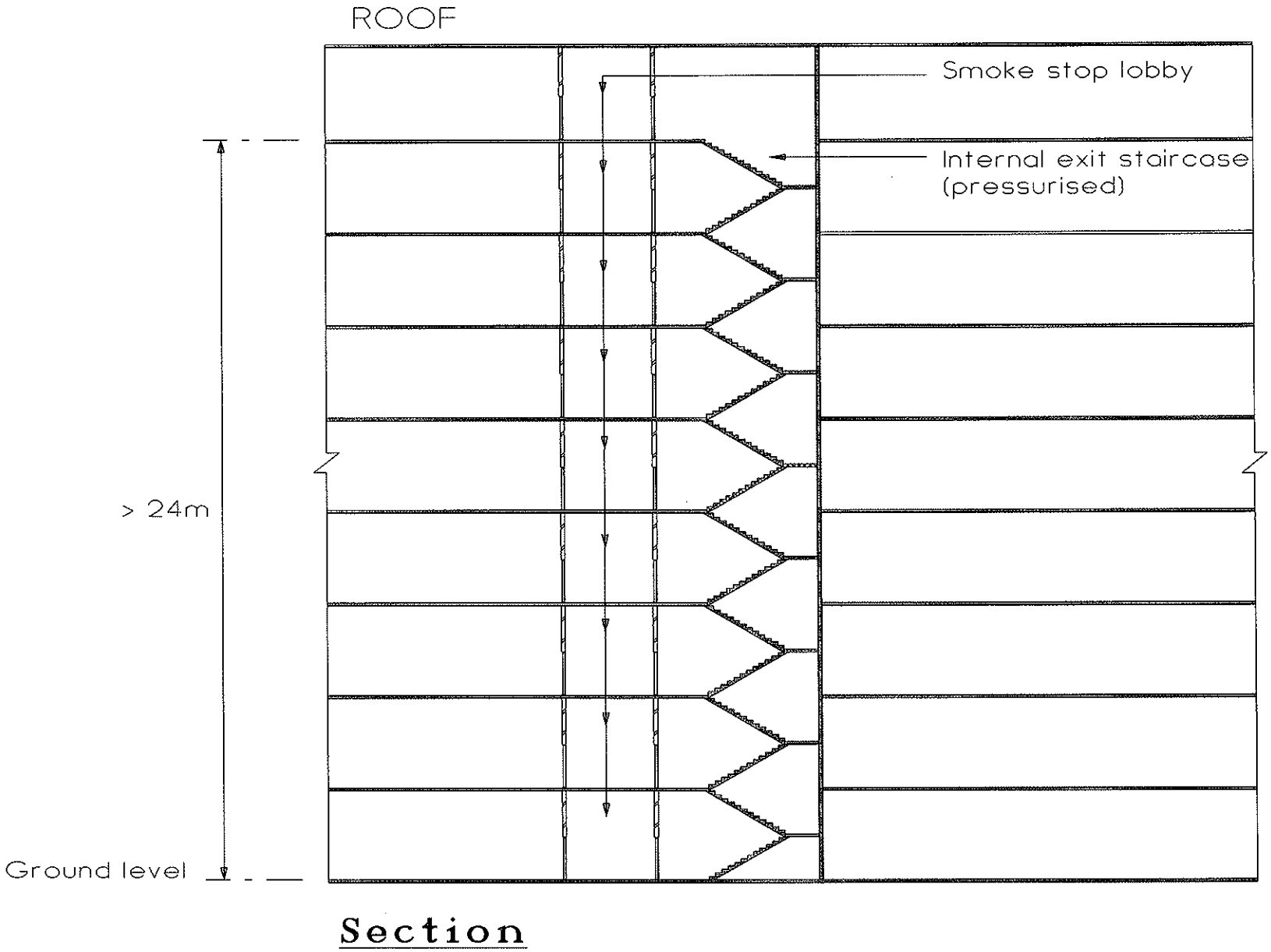


Smoke stop lobby

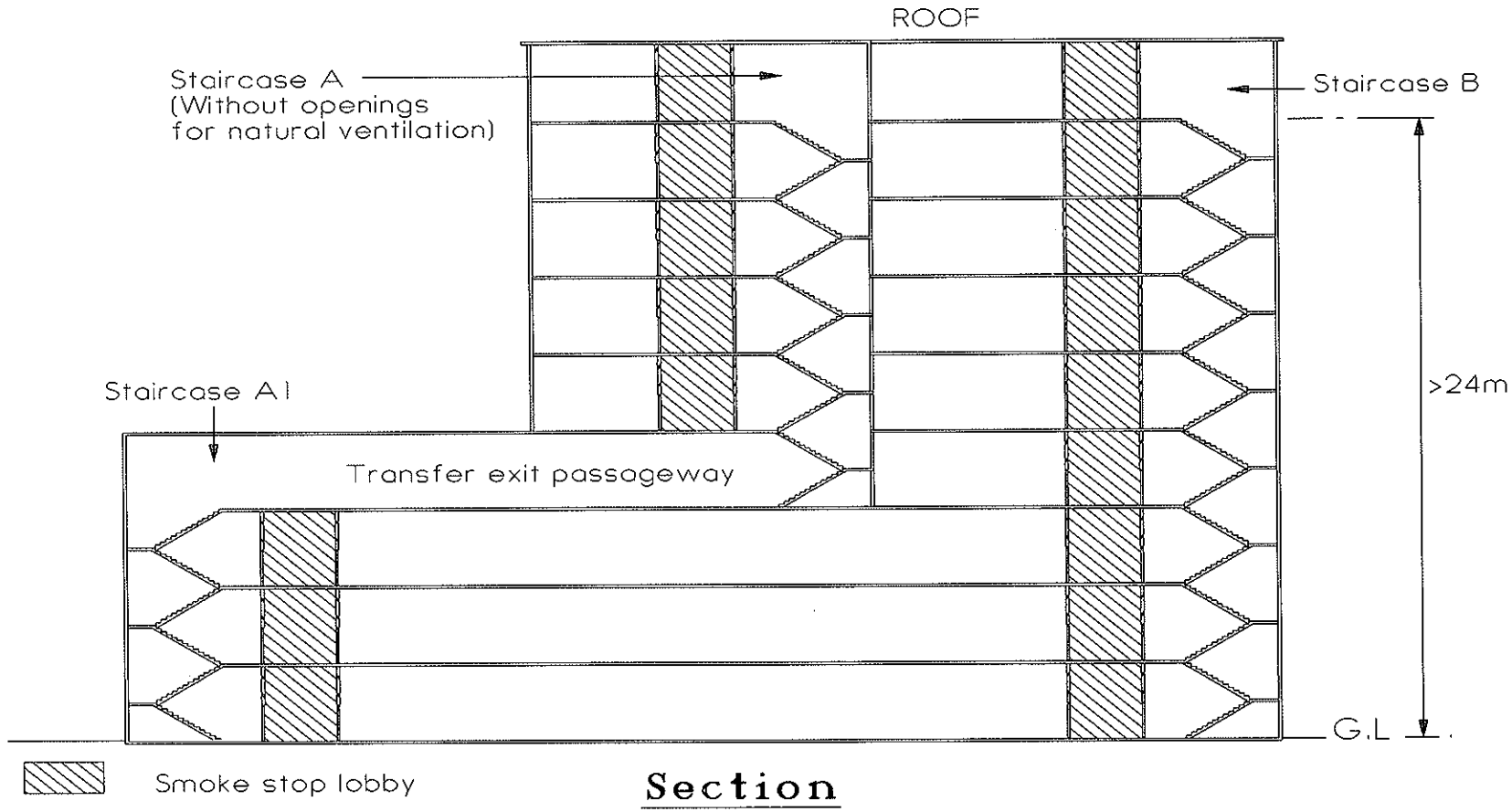
FD Fire door

Rising main

Building exceeding 24m in habitable height

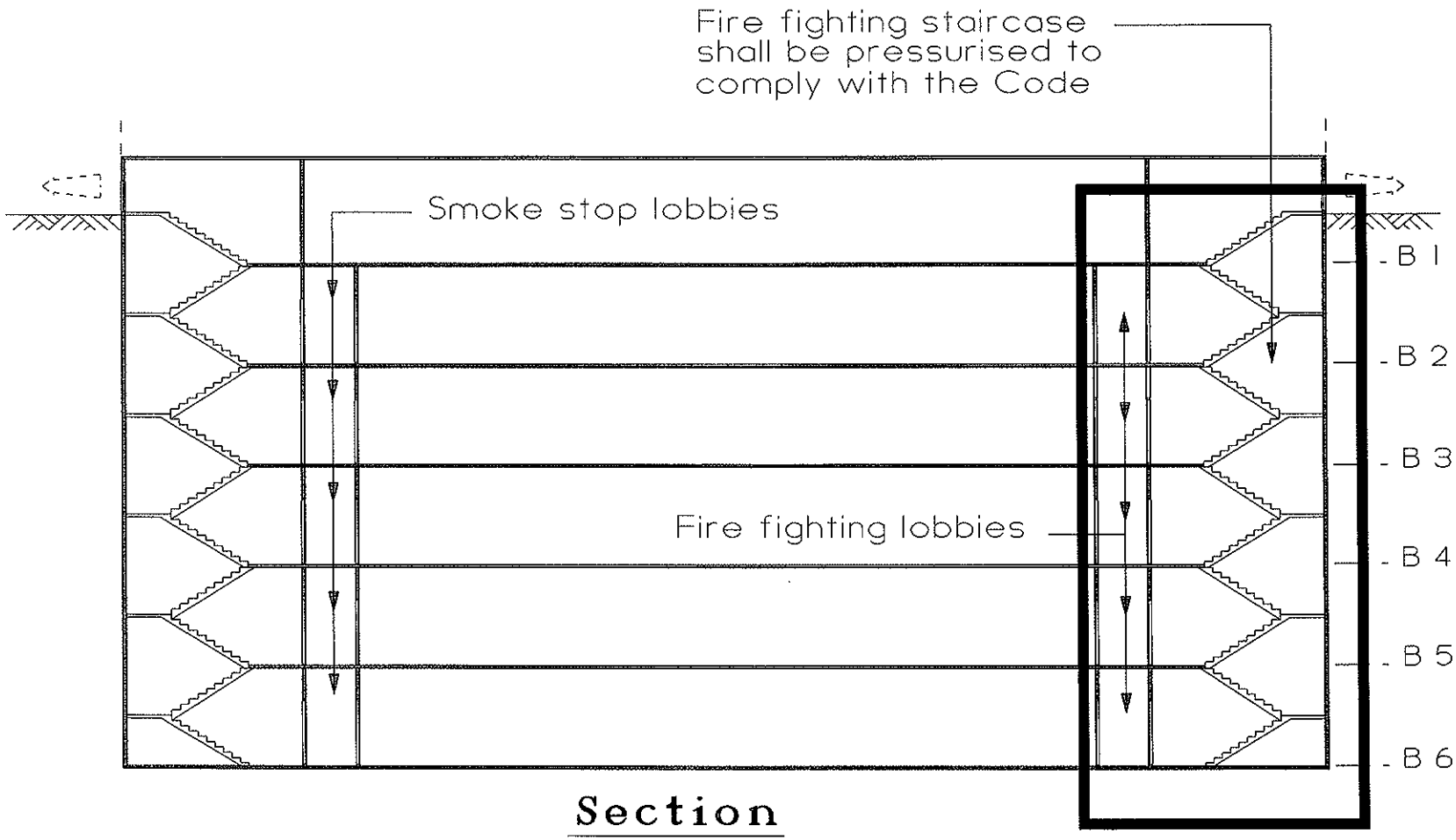

ROOF
Smoke stop lobby
Internal exit staircase
(pressurised)
> 24m
Ground level

Section



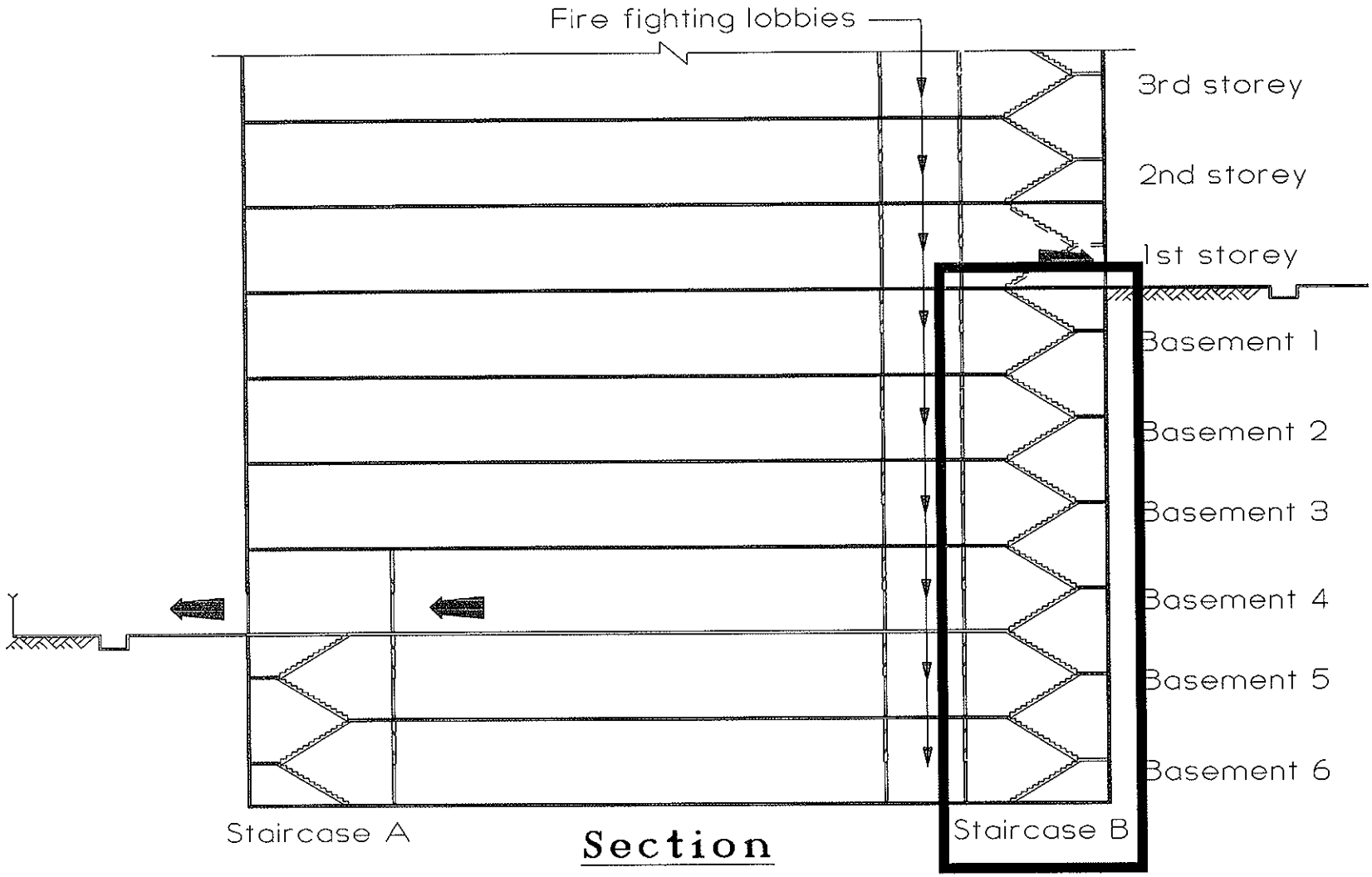
Section

Staircase A and transfer staircase A1 is considered as one single staircase sharing a common protected shaft. As staircase A is an internal staircase without openings for natural ventilation, exceeding a habitable height of 24m, it is required to be provided with M/V and pressurisation. Since, staircase A1 is acting as a transfer staircase, it shall likewise be M/V and pressurised notwithstanding the fact it can be naturally ventilated through external openings. The transfer exit passageway which connects staircases A and A1 should also be M/V and pressurised. It is not acceptable to have partial pressurisation to staircase A by introducing a door across the transfer passageway, such that staircase A1 is separated for the provision of natural ventilation. The reason is that by providing a door across the transfer passageway, it would impede the movement of occupants moving towards staircase A1. In this way, the evacuation process within the whole shaft of staircase A would be slowed down.



Section

In a building comprising more than 4 basement storeys, the exit staircase designated as fire fighting staircase shall be pressurised.

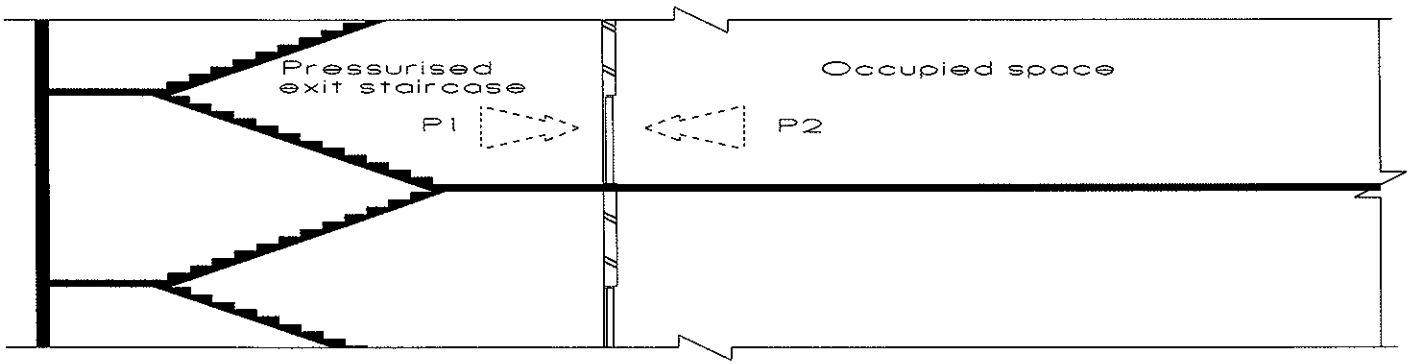


Owing to different in ground levels, staircase B is serving more than 4 basements and is therefore designated as a fire fighting staircase complemented with a fire fighting lobby at each storey.

7.2.2

Pressurisation Level	
(a)	When in operation, the pressurisation system shall maintain a **pressure differential of not less than 50 Pa** between the pressurised exit staircase and the occupied area when all doors are closed.
(b)	Where a pressurisation system is extended to the smoke stop lobby, the **pressure gradient** shall be such that the pressure at the exit staircase shall always be higher.
(c)	The force required to open any door against the combined resistance of the pressurising air and the automatic door-closing mechanism **shall not exceed 110 N at the door handle**.

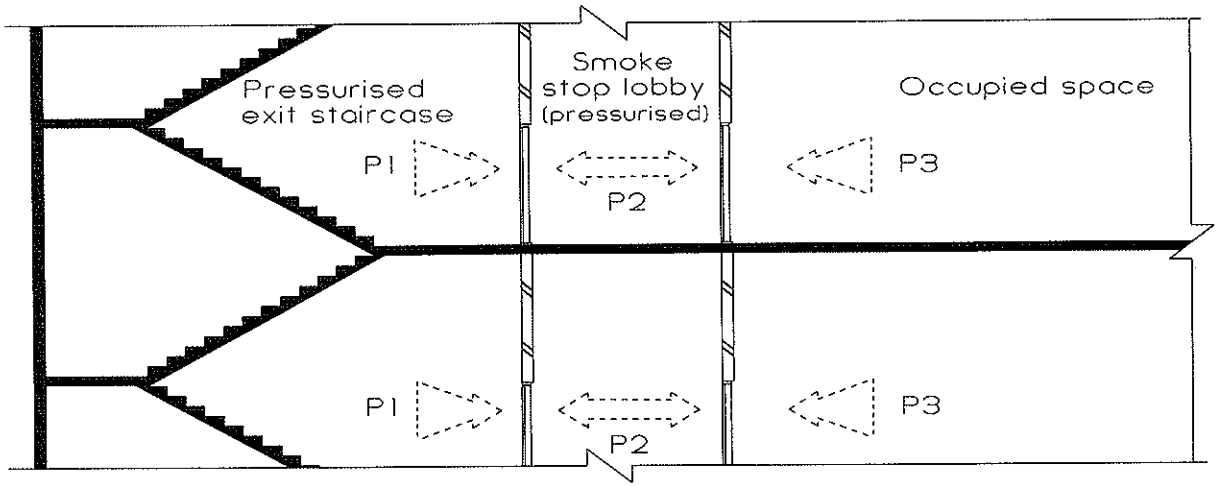
Pressurisation level



Section

P1 = Pressurisation system pressure
P2 = occupied area pressure
P1 - P2 ≥ 50 pa
Pressure P1 is greater than P2 in occupied space

Maintaining pressure differential

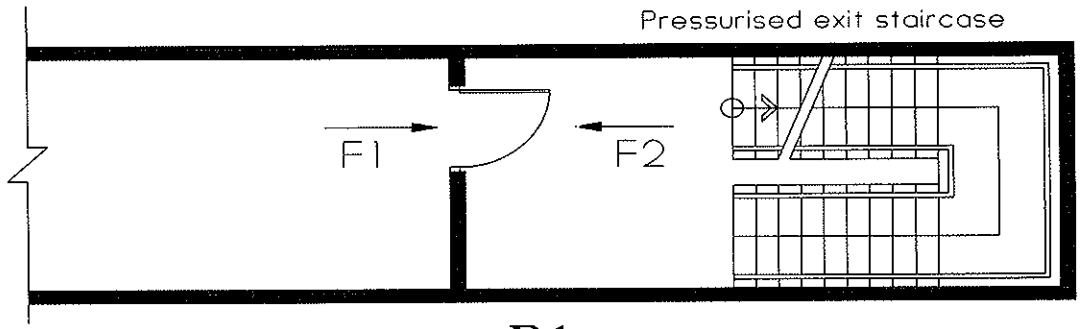


Section

Pressure gradient

P1 = Pressurisation system pressure
P1 > P2 > P3
P1 - P3 ≥50pa
Pressure P1 in staircase is greater than pressure P2 in smoke stop lobby, P2 is greater than pressure P3 of occupied space

Force required to open door

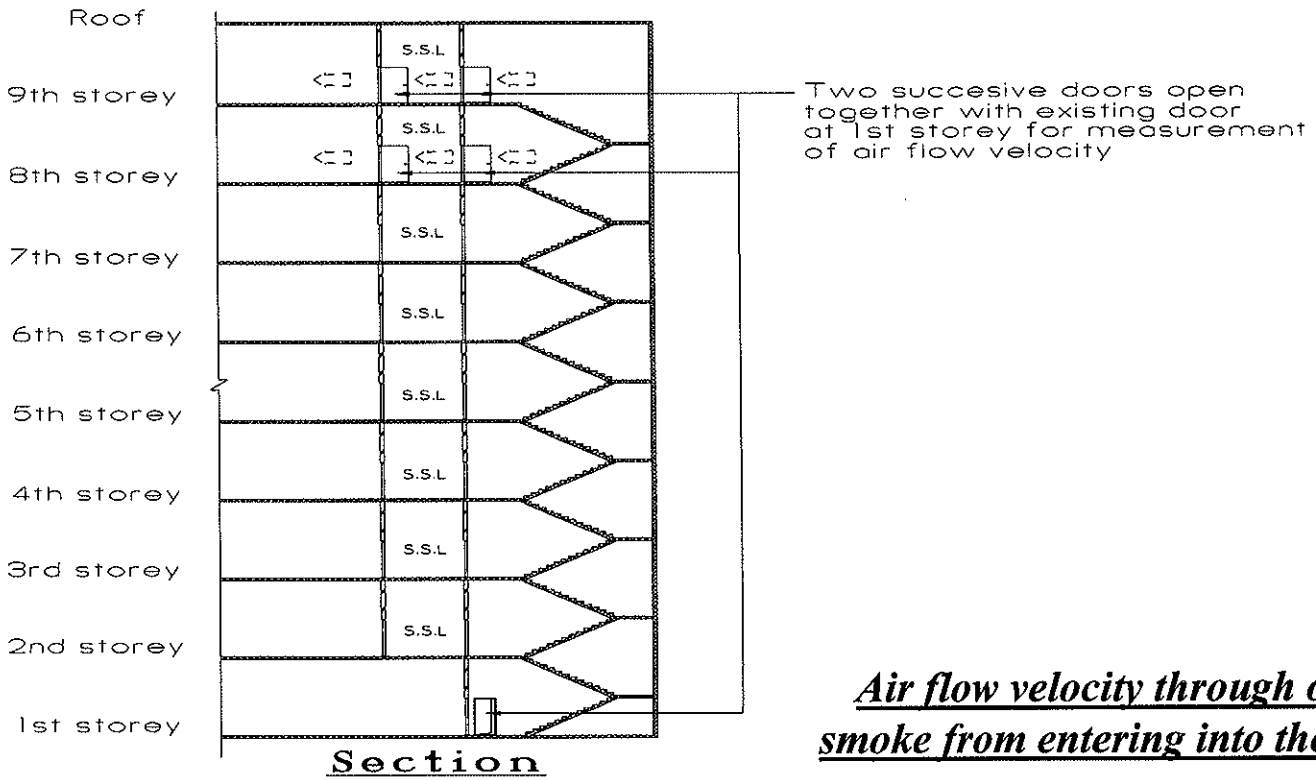


Plan

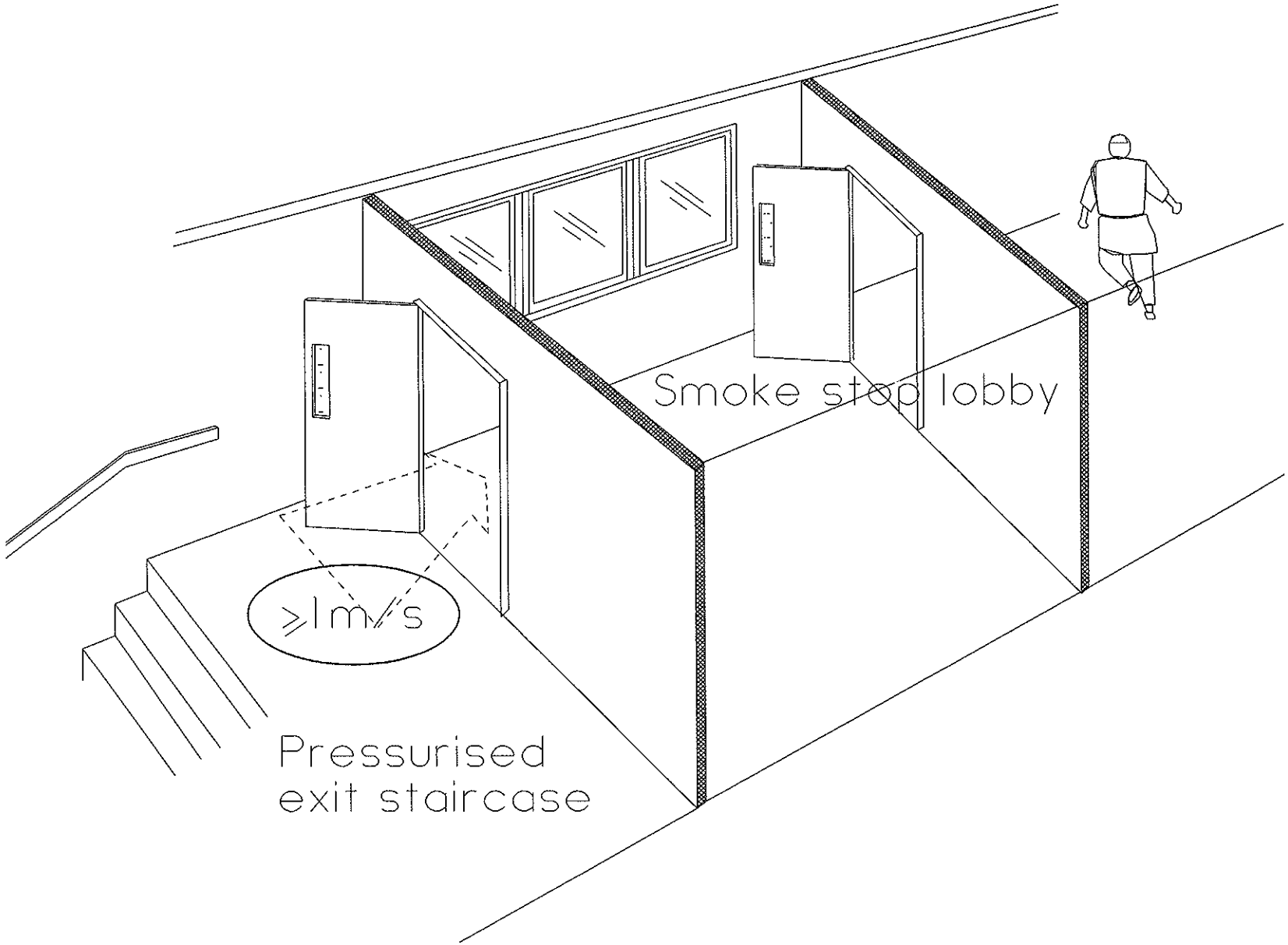
F1 = Force to open door
F2 = Pressurising force

7.2.3 When in operation, the pressurisation system shall maintain an airflow of sufficient velocity through open doors to prevent smoke from entering into the pressurised area. The flow velocity shall be attained when a **combination of two doors from any two successive storeys** and the **main discharge door** are fully open. Magnitude of the velocity averaged over the full area of each door opening **shall not be less than 1.0 m/s.**

Egress velocity



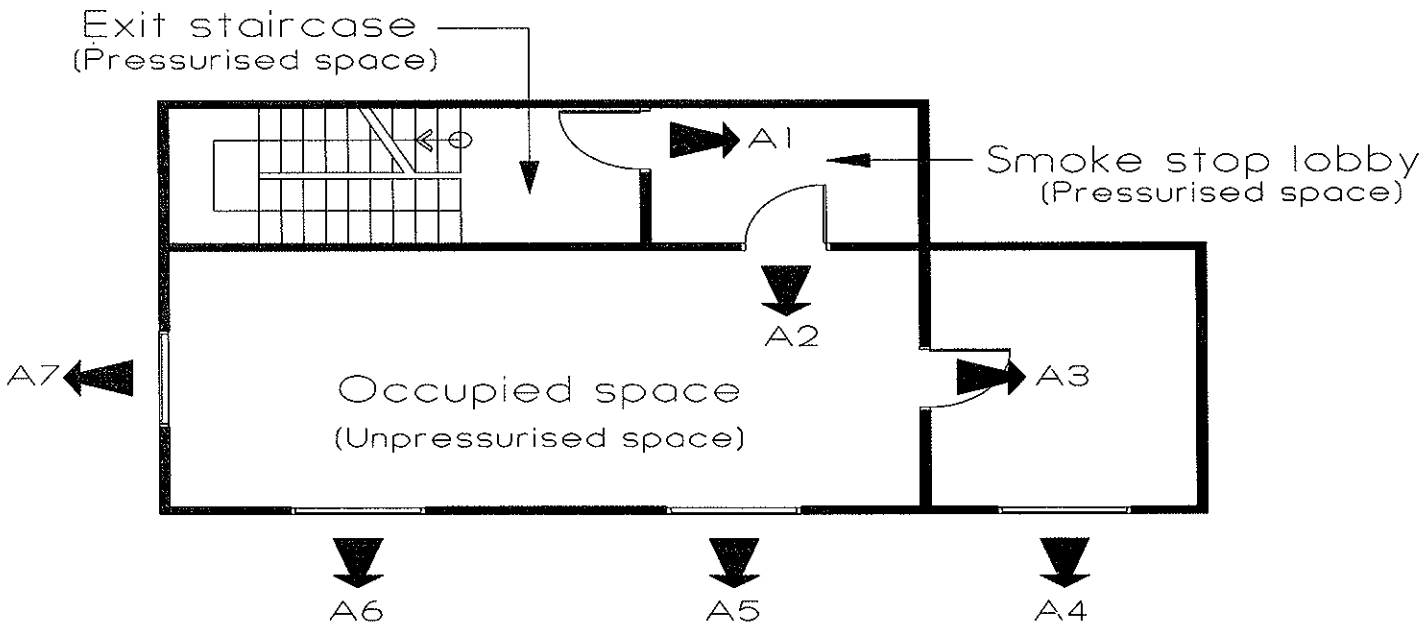
Air flow velocity through open door to prevent smoke from entering into the pressurised staircase


Smoke stop lobby
≥1m/s
Pressurised
exit staircase

7.2.4

Leakages	
(a)	The rate of supply of pressurised air to the pressurised areas shall be sufficient to make up for the loss through leakages into the unpressurised surroundings.
(b)	Adequate relief of leaked air out of the occupied area shall be provided to avoid a pressure build-up in this area. The relief may be in the form of perimeter leakages or purpose-built extraction systems.

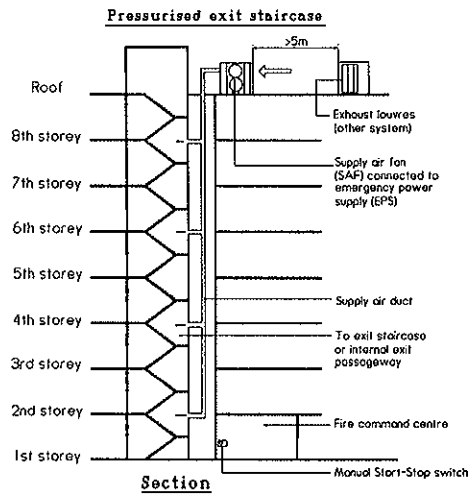
Leakages

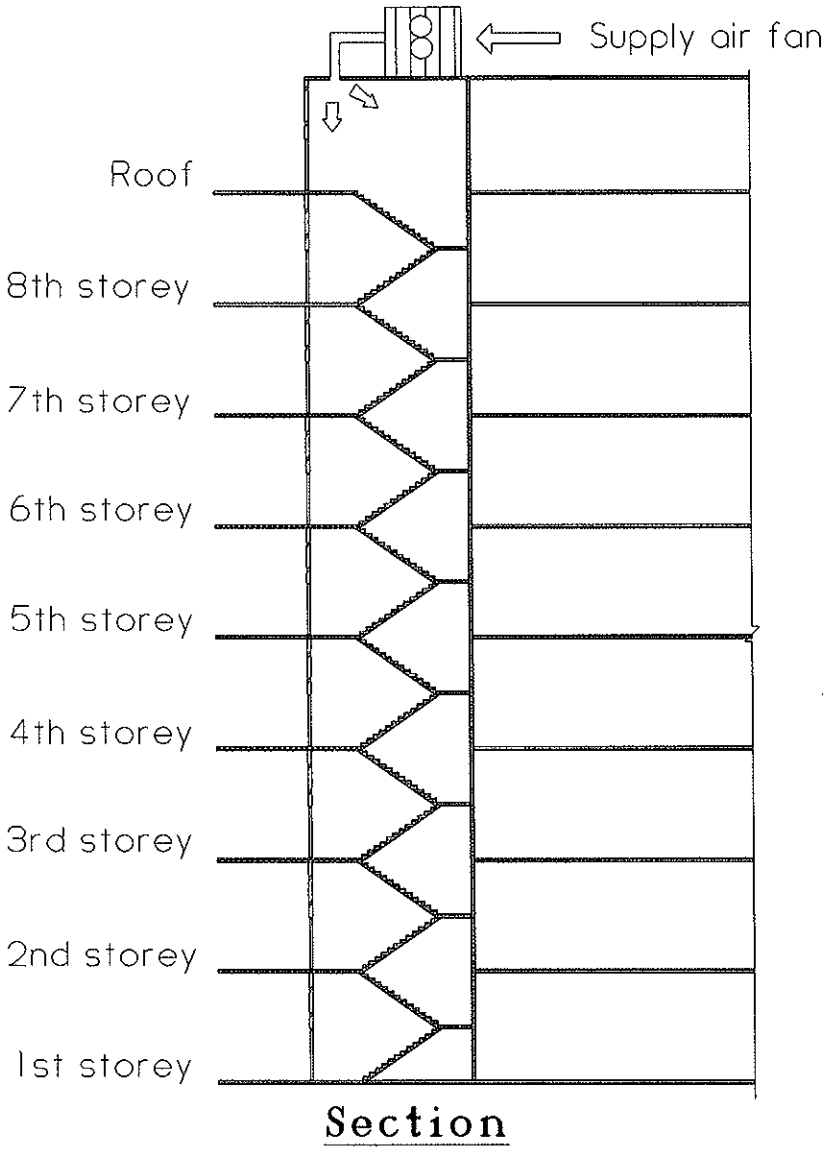


7.2.5

Distribution of Pressurising Air	
(a)	The number and distribution of injection points for supply of pressurising air to the exit staircase should ensure an even pressure profile complying with Cl. 7.2.2.
(b)	The arrangement of the injection points and the control of the pressurisation system shall be such that when opening of doors or other factors cause significant variations in pressure difference, condition in Cl. 7.2.2 should be restored as soon as practicable.

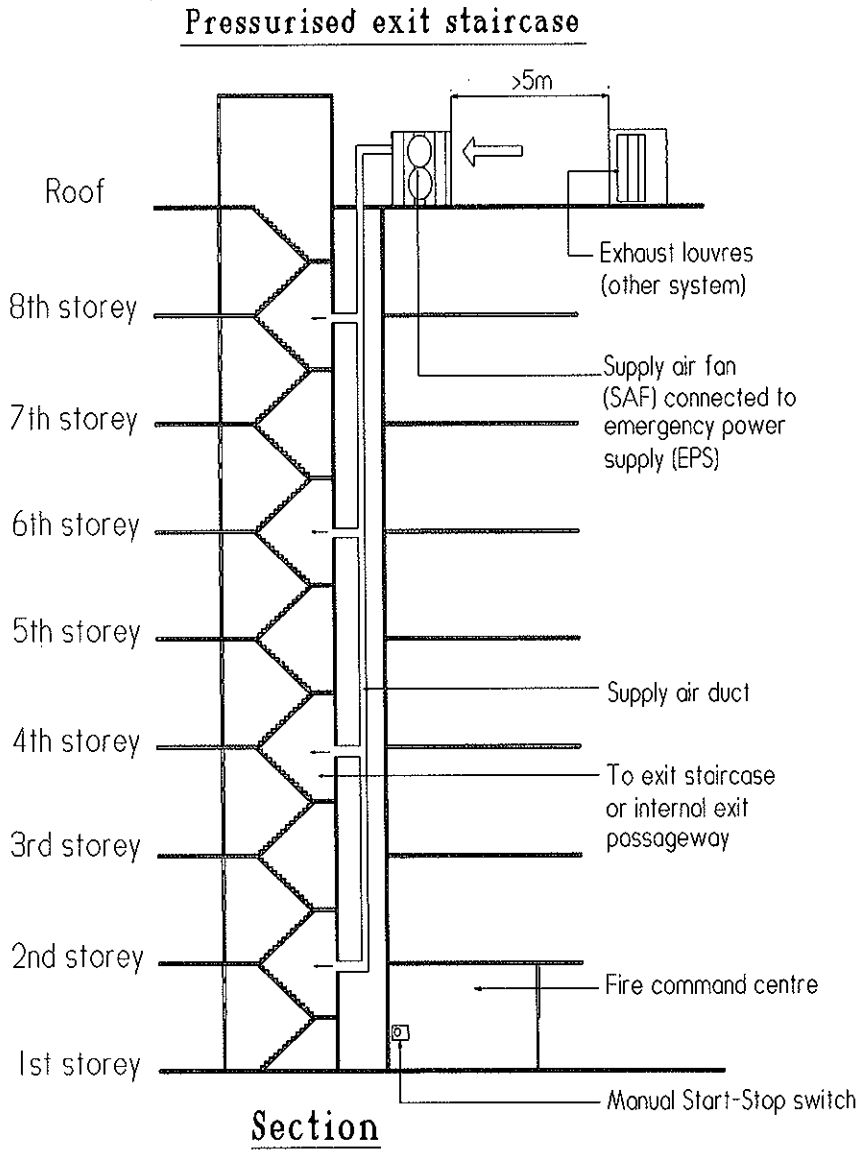
Distribution of pressurising air





Section

Not acceptable



Section

Acceptable

7.2.6

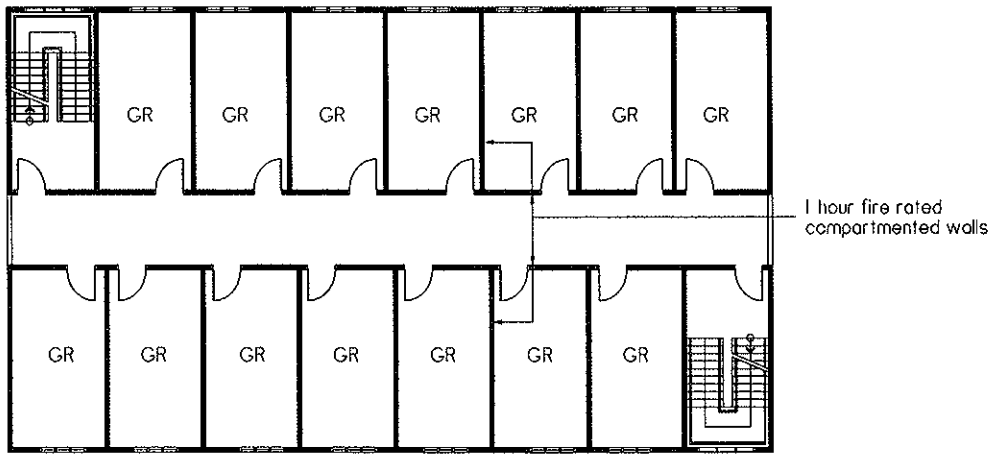
Equipment	
(a)	All the equipment and the relevant controls associated with the pressurisation system shall be so designed and installed to ensure satisfactory operation in the event of and during a fire.
(b)	Supply air for pressurisation system shall be drawn directly from the external and its intake shall not be **less than 5 m** from any exhaust discharge openings.
(c)	The pressurisation system shall be **automatically activated by the building fire alarm system.** In addition, a **remote manual start-stop switch** shall be made available to firemen at the **fire command centre, or at the fire indicating board** where there is no fire command centre. **Visual indication** of the operation status of the pressurisation system shall be provided.

Equipment

7.3 - PRESSURISATION OF INTERNAL CORRIDORS IN HOTELS

7.3.1 Where **internal corridors in hotels** are required to be pressurised in compliance with **Cl. 2.7.1(c)**, the pressure within such corridors shall be higher than that in the guest rooms and the pressure within the internal exit staircases higher than that of the corridors.

Pressurisation of internal corridors in hotels



GR : Guest Rooms

: Min. $\frac{1}{2}$ hour fire door fitted with automatic self-closing device

2.7.1 Hotel bedrooms with access through an internal corridor shall comply with the requirements as follows:

Internal corridor to hotel

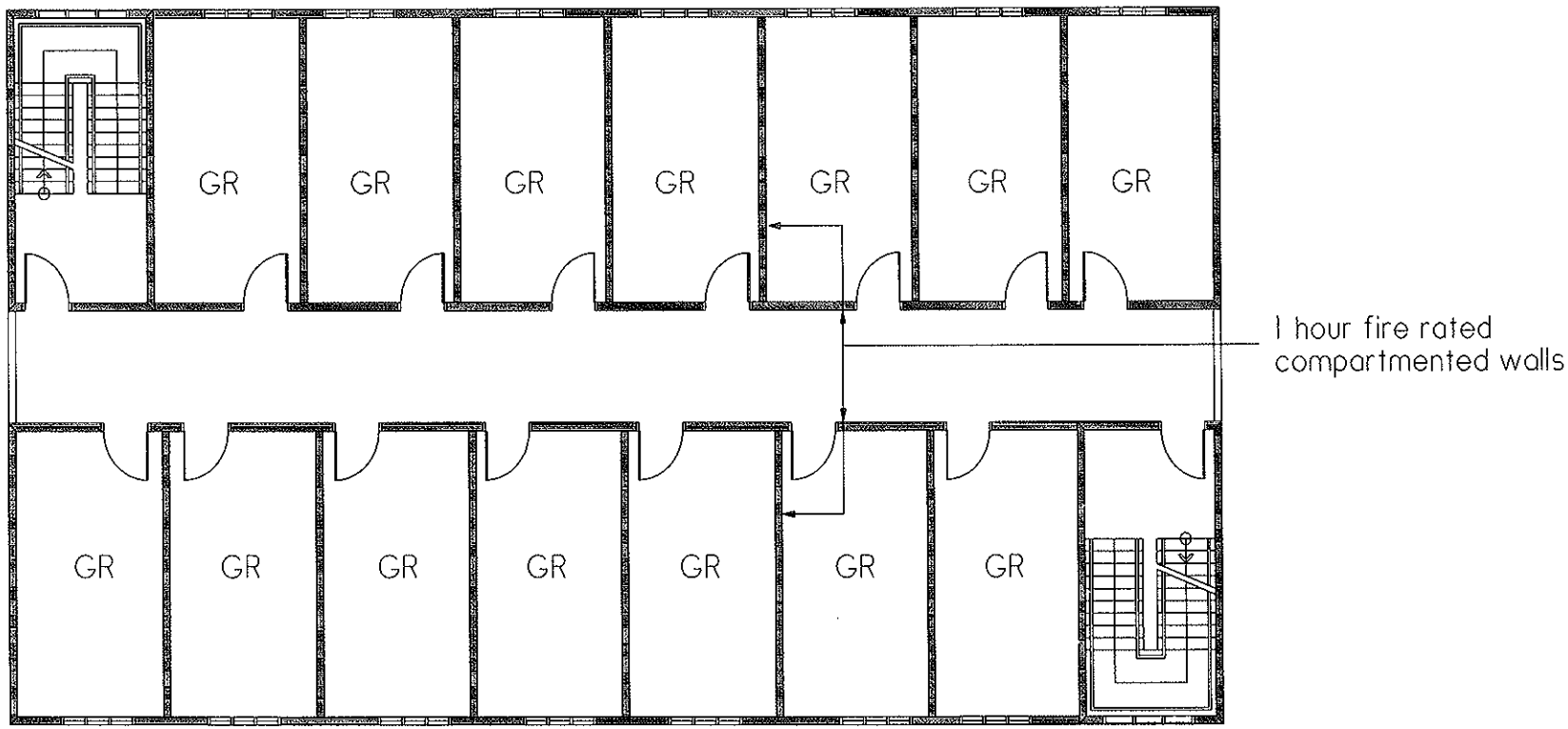
(a) Hotel bedrooms shall be separated from the internal corridor by a wall having fire resistance of at least 1 hour, and

Bedrooms

(b) Doors opening into internal corridors shall have fire resistance of at least half an hour and fitted with automatic self-closing device to comply with the requirements of Cl. 3.9.2, and

(c) Internal corridors shall be naturally ventilated with fixed openings in an external wall, such ventilation openings being not less than 15 per cent of the floor area of the internal corridor, and internal corridors which cannot be naturally ventilated shall be pressurised to comply with the requirements in chapter 7.

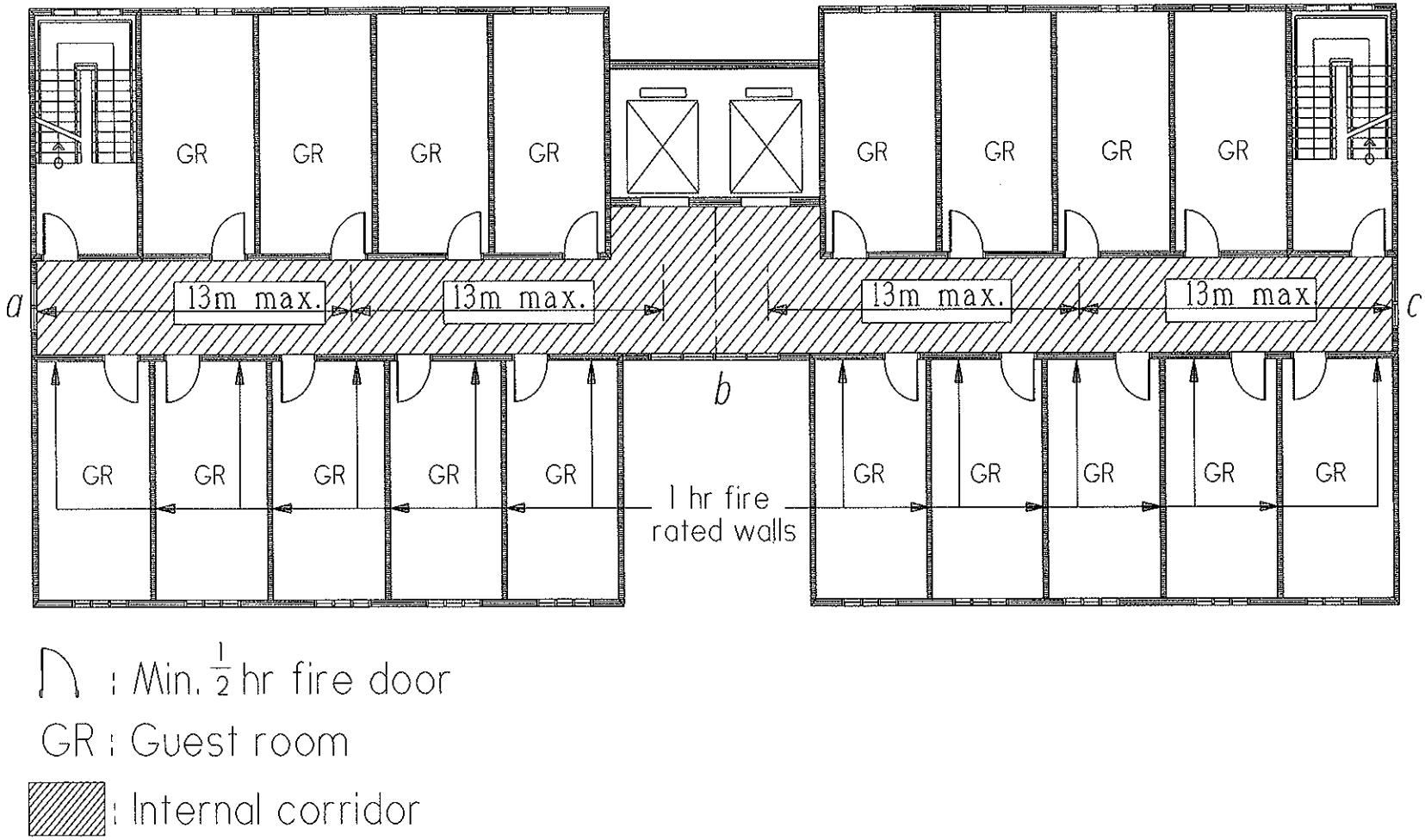
(d) Other rooms or spaces which open into or form part of the bedroom corridor which may prejudice the means of escape provision shall be required to be compartmented to the same extent as the bedrooms.



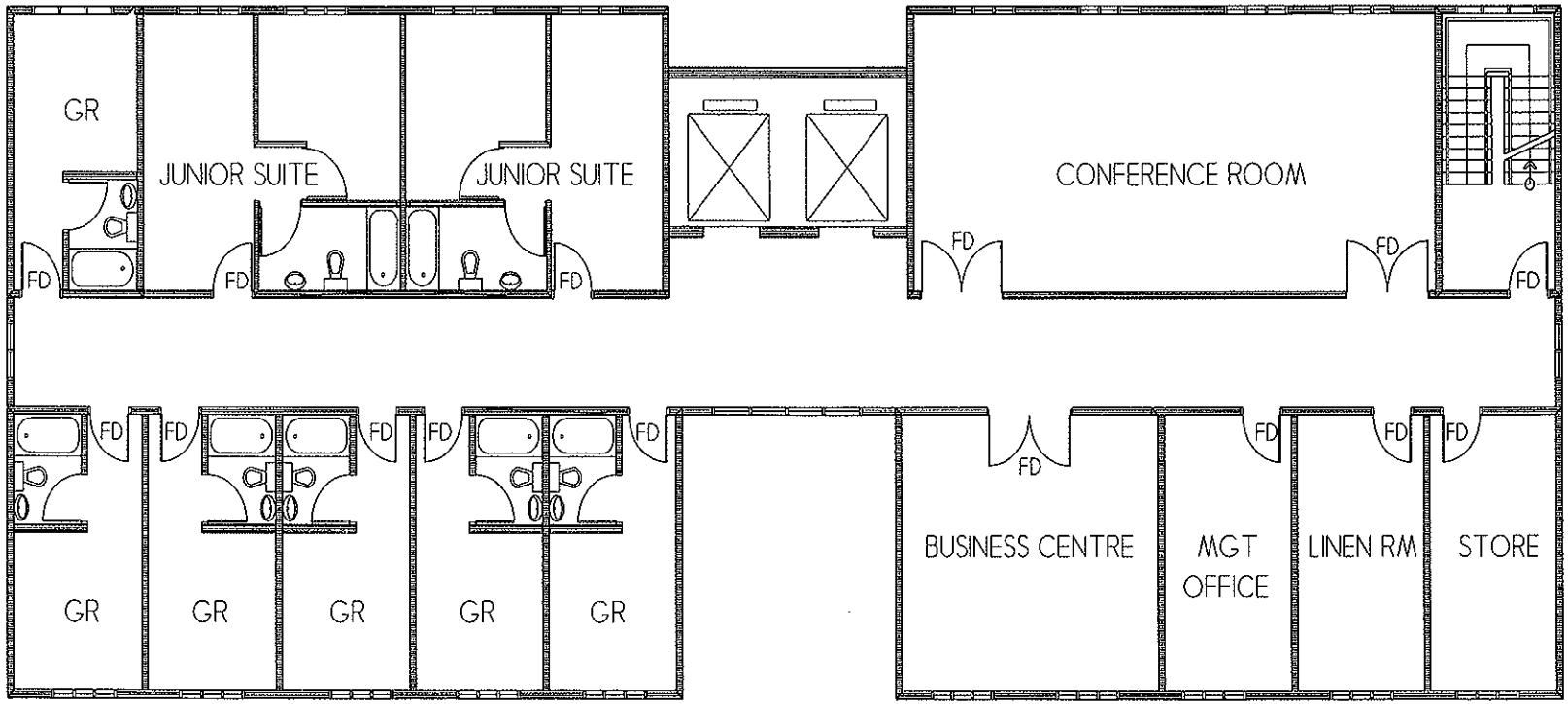
GR : Guest Rooms

: Min. $\frac{1}{2}$ hour fire door fitted with automatic self-closing device

Each guestroom is treated as a fire compartment. Walls facing the corridor and between guestrooms may be constructed of fire rated materials other than masonry. They shall be of full height carried right-up to the underside of the soffit of the floor slab above or to an imperforate fire rated ceiling or to the roof coverings.



For natural ventilation to the internal corridor, the total fixed openings (a + b + c) shall not be less than 15% of the area of the internal corridor. Alternatively, internal corridor can be provided with mechanical ventilation and pressurised to comply with the requirements in Chapter 7. No part of the corridor shall be at a distance of more than 13m from any ventilation openings.



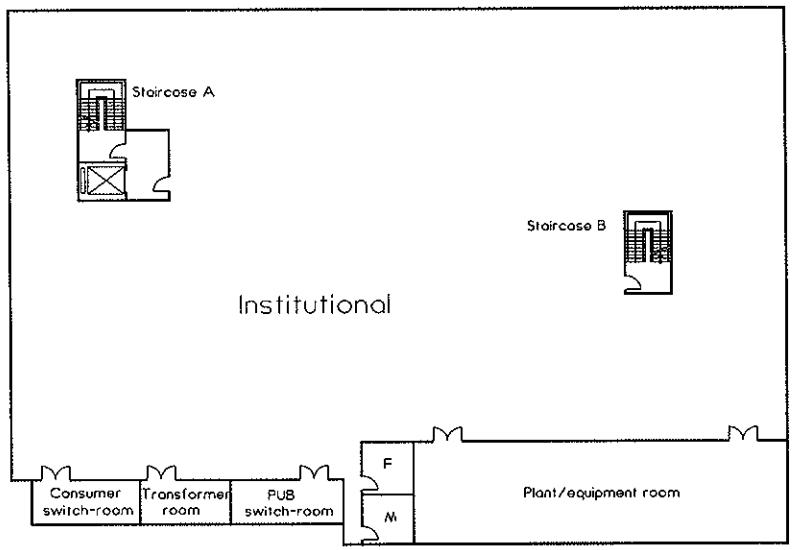
FD : Min. $\frac{1}{2}$ hr fire door
GR : Guest room

Other rooms or spaces include linen room, which required to be fire compartmented with 1-hour fire rated enclosure and ½ hour fire door respectively. Lounge area, business centre etc. should be treated as guestroom. Therefore, compartmentation is required.

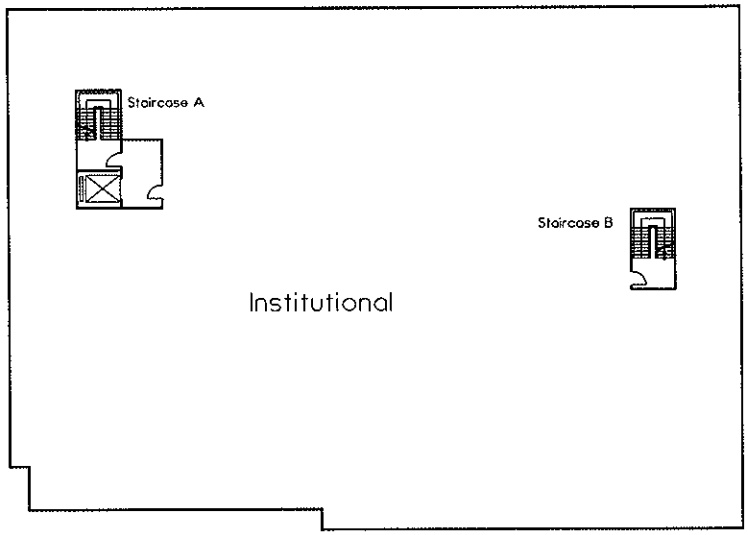
7.4 - BASEMENT SMOKE CONTROL SYSTEM

7.4.1 Scope

(a)	Where the **total aggregate floor area of all basement storeys does not exceed ~~1900~~ 2000 sq m**, smoke vents in accordance with **Cl.7.4.2 shall be provided**.
(b)	Where the total aggregate floor area of all basement storeys **exceeds ~~1900~~ 2000 sq m, engineered smoke control system** that complies with the requirements stipulated in **Cl.7.4.3** shall be provided for all parts of basement with the following exceptions:

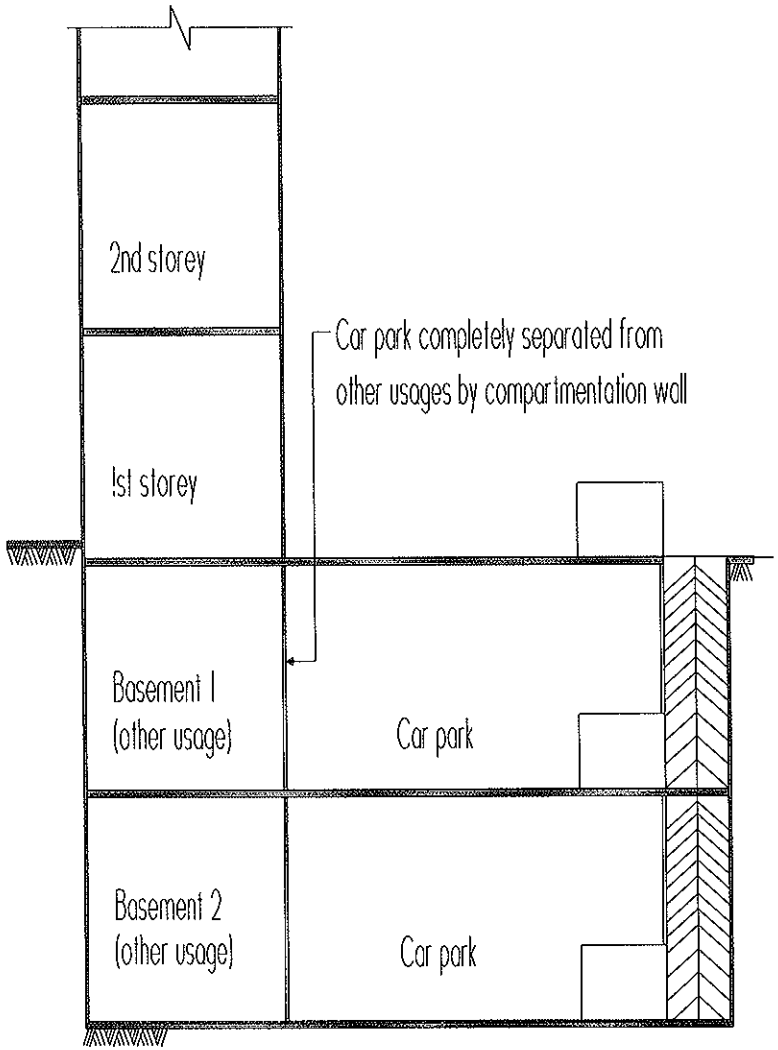


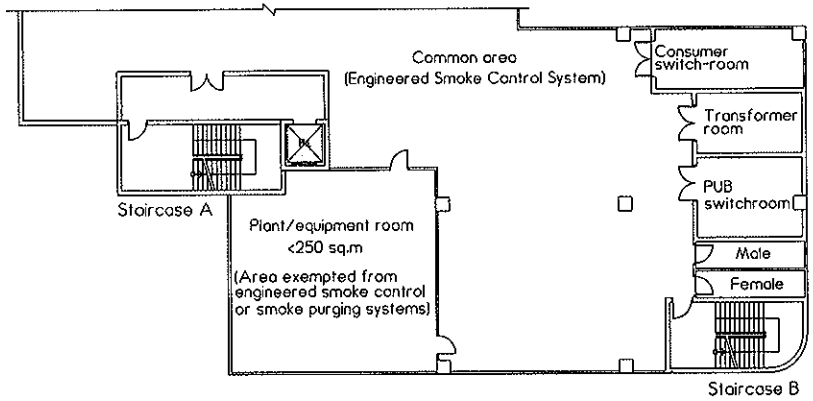
Basement 1



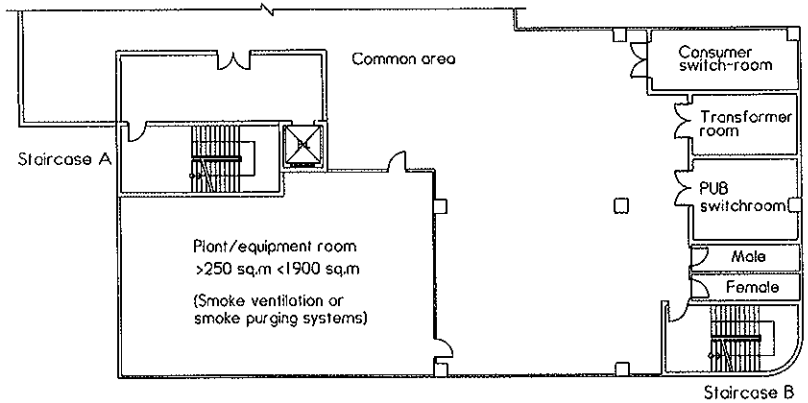
Basement 2

(i)	Where the basement or a portion of the basement is used as carpark, **Cl.7.1.9 can be adopted to the carpark provided it is compartmented from rest of the basement**;	Exception
(ii)	**Plant/equipment room with floor area not exceeding 250 sq m and compartmented from rest of the basement**, and provided with **two doors for better reach in fire fighting operation**.	
(iii)	Plant/equipment room with floor area exceeding 250 sq m but not exceeding 1900 sq m, **smoke vents** in accordance with cl.7.4.2 or **smoke purging system** of at least 9 air-change per hour shall be provided.	
(iv)	**Service areas such as laundries, office, storeroom and workshops (restricted to staff only) which are compartmented, smoke venting provision in accordance with Cl.7.4.2 or smoke purging system of at least 9 air-change per hour may be accepted for those areas in lieu of the engineered smoke control system.** Automatic fire alarm/extinguishing system in accordance with Table 6.4A shall be provided where required.	





Part plan of basement storey



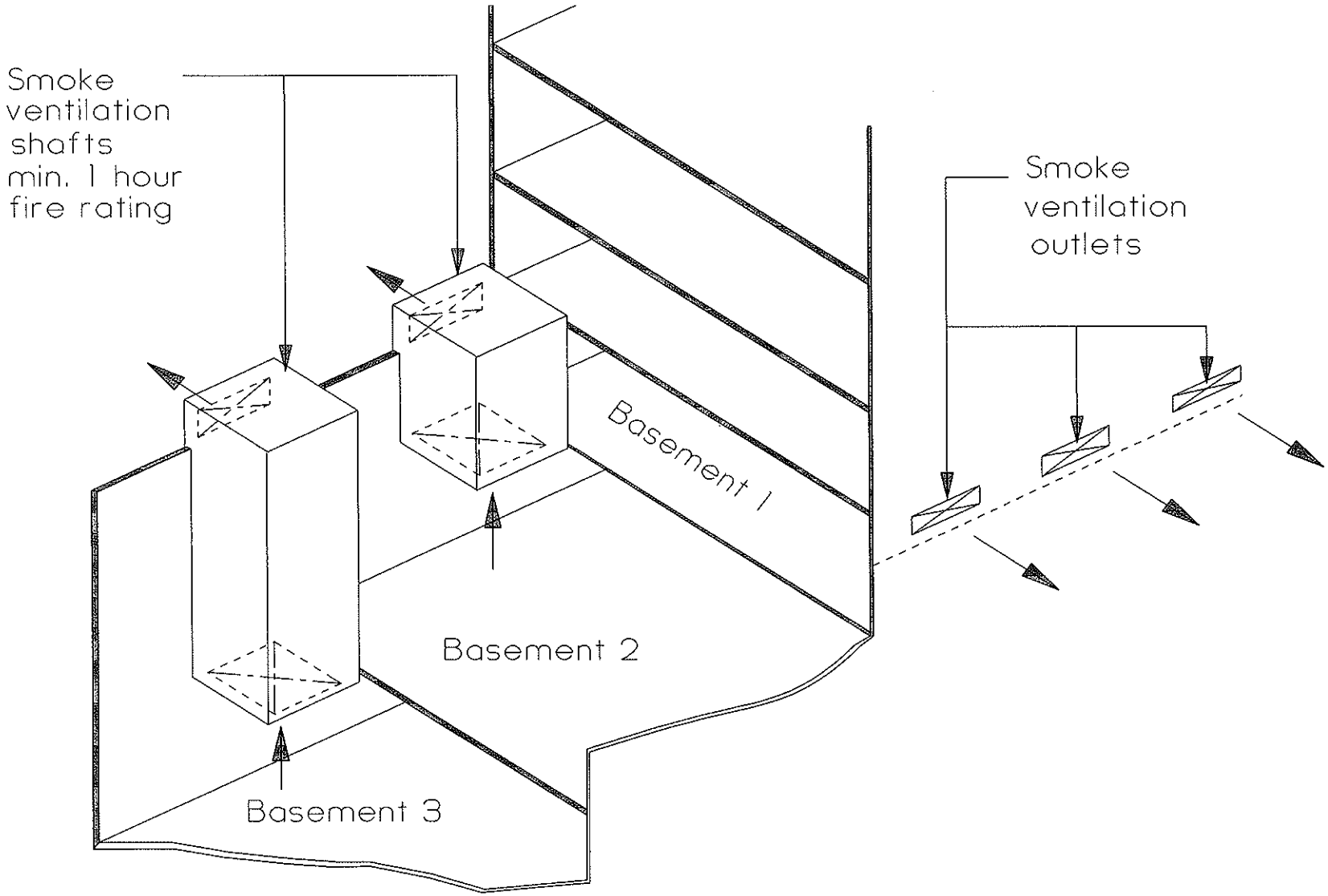
Part plan of basement storey

7.4.2

Smoke vents shall be adequately distributed along perimeter of basement and their outlets shall be easily accessible during fire fighting and rescue operations. Installation shall comply with the following requirements:	
(a)	The **number and their sizes** shall be such that the aggregate effective vent openings shall not be less than **2-½ per cent** of the basement floor area served.
(b)	The **vent outlets** if covered under normal conditions **shall be openable in case of fire.**
(c)	The position of all vent outlets and the areas they serve shall be suitably indicated adjacent to such outlets.
(d)	Where **ducts are required to connect the vent to outlets**, the ducts shall either be enclosed in structure or be constructed **to give at least 1 hour fire resistance.**
(e)	**Separate ducts and vent outlets** shall be provided for **each basement storey.**

Smoke vents

Basement occupancies smoke vents



7.4.3	Where **engineered smoke control system is required**, it shall be provided as specified in **Cl. 7.6**.	Engineered smoke control

7.5 - SMOKE CONTROL SYSTEM

7.5.1

A smoke control system specified in Cl.7.6 shall be provided where:	
(i)	The requirements for compartmentation specified in Cl. 3.2.1 and 3.2.4(a) and (b) are relaxed under the conditions in **Cl. 3.2.6** for **`Atrium spaces'** in a building; and
(ii)	The **total floor area** of **any compartment** in a building or part of a building exceeds **5000 sq.m**.

Smoke control system

3.2.6 The Relevant Authority may consent to modify the requirements under Cl. 3.2.1 and 3.2.4(a) and (b) of this Code for the design of **'Atrium spaces'** in a building provided the following conditions are complied with : Provision for atrium spaces

(a) The minimum plan area of the Atrium void shall be **not less than 93 m²** and no horizontal dimension between opposite edges of the floor opening is **less than 6 m wide**; and *

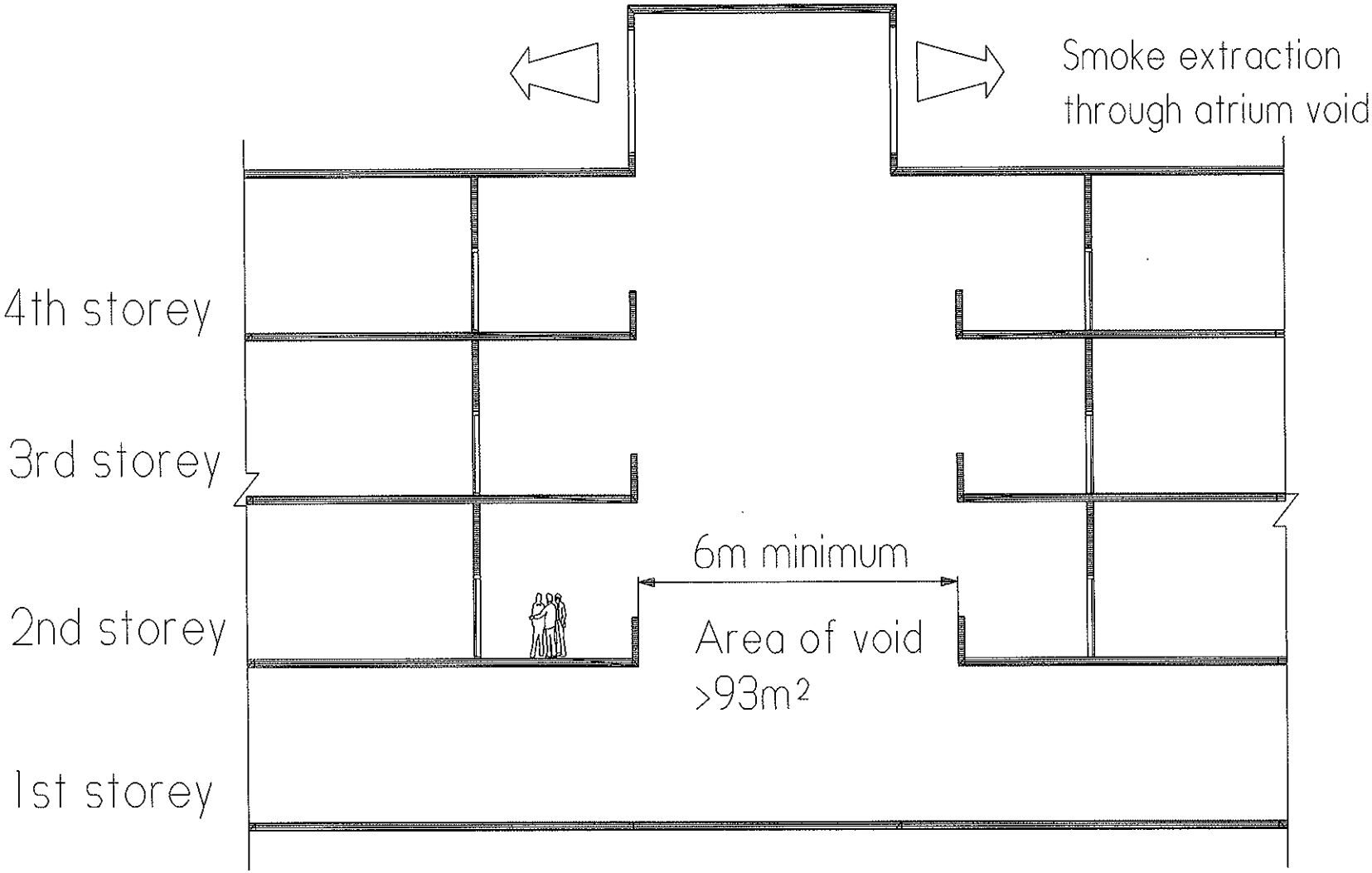
(b) Occupancy within the floor space of the Atrium meets with the specification for **low or ordinary hazard content**; and *

(c) The atrium is open and unobstructed in a manner such that it may be assumed that a fire in any part of the space will be **readily obvious** to the occupants before it becomes a hazard; and

(d) The building is fitted throughout with an **automatic sprinkler system** to comply with the requirements in Chapter 6; and

(e) The building is fitted with an **engineered smoke control system** in accordance with cl.7.6; and

(f) Provision of openings and enclosures, and the planning of **means of escape** shall be subject to the approval of the Relevant Authority.


Smoke extraction
through atrium void
4th storey
3rd storey
6m minimum
2nd storey
Area of void
>93m²
1st storey

Section

7.6 - ENGINEERED SMOKE CONTROL SYSTEM

7.6.1

The engineered smoke control system shall be in the form of a smoke ventilation system by natural or mechanical extraction designed in accordance with:	
(a)	**BR 186 - Design principles for smoke ventilation in enclosed shopping centres**; and
(b)	**BR 258 - Design approaches for smoke control in atrium buildings**; or
(c)	Other **acceptable standards.**
(Note: BR 186 and 258 are reports published by the Fire Research Station, Building Research Establishment, Borehamwood, Herts WD62BL).	

Accep-table design guidance

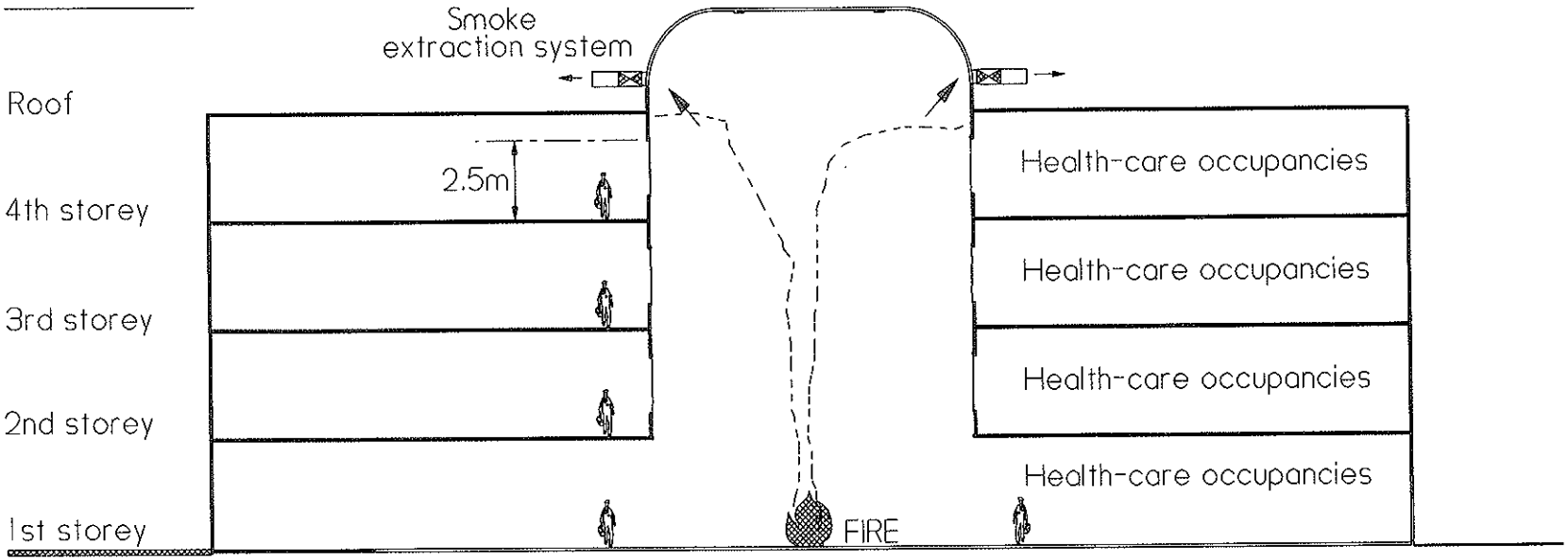
7.6.2	The building to be provided with smoke ventilation system shall be **sprinkler protected**.	Sprinkler system
7.6.3	Capacity of the smoke ventilation system shall be calculated based on the incidence of a **likely maximum fire size for a sprinkler controlled fire** as recommended in the following table:	Fire size

	Fire Size	
Occupancy (Sprinklered)	Heat Output (MW)	Perimeter of Fire (m)
Shops	5	12
Offices	1	14
Hotel Guest Room	0.5	6
Hotel Public Areas	2.5	12
Assembly Occupancy with fixed seating	2.5	12

7.6.4 The capacity of a smoke ventilation system shall be capable of handling the largest demand for smoke exhaust from the **worst case scenario**.

Capacity of smoke ventilation system

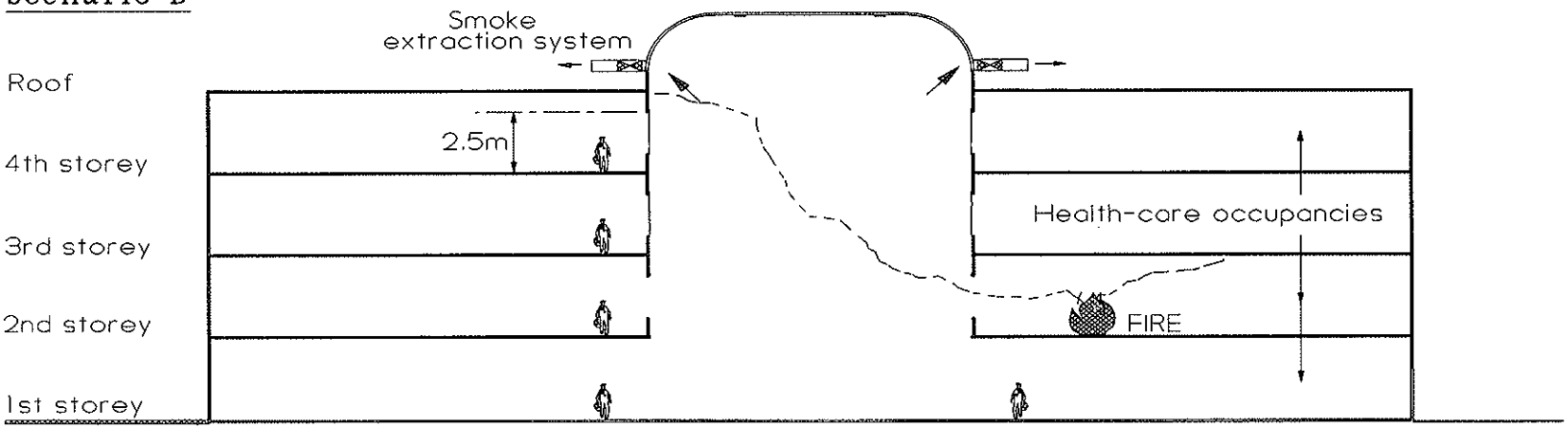
Scenario A



Smoke curtain

Section

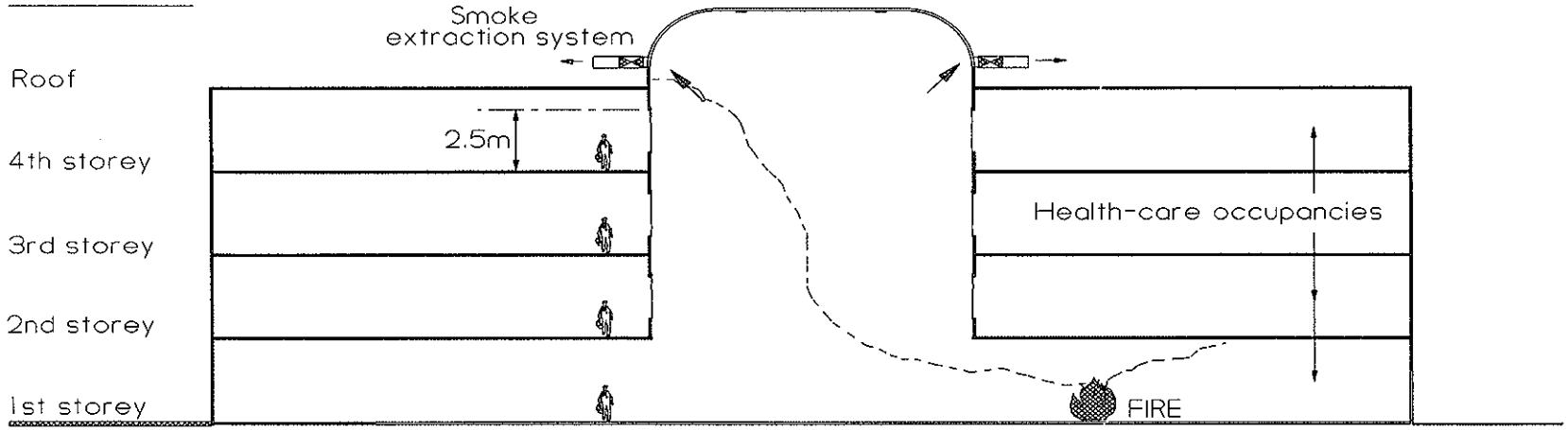
Scenario B



Smoke curtain

Section

Scenario C

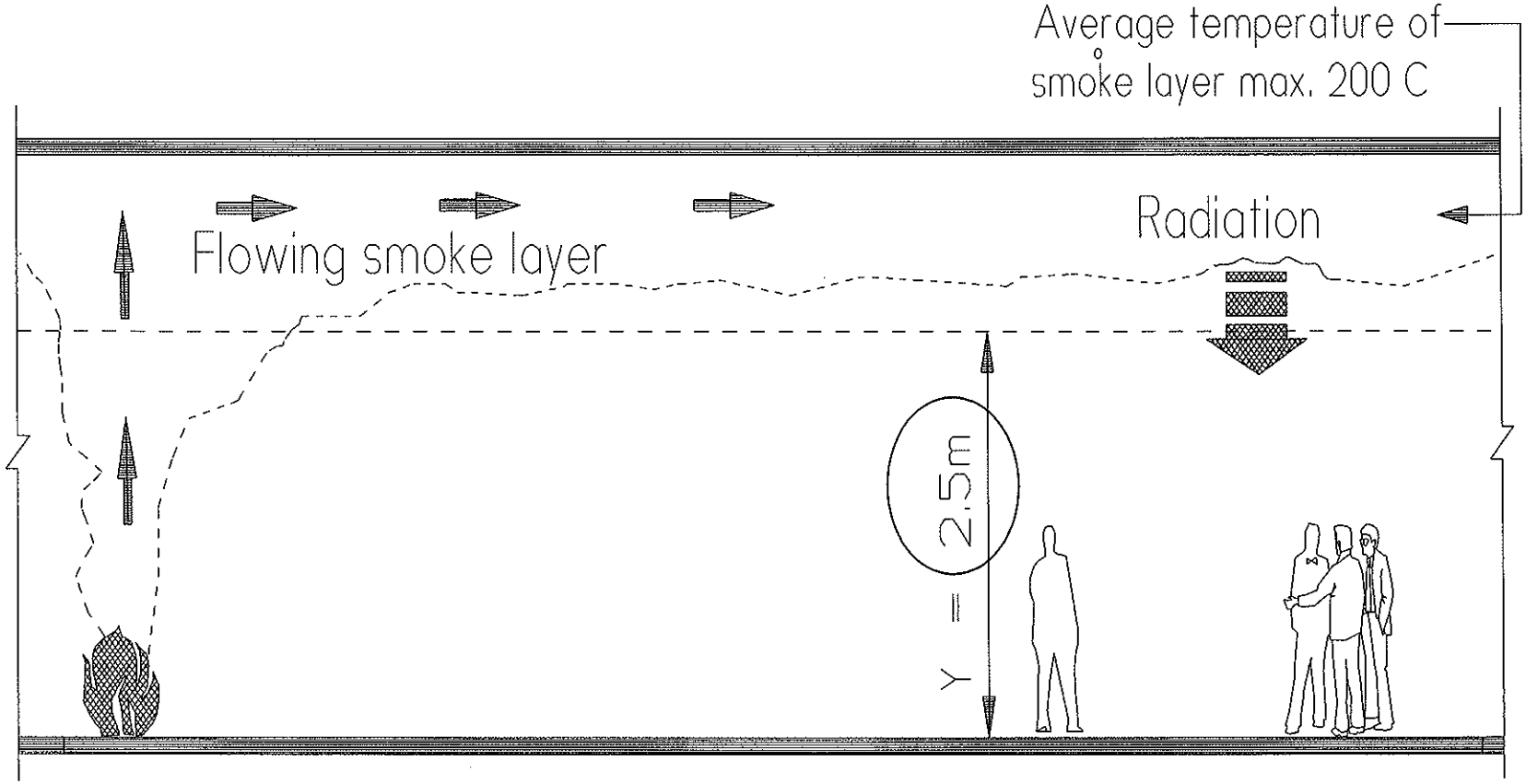


Smoke curtain

Section

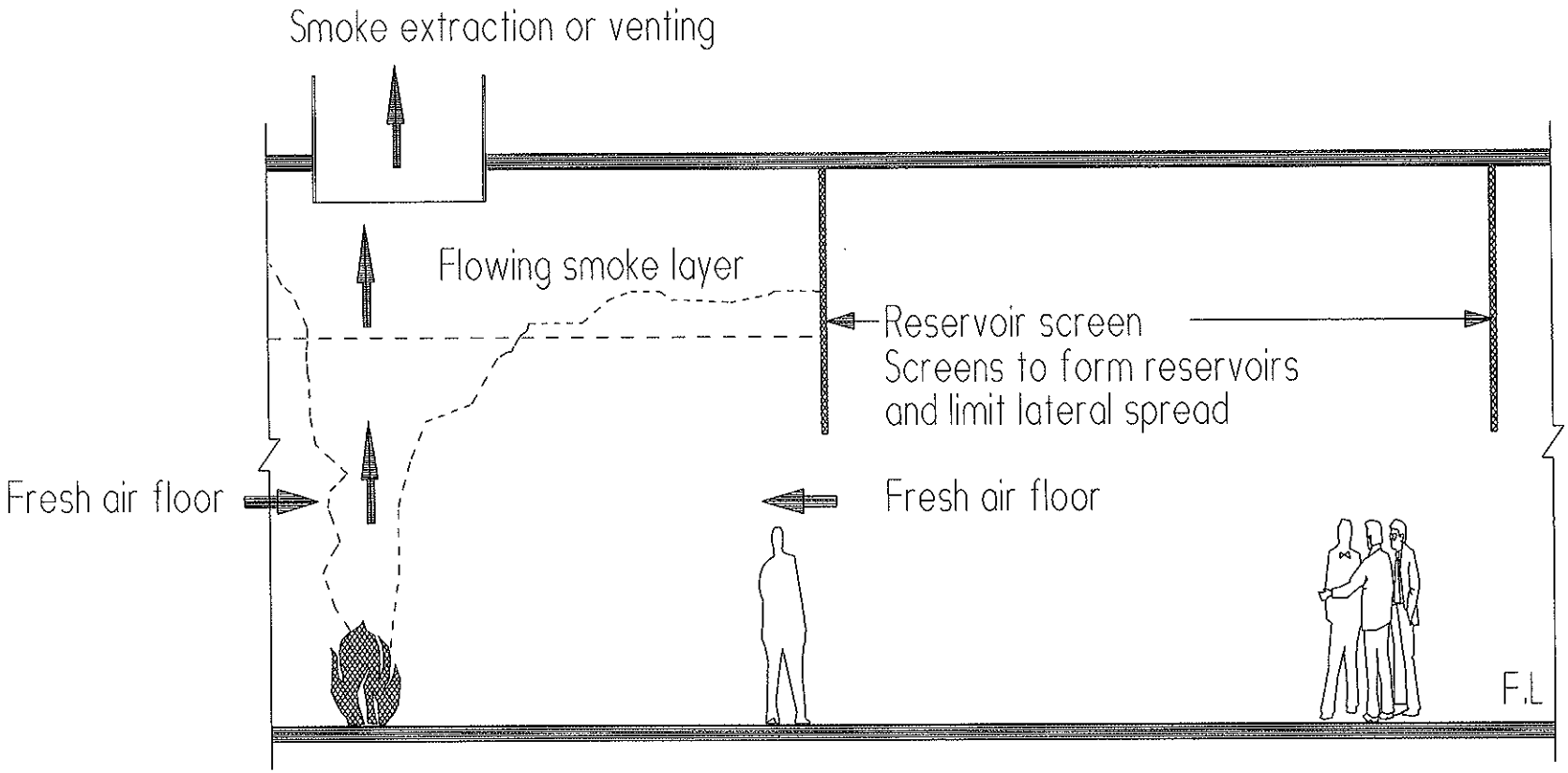
7.6.5 The design smoke layer base shall be above the heads of people escaping beneath it. The **minimum height shall be 2.5 m.**

Clear layer



7.6.6 **Smoke reservoirs** to prevent the lateral spread of smoke, and to collect smoke for removal **shall be of non-combustible construction capable of withstanding smoke temperatures.**

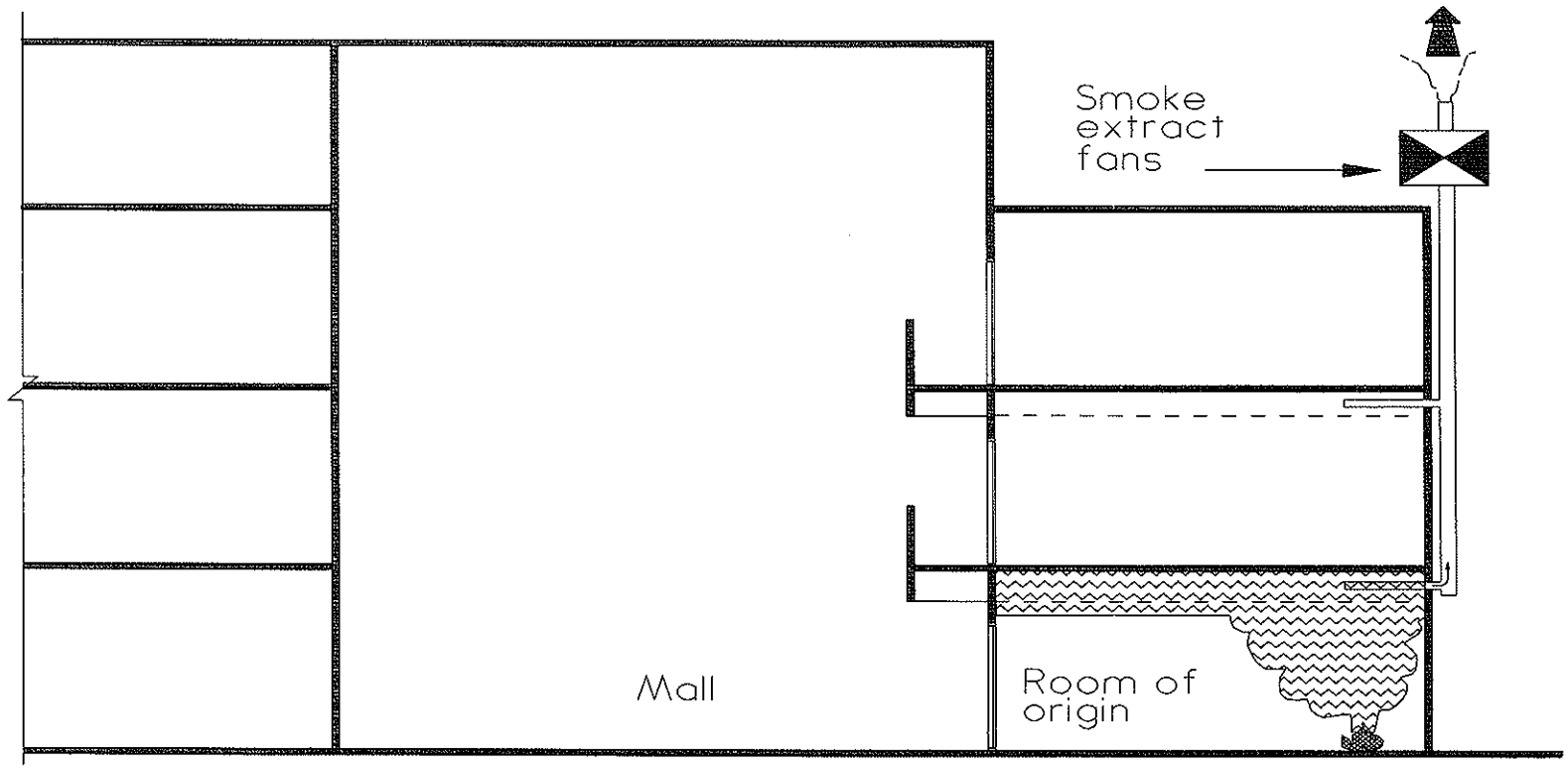
Smoke reservoir



7.6.7

For cases where smoke is removed from the room of origin the smoke reservoir size for a smoke ventilation system shall not exceed:	
(a)	**2000 sq m for natural smoke ventilation system.**
(b)	**2600 sq m for mechanical smoke ventilation system.**

Smoke reservoir size



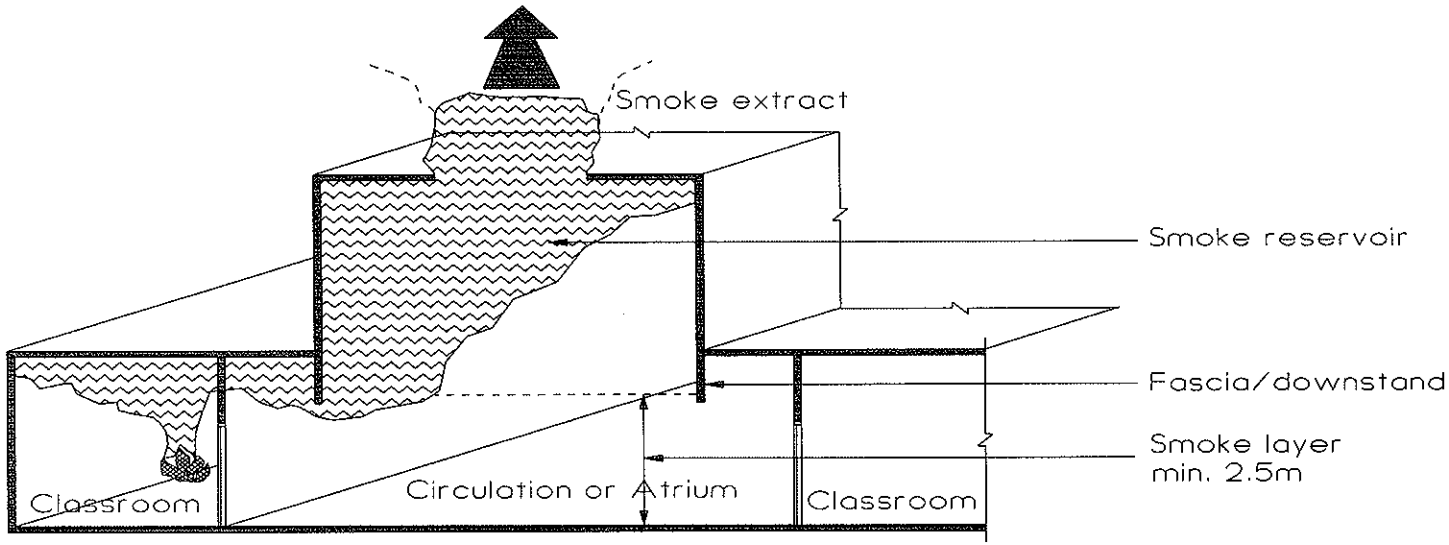
Section

7.6.8

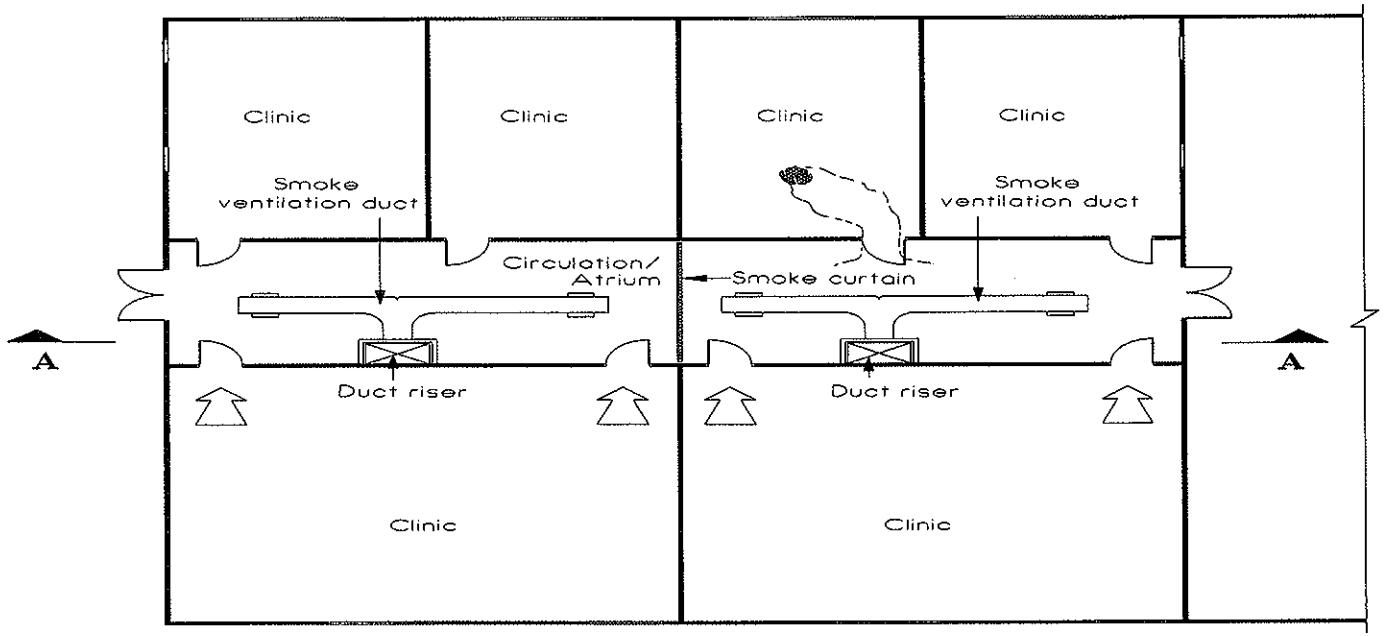
For cases where smoke is removed from the circulation space or atrium space the smoke reservoir size for a smoke ventilation system **shall not exceed** :	
(a)	**1000 sq m** for natural smoke ventilation system.
(b)	**1300 sq m** for mechanical smoke ventilation system.

Removal of smoke from circulation or atrium spaces

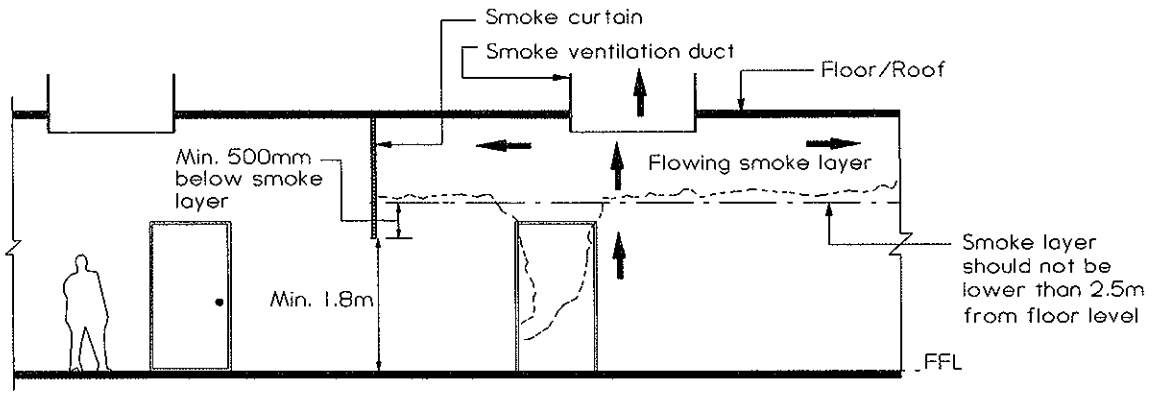
Smoke extraction from atrium circulation space



Section



Plan

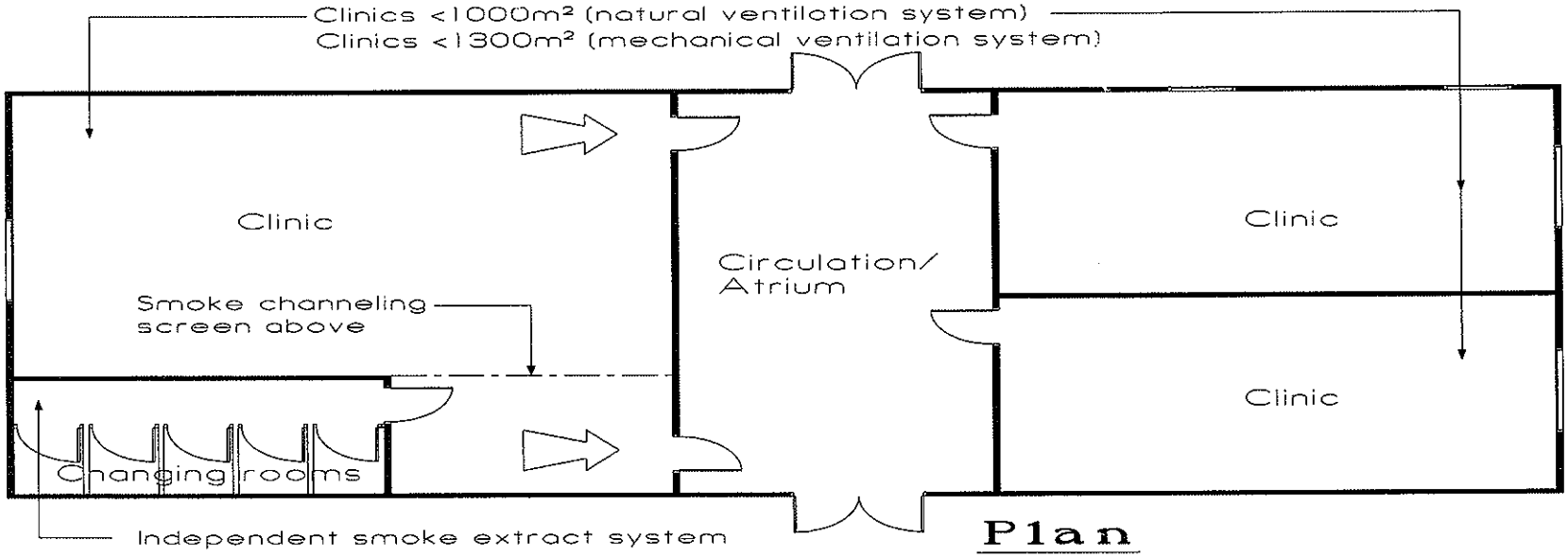


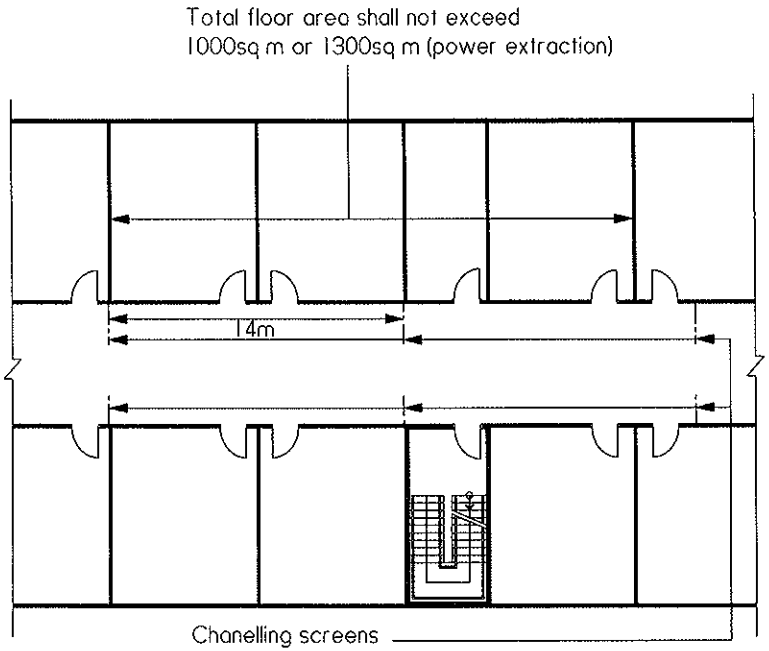
Elevation A

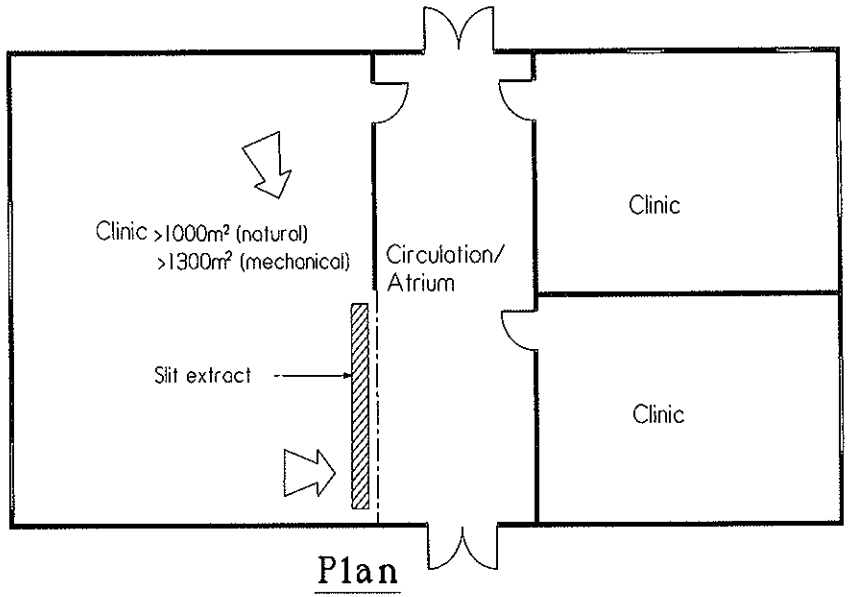
7.6.9

For cases where **smoke is removed from the circulation space or atrium space**, the rooms discharging smoke into the circulation space/atrium spaces shall either:	
(a)	have a floor area of **not exceeding 1000 sq m** (for natural ventilation system) or **1300 sq m** (for mechanical ventilation system) or
(b)	be subdivided such that smoke is vented to the circulation space or atrium only from part of the room with floor area not exceeding 1000 sq m (for natural ventilation system) or 1300 sq m (for mechanical ventilation system) that are adjacent to the circulation space or atrium. However, the remainder of the room needs to be provided with an independent smoke ventilation system(s).

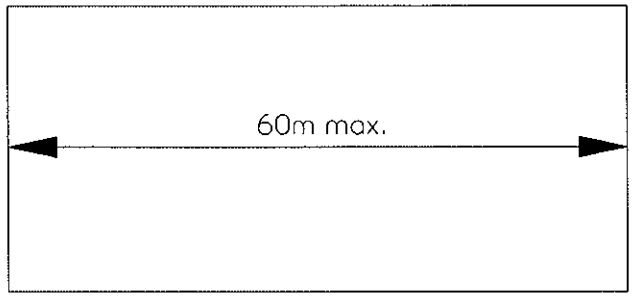
Discharge of smoke into circulation/ atrium spaces


Clinics <1000m² (natural ventilation system)
Clinics <1300m² (mechanical ventilation system)
Clinic
Smoke channeling screen above
Circulation/ Atrium
Clinic
Clinic
Changing rooms
Independent smoke extract system
Plan

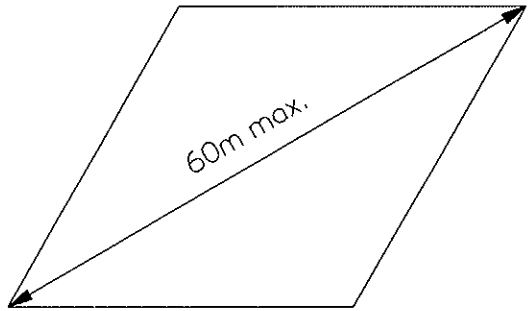

Total floor area shall not exceed
1000sq m or 1300sq m (power extraction)
14m
Chanelling screens


Clinic >1000m² (natural)
>1300m² (mechanical)
Slit extract
Circulation/ Atrium
Clinic
Clinic
Plan

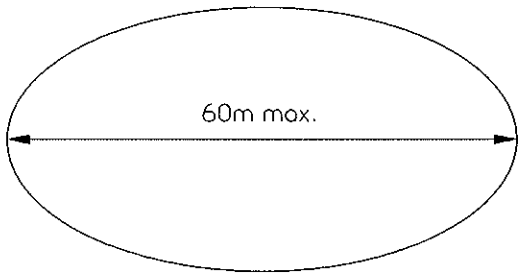
7.6.10 | The maximum length of the smoke reservoir **shall not exceed 60 m.** | Length of smoke reservoir



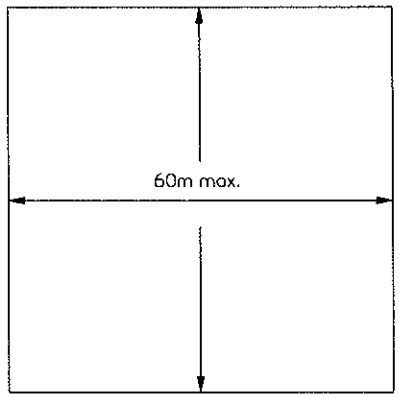
Rectangle shaped smoke reservoir



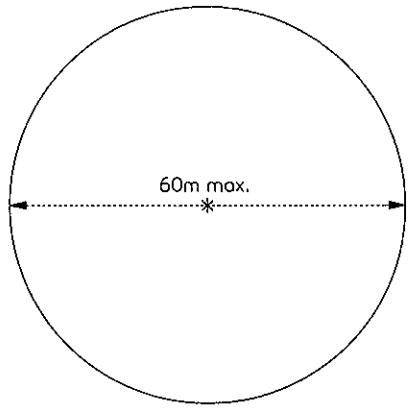
Rhombus shaped smoke reservoir



Oval shaped smoke reservoir



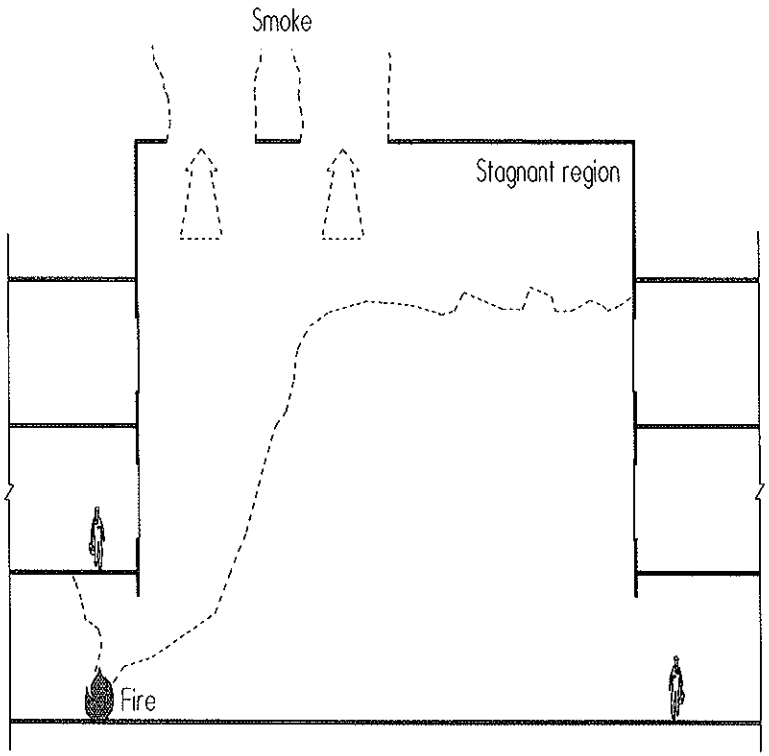
Square shaped smoke reservoir

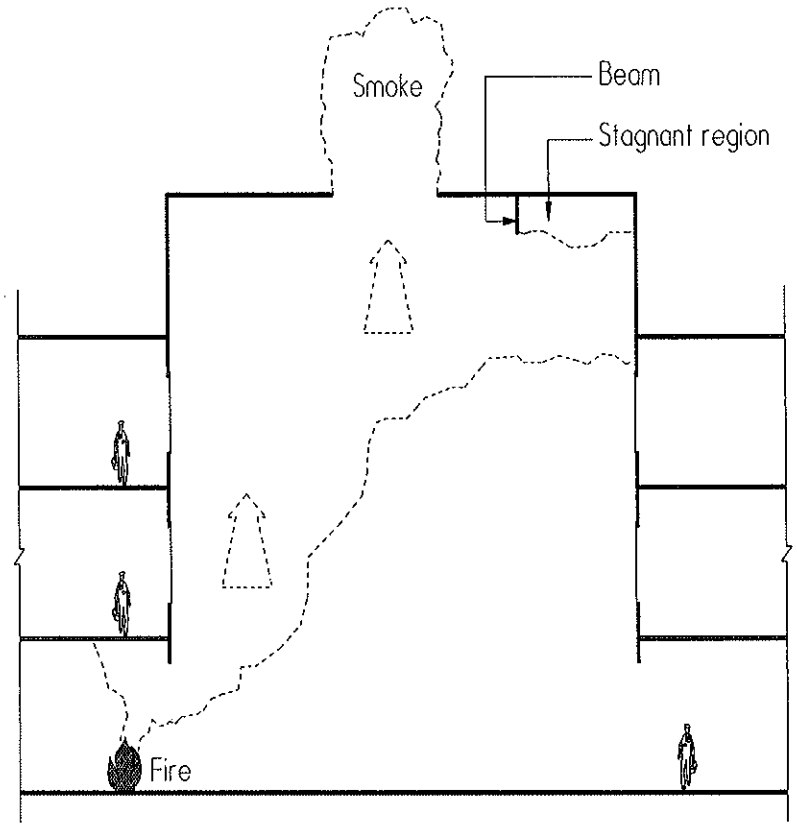


Circular shaped smoke reservoir

7.6.11 **Adequate arrangement(s)** shall be made in **each smoke reservoir for the removal of smoke** in a way that will prevent the formation of **stagnant regions**.

Stagnant regions





7.6.12

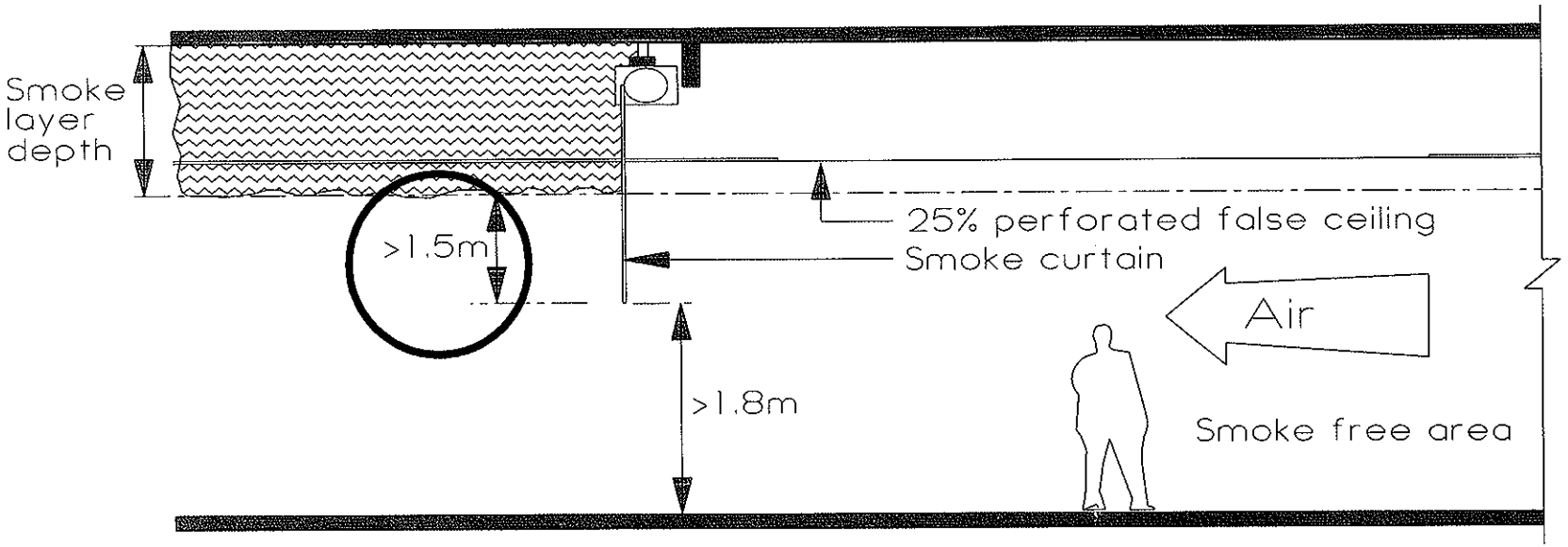
Owing to practical limitation, a smoke ventilation system shall have:	
(a)	a maximum mass flow not exceeding **175 kg/s**; and
(b)	a minimum smoke layer temperature of **18°C above ambient.**

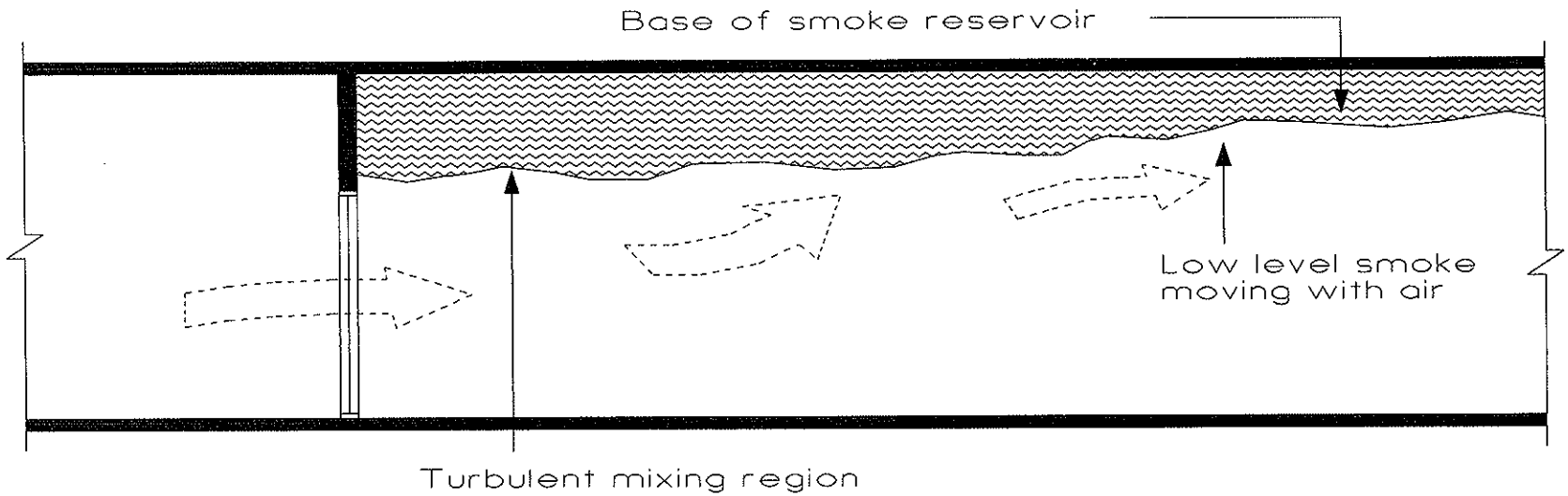
(a) *It has commonly been found that very large exhaust rates, typically larger than about 175kg/s, would require large and heavy fans or ventilators. Large and heavy fans or ventilators when in operation would cause vibration problems to the building structures.*

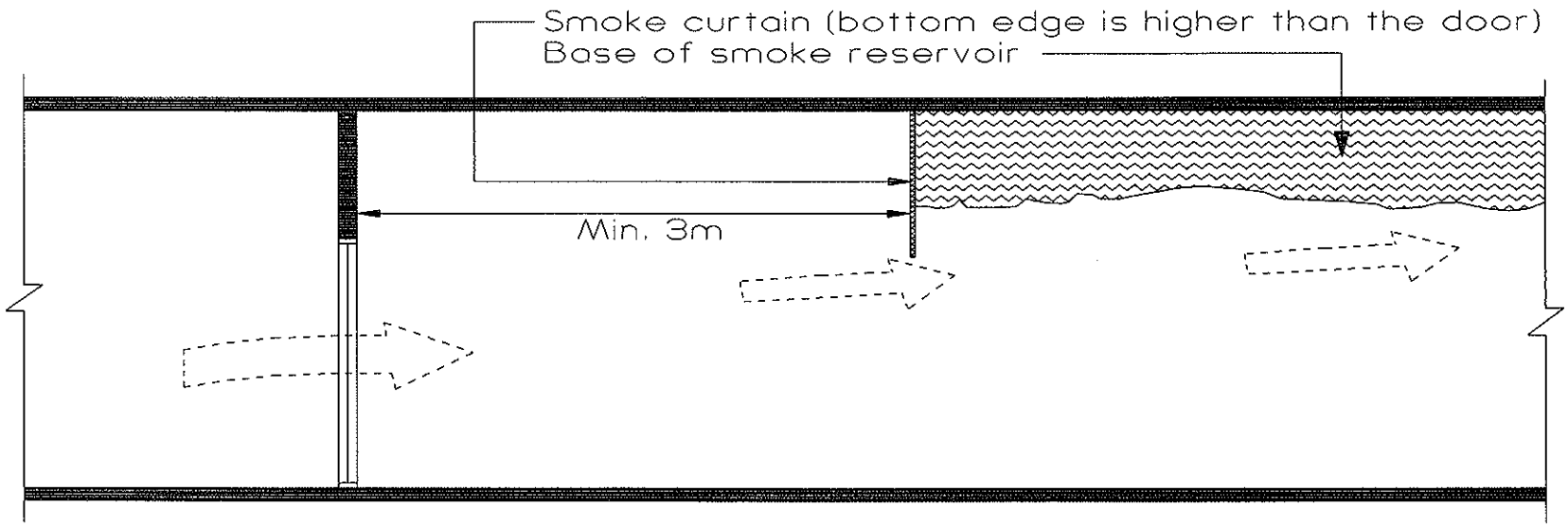
(b) *A minimum design temperature is required to maintain stability of the smoke layer. Smoke layers, which have temperatures approaching that of the replacement air will have a tendency to mix with this air rather than to float above it.*

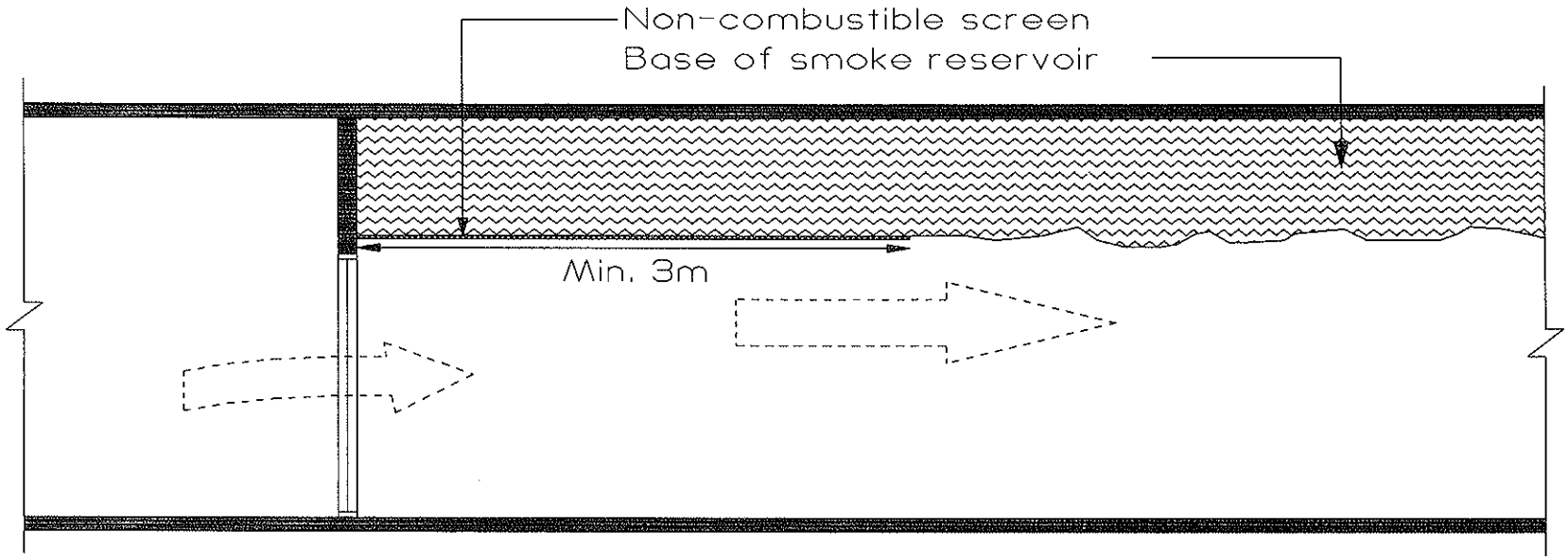
The stipulated minimum design layer temperature is intended to be high enough to allow safe operation of the system for fires, which are smaller than the full design size.

7.6.13	Replacement air shall be by natural means drawing air directly from the external.		
	(a)	The design replacement **air discharge velocity shall not exceed 5.0 m/s** to prevent the escapees being hindered by the air flow.	Replacement air velocity
	(b)	Replacement air intake shall be sited **at least 5 m away from** any exhaust air discharge.	Distance from exhaust air discharge
	(c)	Replacement air shall be discharged at a low level, **at least 1.5 m beneath the designed smoke layer**, to prevent "fogging" of the lower clear zone.	Replacement discharge position
	(d)	Where the **inlet cannot be sited at least 1.5 m below the smoke layer**, a smoke curtain or a barrier shall be used to prevent replacement air distorting the smoke layer.	Siting of inlets
	(e)	Where replacement air is taken through inlet air ventilators or doorways, **devices shall be incorporated to automatically open such inlet ventilators and doors** to admit replacement air upon activation of the smoke ventilation system.	


Smoke
layer
depth
>1.5m
25% perforated false ceiling
Smoke curtain
Air
>1.8m
Smoke free area

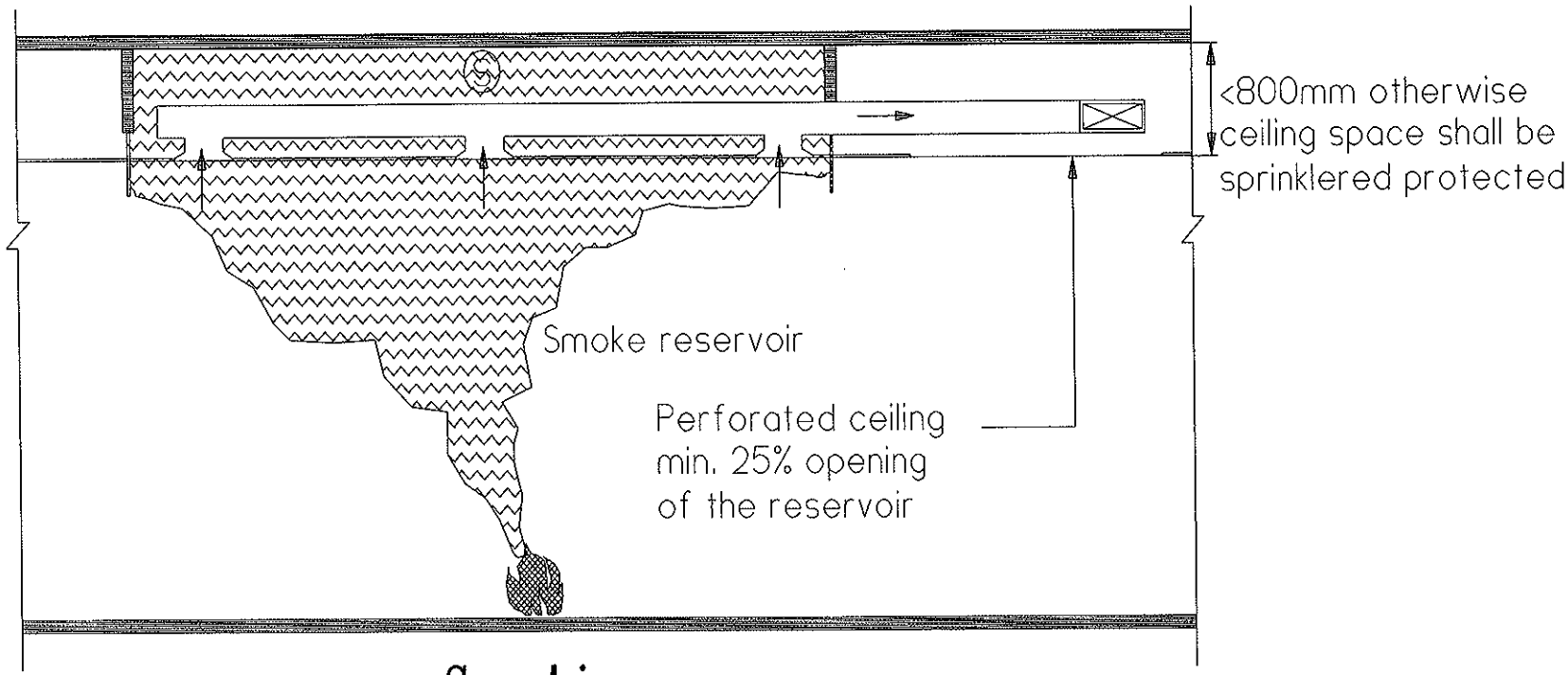

Base of smoke reservoir
Low level smoke
moving with air
Turbulent mixing region


Smoke curtain (bottom edge is higher than the door)
Base of smoke reservoir
Min. 3m


Non-combustible screen
Base of smoke reservoir
Min. 3m

7.6.14 For cases where the smoke reservoir is above the **false ceiling**, the ceiling shall be of perforated type with **at least 25% opening**.

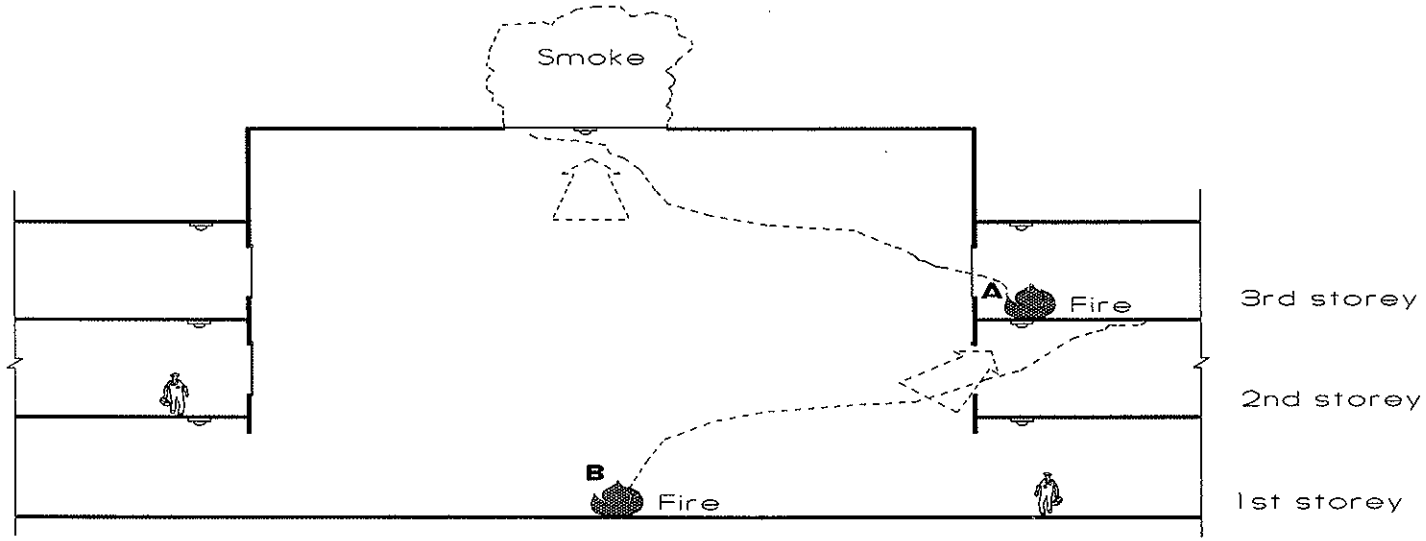
Perforated ceiling



Section

Ⓢ Smoke detector

7.6.15	The smoke ventilation system shall be provided with **secondary source of power supply**.	Emergency power supply
7.6.16	The smoke ventilation system **shall be activated by smoke detectors located in the smoke control zone**. Use of smoke detectors for activation must be carefuly designed so that accidental or premature activation of smoke detectors on a non-fire zone due to smoke spills or spread from other areas must be avoided.	Mode of activation



7.6.17	Provision of activating **smoke detectors** shall comply with **CP 10**.	
7.6.18	A **remote manual activation and control switches** as well as visual indication of the operation status of the smoke ventilation system **shall also be provided at the fire command centre** and where there is no fire command centre, **at main fire indicator board**.	Manual activation
7.6.19	Except for ventilation systems in **Cl. 5.2.1 (g) and (h),** all other **air-conditioning and ventilation systems within the areas served shall be shut down automatically upon activation of the smoke ventilation system**.	Shut down of other air conditioning & ventilation systems

5.2.1 (g) Mechanical ventilation where required for the following rooms or spaces shall be provided with secondary source of supply in accordance with SS CP 13 Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings:

Secondary source of supply

(i) exit staircases and exit passageways;

(ii) smoke-stop and fire fighting lobbies;

(iii) areas of refuge within the same building;

(iv) basement carparks;

(v) fire command centres;

(vi) flammable liquid/gas storage rooms;

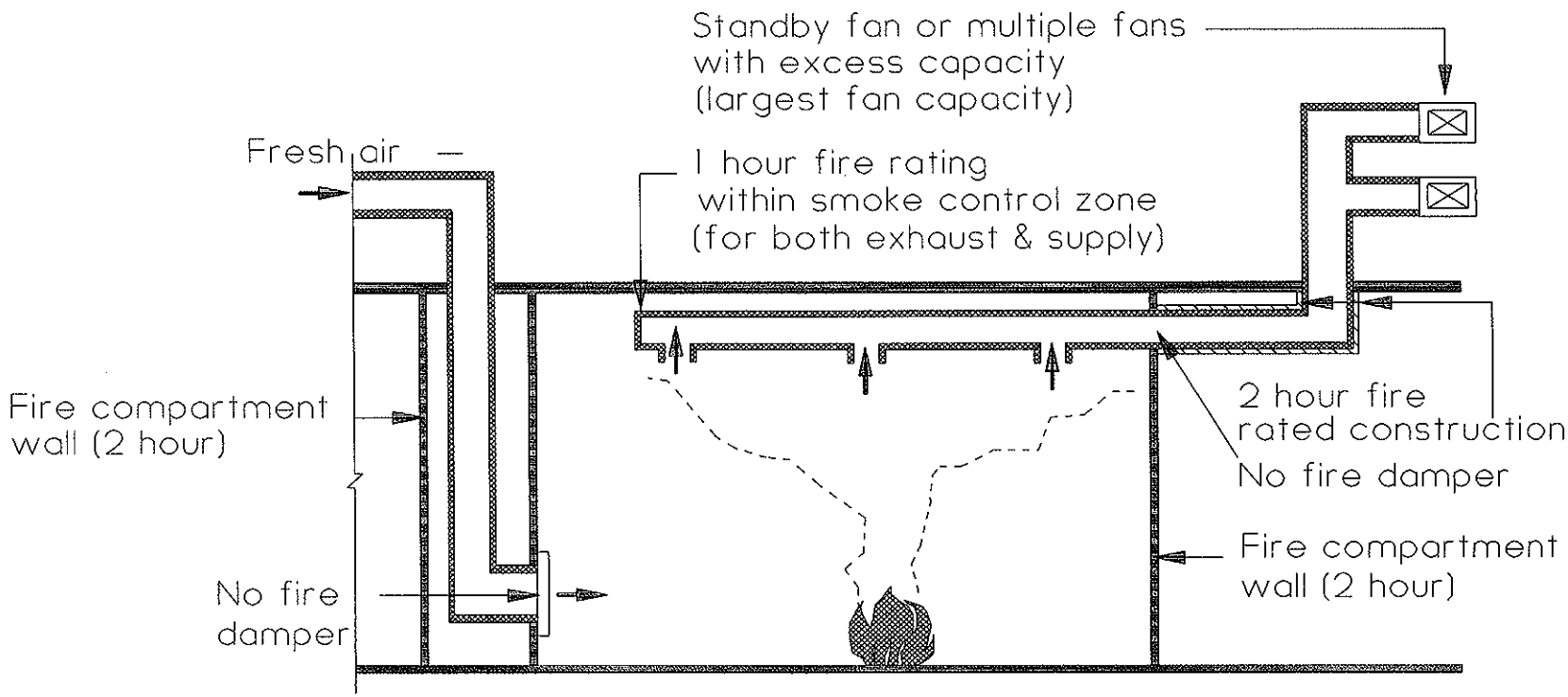
(h) Where mechanical ventilation is installed to provide air for the operation of the following equipment, secondary source of supply shall be provided:

(i) emergency generator;

(ii) engine driven fire pump.

7.6.20 Either a **standby fan or multiple fans with excess capacity** shall be provided for each mechanical smoke ventilation system such that **in the event the duty fan or the largest capacity fan fails**, the designed smoke extraction rate will still be met. The **standby fan shall be automatically activated in the event the duty fan fails.**

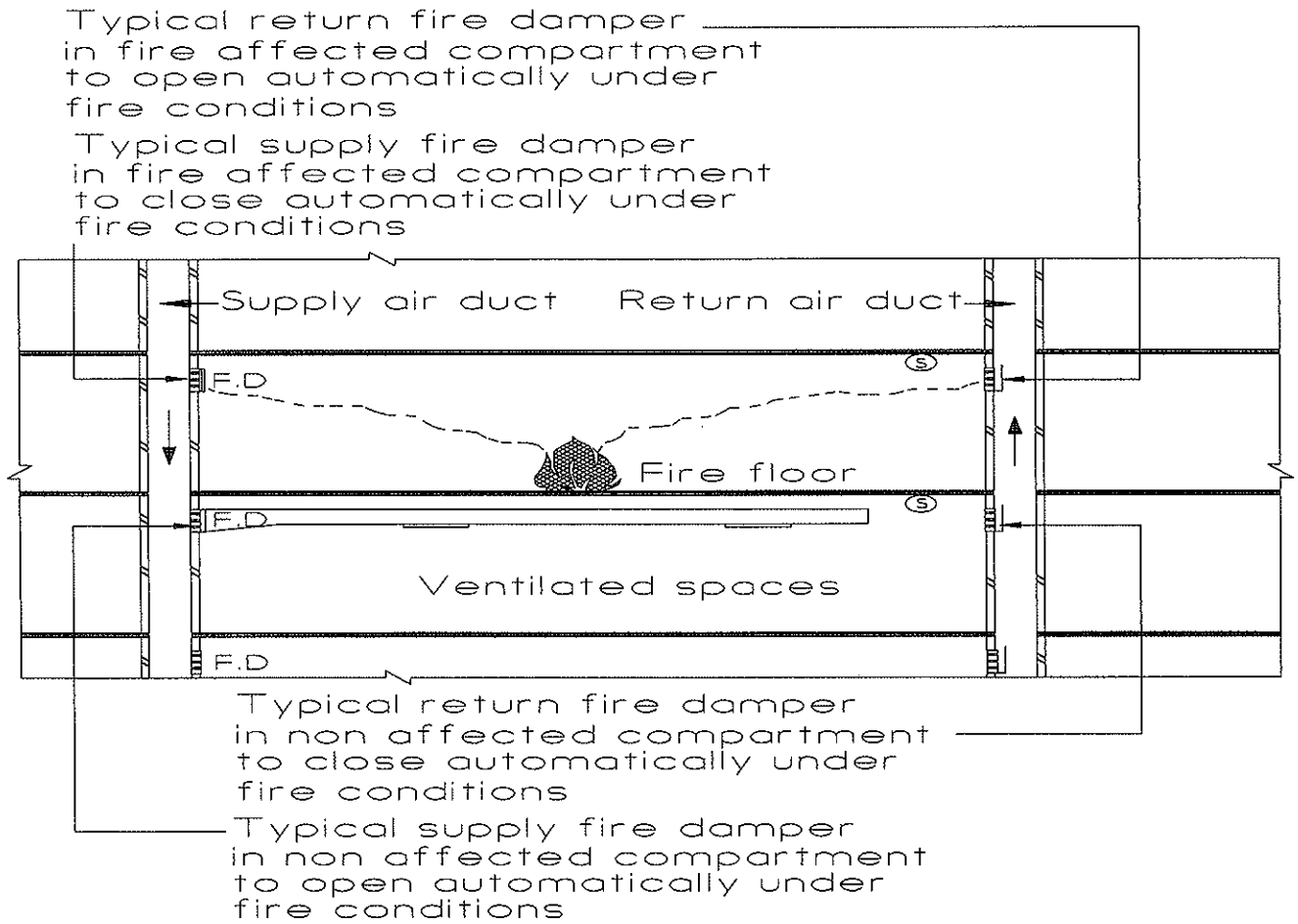
Standby fans or multiple fans



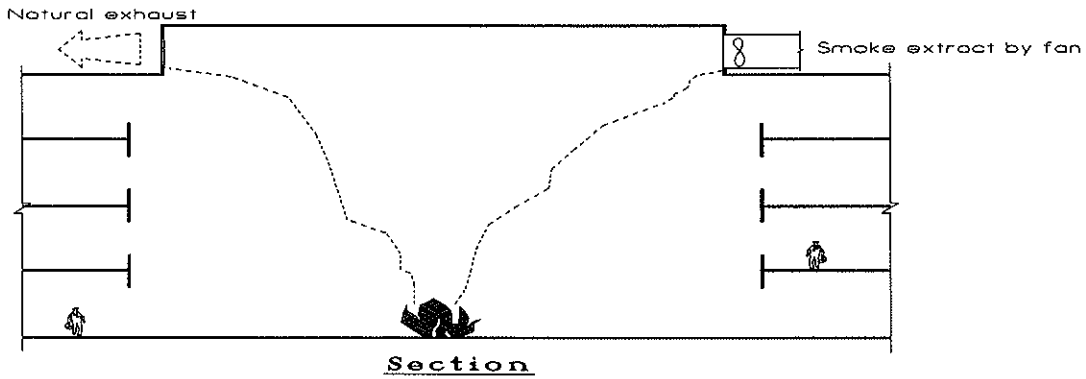
Section

7.6.21	**Fans** shall be capable of operating at **250°C for 2 hours.**	
7.6.22	The fans and associated smoke control equipment **shall be wired in protected circuits** designed to ensure continued operation in the event of the fire.	Protected circuits
7.6.23	The electrical supply to the fans shall, in each case, be connected to a sub-main circuit exclusive thereto after the main isolator of the building. **The cables shall be of at least 1-hour fire resistance in accordance with SS CP 299.**	Electrical supply
7.6.24	**Smoke ventilation ducts (both exhaust and replacement air ducts) shall be of at least 1 hour fire resistance**. Where a duct passes through other fire compartment of higher rating, the duct shall be constructed to have the rating as that of the compartment. The rating shall apply to fire exposure from both internal and external of the duct or structure and the duct shall also comply with sub-cl.7.1.1(j).	

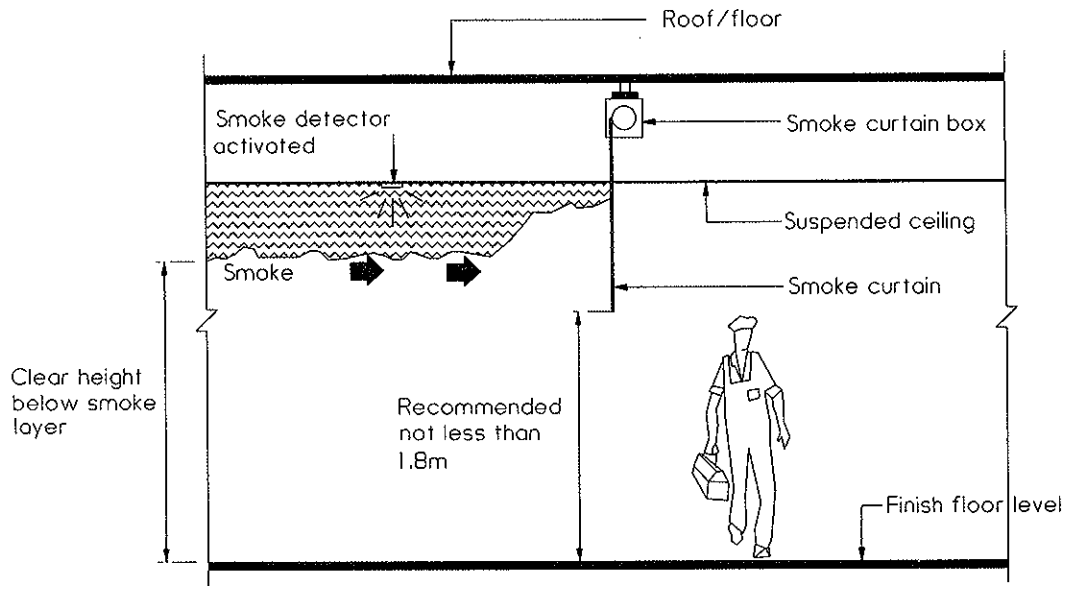
7.6.25 **Fire damper <u>shall not be fitted</u> in the smoke ventilation system.**



7.6.26	The time taken for the smoke ventilation system within a smoke zone to be fully operational **shall not exceed 60 seconds from system activation.**		
7.6.27	For natural smoke ventilation system the **natural ventilators** shall be :		Fail-safe system
	(a)	in the **"open" position in the event of power/system failure**; and	
	(b)	positioned such that they will not be adversely affected by **positive wind pressure.**	
7.6.28	**Natural exhaust ventilation** shall not be used together with powered **smoke exhaust ventilation.**		

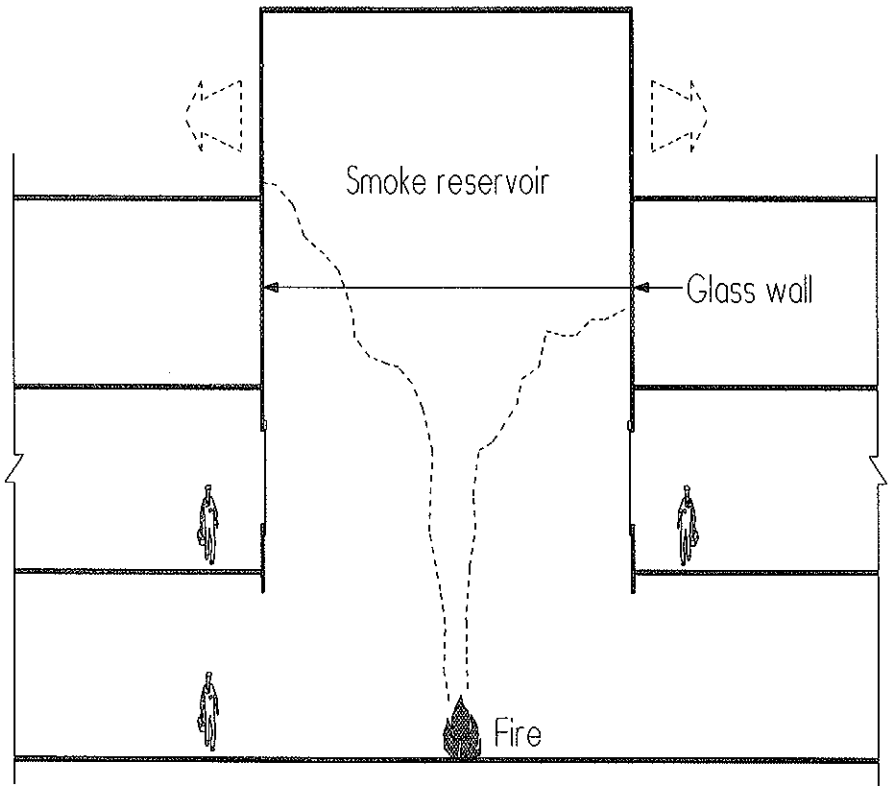


7.6.29	All **smoke curtains** where required, unless permanently fixed in position, shall be brought into position automatically to provide **adequate smoke-tightness and effective depth**.	Smoke curtain
7.6.30	**Smoke curtain** or other smoke barrier at any access route forming part of or leading to a means of escape **shall not in their operational position obstruct the escape of people through such route**.	Obstruction to means of escape

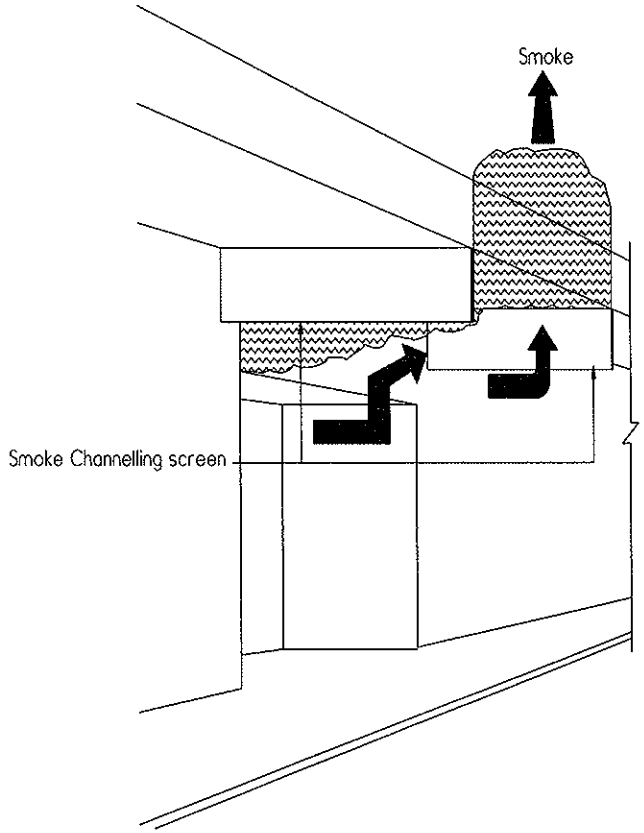


7.6.31 Where **glass walls or panels** are being used as smoke screens to form a smoke reservoir or as **channelling screens**, they shall be able to **withstand the design highest temperature**.

Smoke or chane-lling screens



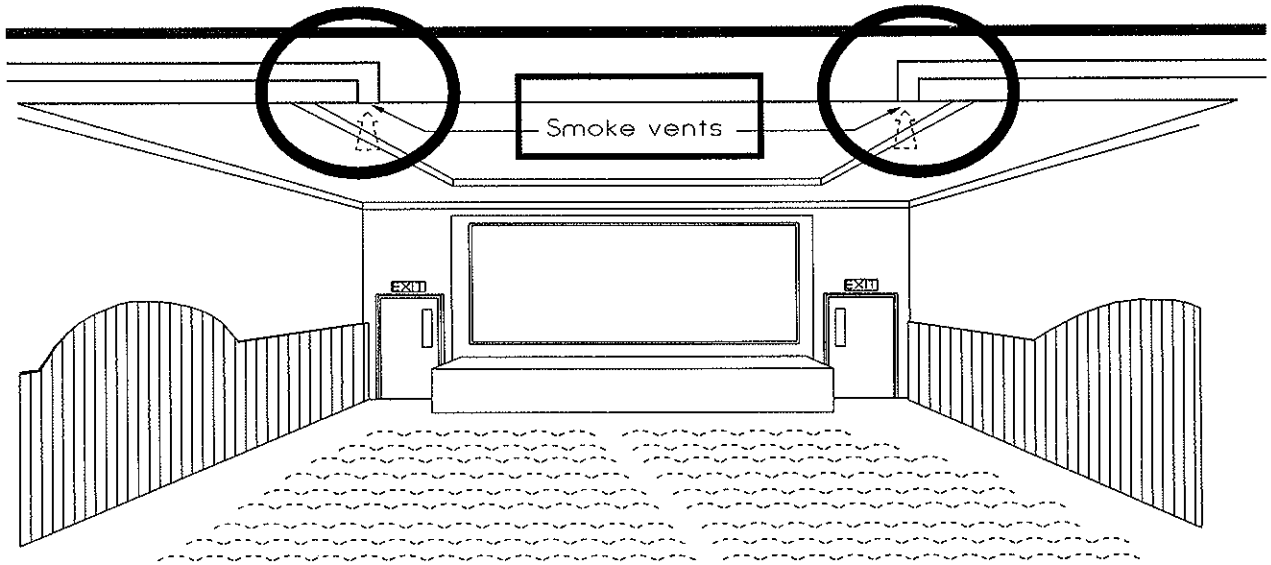
Section



7.6.32 All **smoke control equipment (including smoke curtains)** shall be supplied and installed in accordance with the accepted standards eg **BS 7346**.

7.7 - AUDITORIUM (CINEMAS, THEATRES ETC) SMOKE CONTROL SYSTEM

7.7.1	Provision of smoke vents having **2½% of the floor area** shall be provided to auditorium which is not sprinkler protected and to auditorium having **floor area more than 500m², if sprinkler protected**. The **opening** of the **smoke vents** shall be by **automatic device**.
7.7.2	In place of smoke vents, an **engineered smoke control system** would be considered as acceptable.

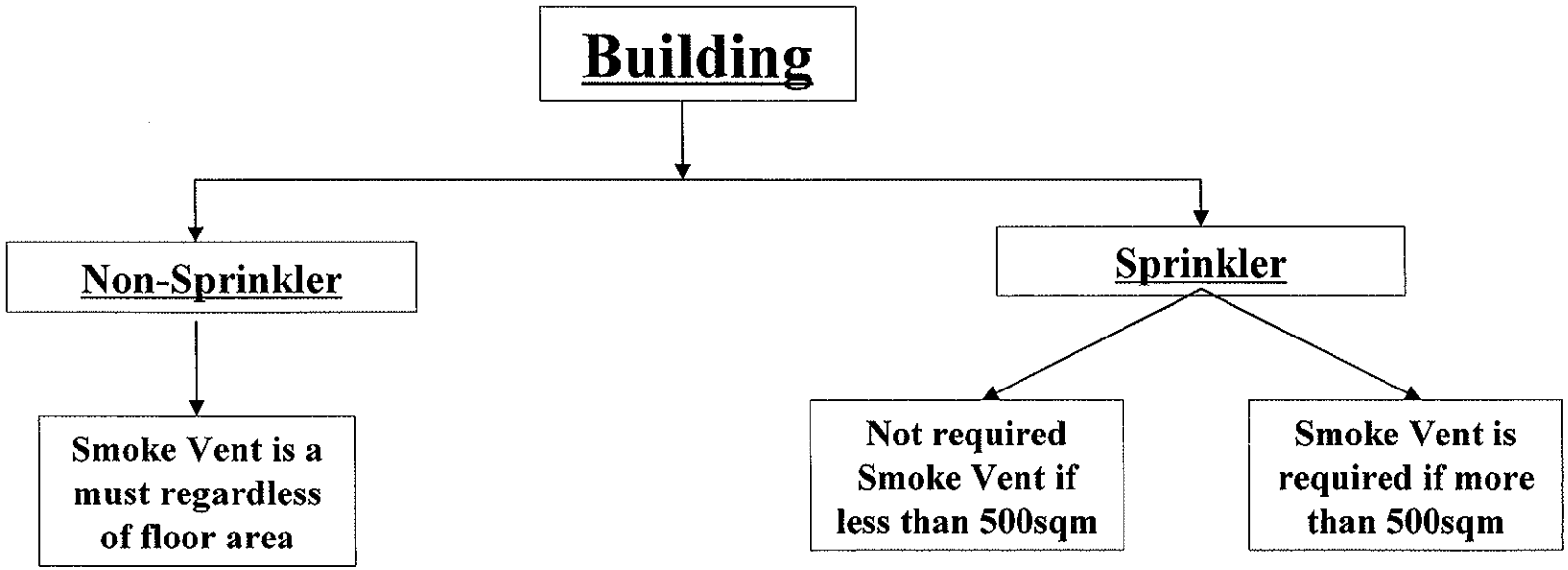


Auditorium

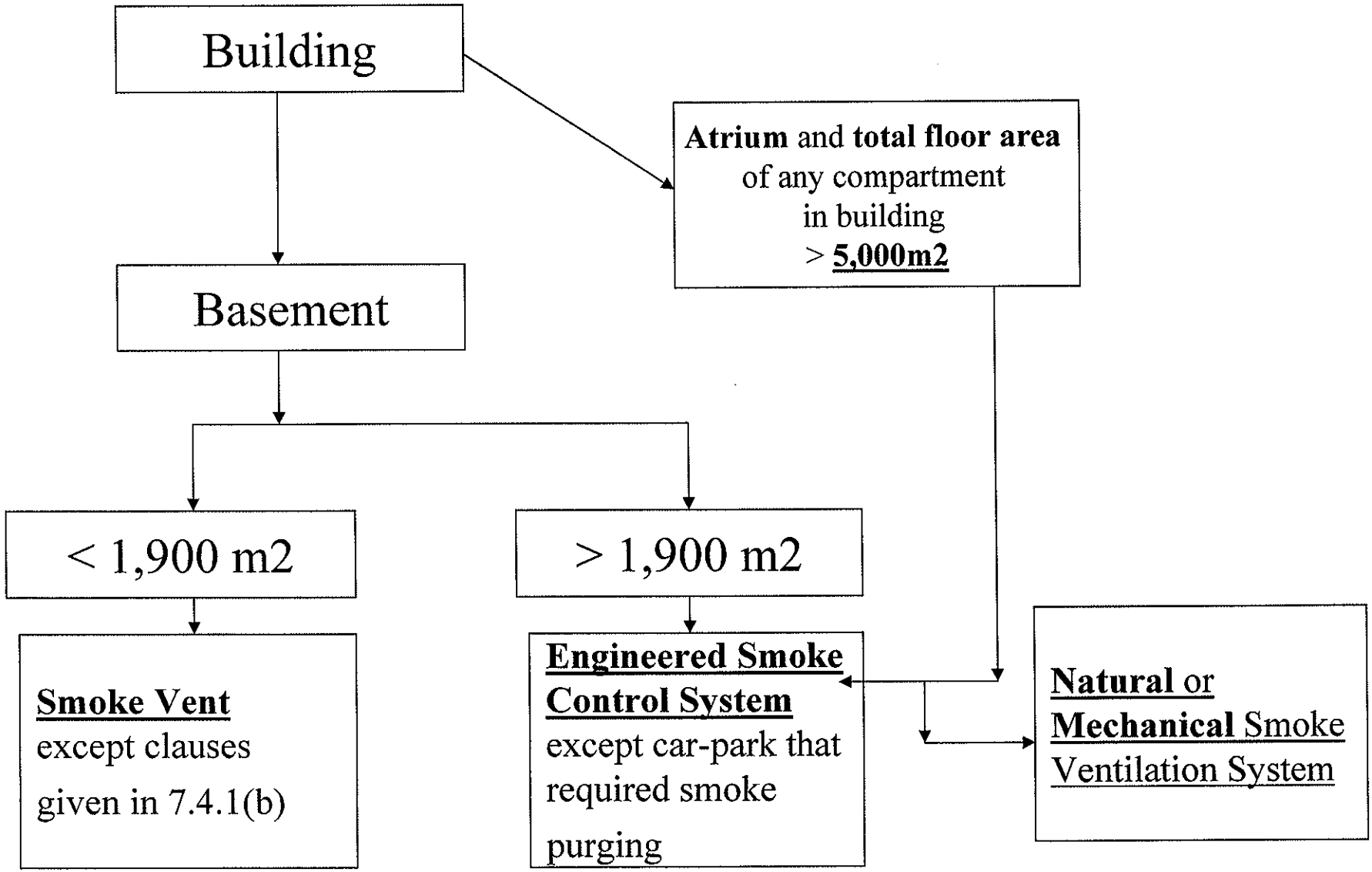
7.7 - AUDITORIUM (CINEMAS, THEATRES ETC) SMOKE CONTROL SYSTEM

7.7.1 Provision of smoke vents having **2½% of the floor area** shall be provided to auditorium which is not sprinkler protected and to auditorium having **floor area more than 500m^2, if sprinkler protected**. The **opening** of the **smoke vents** shall be by **automatic device**.

Explanation :



Further Understanding of SC,SV and SP



CONCLUSION

- AIR-CONDITIONING & MECHANICAL VENTILATION SYSTEMS
- PRESSURISATION FOR EXIT STAIRCASES
- RESSURISATION OF INTERNAL CORRIDORS IN HOTELS
- BASEMENT SMOKE CONTROL SYSTEM
- SMOKE CONTROL SYSTEM
- ENGINEERED SMOKE CONTROL SYSTEM
- AUDITORIUM (CINEMAS, THEATRES ETC) SMOKE CONTROL SYSTEM