

CHAPTER 7

MECHANICAL VENTILATION AND SMOKE CONTROL SYSTEMS

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:
- (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:-
- (1) 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;
- (2) when involved in fire generate a minimum amount of smoke and toxic gases; and
- (3) be at least 1.0 m away from a fire damper.
- (iv) Flexible connections at the extremity of ventilation ductwork connecting terminal units, extract units and ventilation grilles shall not exceed 4 m.

Construction of ductwork

Duct linings & coverings

Flexible joint and connection

Flexible joints, which are normally provided to prevent and/or allow for thermal movements in the duct system, shall not exceed 250 mm in length. Flexible joints shall be made of material classified as 'not easily ignitable' when tested under BS 476: Part 5.

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| (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 may be permissible if: | Plastic and foam rubber insulation |
| | (1) the material is the self-extinguishing type acceptable to the Relevant Authority; | |
| | (2) 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. | |
| (d) | Enclosure of ducts shall comply with the requirements in sub-clause 3.8.9(a). | Duct enclosure |
| (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. | Ductwork through smoke-stop or fire fighting lobbies |
| (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- | Plenum |
| (i) | The concealed space contains only: | |

- (1) 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;
- (2) 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;
- (3) other ventilation ducts complying with sub-cl. (b);
- (4) communication cables for computers, television, telephone and inter-communication system;
- (5) fire protection installations;
- (6) pipes of non-combustible material conveying non-flammable liquids

(ii) The supports for the ceiling membrane are of non-combustible material.

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

Separating walls

(h) Fire Dampers

Any fire damper shall have a fire resisting rating of not less than that required for the compartment wall or compartment floor through which the relevant section of the ventilation duct passes. Fire dampers shall be of the type approved by the relevant authority and constructed in accordance with the requirements in SS 333 - Specifications of fire dampers.

(i) Ventilation ducts which pass directly through a compartment wall or compartment floor shall comply with the following -

Provision of fire dampers

- (1) 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;
- (2) 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.

(ii) Installation of fire dampers

Installation of fire dampers

(1) Fire dampers shall be installed so that the casing completely penetrates through the compartment wall or floor and the casing shall be retained either:

* On both sides by means of flanges in such a manner that it can expand under fire conditions without distorting the blades in the closed position, or

* On the accessible side by means of one flange only, which can be fixed to the damper and to the wall through slotted holes to allow for expansion.

(2) Flanges shall be butted against the face of the compartment wall or floor and fixed to the damper casing.

(3) Ductwork connected to the damper shall be attached in such a manner as to ensure that the damper remains securely in position and is fully functional in the event of damage of ductwork.

(4) The clearance between the damper body and the sides of the penetration shall not be less than that of the tested prototype and not greater than half the width of the angle section of the collar.

(5) The space between the damper body and the opening in the wall or floor shall be fire-stopped.

(6) Vertically positioned fire dampers shall be installed in such a manner that the direction of air flow assists the closure of the damper.

(7) The distance between the plane through a closed fire damper and ducting, flexible connections, duct coverings, internal linings and the like, shall be

Connections to fire dampers

* Not less than 1 m when such parts are made of materials with fusing temperatures less than 1000°C, and

* Not less than three times the diagonal or

diameter of the damper and in no case less than 2 m when such parts are made of materials that are combustible except for vapour barrier to thermal insulation.

- (8) Each fire damper installation shall be provided with an inspection access door either upstream or downstream as appropriate. The access door dimension shall preferably measure 450 mm (length) × 450 mm (width); for smaller ducts, the door width dimension may be reduced to the width or depth of the duct. Access doors shall be hinged and fitted with sash locks, and constructed of minimum 1.25 mm sheet steel suitably braced. Openings in ducts shall be stiffened by sheet steel frame. Access door in ventilation duct for inspection of fire damper
- (iii) Fire dampers shall not be fitted in the following locations: Prohibition of fire dampers
- (1) openings in walls of a smoke extract shaft or return air shaft which also serves as a smoke extract shaft;
 - (2) openings in walls of a protected shaft when the openings have a kitchen exhaust duct passing through it; or
 - (3) anywhere in an air pressurising system;
 - (4) where explicitly prohibited in this Code.
- (iv) Where a fire damper is required by this Code to be installed in the air-conditioning and mechanical ventilation system, its type, details of installation, connection of accessories, inspection door, etc shall be in accordance with 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
 - (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 -

- (1) No opening is greater in area than that corresponding in the prototype test panel;
- (2) The aggregate area of the openings per unit ceiling area does not exceed that of the prototype test panel; and
- (3) The proximity of any opening to any structural member is not less than that in the prototype test panel.

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| (j) | <ol style="list-style-type: none"> (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. (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 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/mm² 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. | Fire rated duct |
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| (k) | <p>Openings for the intakes of outdoor air to all air handling systems, mechanical ventilation systems, pressurisation systems of exit staircases and internal corridors, and smoke control systems shall be no less than 5m from any exhaust discharge openings.</p> <p>All return air openings and outdoor air intakes shall be so located and arranged that sources of ignition such as lighted matches and cigarette butts accidentally entering the openings and intakes shall not be deposited onto the filter media.</p> | Locations of intakes and return air openings |
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7.1.2 Air handling unit room

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| (a) | Air handling systems shall not use protected shaft of exits, smoke-stop lobbies, including its concealed space for supply, exhaust or return air plenums. Rooms having no | Air handling unit rooms |
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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).

- (b) Smoke detectors of approved type shall be incorporated in the return air stream immediately adjacent to:
 - (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.
- (d) Where the air handling units in a building are not centrally controlled, each air-handling unit exceeding 8,500 m³/h shall be provided with a manual stop switch located at a convenient and accessible point to facilitate quick shutting down of the fan in case of fire. This switch shall preferably be located on the wall next to the door opening of the air-handling equipment room.

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.
- (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:
 - (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.
- (iv) The ventilation system shall be of supply mode only of not less than 4 air changes per hour.
- (v) The mechanical ventilation 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 mechanical ventilation system shall be provided.

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:

Mechanically ventilated smoke-stop lobby and fire fighting lobby

- (a) The ventilation system shall be of supply mode only of not less than 10 air changes per hour.
- (b) Supply air shall be drawn directly from the external with intake point not less than 5m from any exhaust discharge or openings for natural ventilation.
- (c) Any part of the 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. 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 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 mechanical ventilation system shall be provided.

7.1.5 Where mechanical ventilation is installed to provide a smoke free environment for the room housing 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

The Fire Command Centre can either be AC, NV, or MV. The AC or MV shall be independent of each other and any other system serving other parts of the building. Where mechanical ventilation is required, it shall also comply with the following requirements:

Fire command centre

- (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.

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: Kitchen
- (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.

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: Rooms involving use of flammable & explosive substances
- (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.

7.1.9 Where mechanical ventilation system is required for car parking areas in basements with total floor area exceeding 2000 m², 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 2.5% 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. The openings shall be evenly distributed over the car park areas.
- (d) Exhaust air shall be discharged directly to the external and shall not be less than 5m from any air intake openings.
- (e) Exhaust ducts shall be fabricated from heavy gauge steel (1.2mm thick) for the basement car park smoke purging system.
- (f) Exhaust fans of the basement car park smoke purging system shall be capable of operating effectively at 250°C for 2 hours.

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 adequate 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
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.	Pressurisation level
	(b)	Where a smoke stop lobby is also pressurised, 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.	
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
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.	Leakages
	(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.	
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.	Distribution of pressurising air
	(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.	
7.2.6 Equipment			

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| (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. | Equipment |
| (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. | |

7.3 **PRESSURISATION OF INTERNAL CORRIDORS IN HOTELS**

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| 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 |
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7.4 **BASEMENT SMOKE CONTROL SYSTEM**

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| 7.4.1 | (a) Where the total aggregate floor area of all basement storeys does not exceed 2000 m ² , smoke vents in accordance with Cl.7.4.2 shall be provided. | Scope |
| | (b) Where the total aggregate floor area of all basement storeys exceeds 2000 m ² , 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: | |
| | (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 2000 m ² , 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.

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:	Smoke vents
	(a) The number and their sizes shall be such that the aggregate effective vent openings shall not be less than 2.5% 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.	
7.4.3	Where engineered smoke control system is required, it shall be provided as specified in Cl. 7.6.	Engineered smoke control
7.4.4	Smoke purging systems, where permitted under this Code in buildings for basement occupancies of plant/equipment room and service areas such as laundries, office, storeroom and workshops, shall conform to the following requirements:	Smoke purge system for non-car park occupancy
	(a) The purge rate shall be at least 9 air changes per hour.	
	(b) 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 in the absence of a fire command centre in the building, at the main fire alarm panel on the first storey. Visual indication of the operational status of the smoke purging system shall also be provided with this remote control.	
	(c) Horizontal ducts shall be fabricated from heavy gauge steel (1.2 mm thick).	
	(d) The exhaust fan shall be capable of operating effectively at 250°C for 2 hours and supplied from a secondary source of supply.	

- (e) Replacement air shall be provided and if it is supplied by a separate mechanical system, such a system shall be connected to a secondary source of power.

7.5 **SMOKE CONTROL SYSTEM**

7.5.1 A smoke control system specified in Cl.7.6 shall be provided where: Smoke control system

- (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.

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: Acceptable design guidance

- (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).

7.6.2 The building to be provided with an engineered smoke control system shall be sprinkler protected. Sprinkler system

7.6.3 Capacity of the engineered smoke control 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

Occupancy (Sprinklered)	Fire Size	
	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 an engineered smoke control system shall be capable of handling the largest demand for smoke exhaust from the worst case scenario.	Capacity of an engineered smoke control system
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:	Smoke reservoir size
	(a) 2000 sq m for natural smoke ventilation system.	
	(b) 2600 sq m for mechanical smoke ventilation system.	
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 :	Removal of smoke from circulation or atrium spaces
	(a) 1000 sq m for natural smoke ventilation system.	
	(b) 1300 sq m for mechanical smoke ventilation system.	
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:	Discharge of smoke into circulation/atrium spaces
	(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).	
7.6.10	The maximum length of the smoke reservoir shall not exceed 60 m.	Length of 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.	

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.	
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
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 carefully 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
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

- 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 shall not be fitted 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 channelling screens
- 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 (USED OR INTENDED FOR USE AS CINEMA, CONCERT HALL, PERFORMANCE THEATRE) SMOKE CONTROL SYSTEM

- 7.7.1 Provision of smoke vents having 2.5% 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.