



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) Construction of ductwork

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 shall 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 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 1m 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.

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



(c) Pipework insulation

Insulation for pipework associated with the air conditioning and mechanical ventilation systems shall comply with the following requirements:

(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) Plastic and foam rubber insulation

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:

- (1) the material is the self-extinguishing type acceptable to the MFRS
- (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 MFRS.

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 MFRS.

(d) Duct enclosure

Enclosure of ducts shall comply with the requirements in sub-clause 3.8.9(a).

(e) Ductwork through smoke-stop or fire-fighting lobbies

Ventilation ducts shall not pass through smoke stop or firefighting 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.



(f) Plenum

A concealed space between the ceiling and floor above it, ceiling and roof, or raised floor and structural floor of a building can be used as a plenum provided that

- (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 2m, 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.

(iii) Exception

Low-smoke and low-flame plenum rated PVC cables conforming to NFPA 262 are permitted to be run exposed in plenum, provided that :

- (1) The plenum space shall be protected by sprinkler system or gaseous total flooding system
- (2) FCU (Fan Coil Unit) or AHU (Air Handling Unit) using plenum for air return and serving more than one rooms, shall be provided with smoke detector at the return air plenum space to shut down the FCU/AHU on detection of smoke.

(g) Separating walls

No air conditioning or ventilation ducts shall penetrate 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 MFRS and constructed in accordance with the requirements in BS EN 1366.

(i) Provision of fire dampers

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

- (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

- (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) Connection to fire dampers

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

- Not less than 1m 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 2m when such parts are made of materials that are combustible except for vapour barrier to thermal insulation.

(8) Access door in ventilation duct for inspection of fire damper

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 450mm (length) × 450mm (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 1.25mm sheet steel suitably braced. Opening in ducts shall be stiffened by sheet steel frame

(iii) *Prohibition of fire dampers*

Fire dampers shall not be fitted in the following locations:

- (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 pressurizing 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 BS EN 1366.



(i) Fire Resisting Floor ceiling and Roof ceiling

- (1) 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.
- (2) 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.

(j) Fire rated duct

- (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 or equivalent and its usage be approved by the MFRS.
- (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/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.



(k) Locations of intakes and return air openings

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.

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.

7.1.2 Air handling unit room

- (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 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).

Where AHU rooms are vertically stacked, each AHU room shall be separated by a compartment floor at every level.

- (b) Smoke detectors

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 MFRS.
- (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 BS EN 1886.



(d) Stop Switch

Where the air handling units in a building are not centrally controlled, each air-handling unit exceeding 8,500m³/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 5m 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 firefighters at the fire command centre, or at the fire alarm panel where there is no fire command centre. Visual indication of the operation status of the mechanical ventilation system shall be provided.



7.1.4 *Mechanically ventilated smoke stop lobby and fire-fighting lobby*

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 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 MFRS 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 alarm panel where there is no fire command centre. Visual indication of the operation status of the mechanical ventilation system shall be provided.

7.1.5 *Engine driven fire pump and generator*

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;
- emergency generator;

- (a) Supply air shall be drawn directly from the external and its intake point shall not be less than 5m from any exhaust discharge openings. Exhaust discharge shall also be direct to the external and shall not be less than 5m 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 *Fire Command Centre*

The Fire Command Centre can either be AC (Air Conditioning), NV (Natural Ventilation), or MV (Mechanical Ventilation). 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:

- (a) Supply air shall be drawn directly from the external and its intake point shall not be less than 5m from any exhaust discharge openings. Exhaust discharge shall also be direct to the external and shall not be less than 5m 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:
 - (i) The hood and ducts for the exhaust shall have a clearance of 500mm from unprotected combustible materials;
 - (ii) The exhaust shall be discharged directly to the external and shall not be less than 5m 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.
- (b) Sharing of kitchen exhaust system for food and beverage outlets is allowed provided the following conditions are complied with:
- (i) For a food court
 - (1) the food court shall be under a single ownership/ operator;
 - (2) there must be provision for maintenance and cleaning of the exhaust system;
 - (3) the food court owner/operator shall ensure that the kitchen exhaust system is degreased and cleaned regularly; and
 - (4) all kitchen exhaust ducts running outside the food court shall have fire resistant rating of at least 1 hour or shall not be less than that for the elements of structure, whichever is the higher.
 - (ii) For restaurants
 - (1) the restaurants that are sharing the same kitchen exhaust system shall be located next to each other and be on the same storey;
 - (2) the aggregate floor area of the restaurants shall not exceed 1,000m²;
 - (3) common duct shall be provided with common exhaust fan;
 - (4) there must be provision for maintenance and cleaning of the common exhaust system;
 - (5) the common kitchen exhaust system shall be degreased and cleaned regularly;
 - (6) the building shall be protected by an automatic fire sprinkler system;
 - (7) the exhaust hood shall be fitted with a wet chemical fire extinguishing system; and
 - (8) the fire rating of the common kitchen exhaust duct running outside the restaurants shall have fire resistance rating of at least 1 hour or shall not be less than that for the elements of structure, whichever is the higher.



(iii) For other smaller F&B (Food & Beverages) outlets such as snack bars, food kiosks etc.

(1) the F&B outlets that are sharing kitchen exhaust system shall be:

- Within close proximity from each other;
- Within a zone of 1,000m²
- With hood-to-hood distance of not more than 10m; and
- located on the same storey.

(2) the kitchen exhaust duct running outside the F&B outlets shall have fire resistance rating of at least 1 hour or shall not be less than that for the elements of structure, whichever is the higher; and

(3) all other conditions stipulated in (ii)(3) to (7) above shall be complied with.

(Note: Kitchen exhaust duct includes both horizontal and vertical 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:

(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 MFRS. The exhaust shall be direct to the external and shall not be less than 5m 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 *Basement car park*

Where mechanical ventilation system is required for car parking areas in basements with total floor area exceeding 2000m², 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.

- (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 5m 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 24m, any internal exit staircases without adequate provision for natural ventilation shall be pressurised to comply with the requirements in this Code. Where the upper part of the staircase is naturally ventilated, its lower part can be provided with mechanical ventilation or pressurisation, whichever is appropriate in accordance with Cl.2.3.3(h).
- (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.
- (c) Where Purpose Group II staircase storey shelter is provided with mechanical ventilation system or pressurisation system for its exit staircase, a manual fire alarm system complying with BS 5839 shall be installed. The manual call point shall be located at the entrance of each exit staircase at every storey, including the non-residential floors. Activation of any manual call point shall initiate the operation of mechanical ventilation system or pressurisation system.

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 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 *Egress velocity*

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.



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.

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.

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 5m 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 alarm panel 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**

- #### **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.



7.4 BASEMENT SMOKE CONTROL SYSTEM

- 7.4.1
- a) Where the total aggregate floor area of all basement storeys does not exceed 2000m², smoke vents in accordance with Cl.7.4.2 shall be provided.
 - b) Where the total aggregate floor area of all basement storeys exceeds 2000m², 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;
 - (ii) Plant/equipment room with floor area not exceeding 250m² and compartmented from rest of the basement, and provided with two doors for better reach in firefighting operation.
 - (iii) Plant/equipment room with floor area exceeding 250m² but not exceeding 2000m², 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 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*

Smoke vents shall be adequately distributed along perimeter of basement and their outlets shall be easily accessible during firefighting 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 2.5% 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 vents 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 *Engineered smoke control*

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

7.4.4 **Smoke purge system for non-car park occupancy**

Smoke purging systems, where permitted under this Code in buildings for basement occupancies of plant/equipment room and service areas such as storeroom and workshops, shall conform to the following requirements

- 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 (1.2mm 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:

- a) 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
- b) The total floor area of any compartment in a building or part of a building exceeds 5000m².

7.6 **ENGINEERED SMOKE CONTROL SYSTEM**

7.6.1 *Acceptable guidance*

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) BR 368 - Design methodologies for smoke and heat exhaust ventilation or
- (d) Other acceptable standards.

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

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:

| 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 *Capacity of an engineered smoke control system*

The capacity of an engineered smoke control system shall be capable of handling the largest demand for smoke exhaust from the worst case scenario.

7.6.5 *Clear layer*

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

7.6.6 *Smoke reservoir*

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

**7.6.7** ***Smoke reservoir size***

For cases where smoke is removed from the room of origin the smoke reservoir size for a smoke ventilation system shall not exceed:

- (a) 2000m² for natural smoke ventilation system.
- (b) 2600m² for mechanical smoke ventilation system

7.6.8 ***Removal of smoke from circulation or atrium spaces***

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) 1000m² for natural smoke ventilation system.
- (b) 1300m² for mechanical smoke ventilation system

7.6.9 ***Discharge of smoke into circulation/ atrium spaces***

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 1000m² (for natural ventilation system) or 1300m² (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 1000m² (for natural ventilation system) or 1300m² (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 ***Length of smoke reservoir***

The maximum length of the smoke reservoir shall not exceed 60m.

7.6.11 ***Stagnant regions***

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.



7.6.12 Owing to practical limitation, a smoke ventilation system shall have:

- (a) a maximum mass flow not exceeding 175kg/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) Replacement air velocity

The design replacement air discharge velocity shall not exceed 5m/s to prevent the escapees being hindered by the air flow.

(b) Distance from exhaust air discharge

Replacement air intake shall be sited at least 5m away from any exhaust air discharge.

(c) Replacement discharge position

Replacement air shall be discharged at a low level, at least 1.5m beneath the designed smoke layer, to prevent “fogging” of the lower clear zone.

(d) Siting of inlets

Where the inlet cannot be sited at least 1.5m below the smoke layer, a smoke curtain or a barrier shall be used to prevent replacement air distorting the smoke layer.

- (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.

(f) Replacement for engineered smoke control system

Where the automatic roller shutters are used at replacement air inlets in the design and installation of engineered smoke control system, it shall be of perforated type having the required effective free area for the effective operation of the engineered smoke control system.

7.6.14 ***Perforated ceiling***

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

**7.6.15** *Emergency power supply*

The smoke ventilation system shall be provided with secondary source of power supply.

7.6.16 *Mode of activation*

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.

7.6.17 Provision of activating smoke detectors shall comply with BS 5839.

7.6.18 *Manual activation*

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.

7.6.19 *Shut down of other air conditioning & ventilation systems*

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.

7.6.20 *Standby fans or multiple fans*

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.

7.6.21 Fans shall be capable of operating at 250°C for 2 hours.

7.6.22 *Protected circuits*

The fans and associated smoke control equipment shall be wired in protected circuits designed to ensure continued operation in the event of the fire.

7.6.23 *Electrical supply*

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 BS 6387.



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-C1. 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 *Fail-safe system*

For natural smoke ventilation system the natural ventilators shall be :

- (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 *Smoke curtain*

All smoke curtains where required, unless permanently fixed in position, shall be brought into position automatically to provide adequate smoke-tightness and effective depth.

7.6.30 *Obstruction to means of escape*

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.

7.6.31 *Smoke or channelling screens*

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.

7.6.32 All smoke control equipment (including smoke curtains) shall be supplied and installed in accordance with 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.