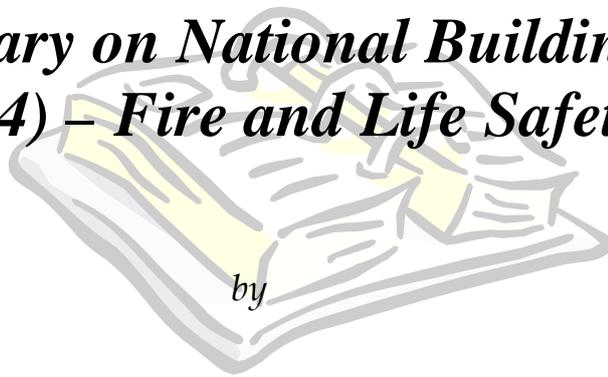

***Commentary on National Building Code
(Part 4) – Fire and Life Safety***



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NATIONAL BUILDING CODE OF INDIA

PART 4 FIRE AND LIFE SAFETY-2005

(Second Revision of SP 7-Part 4)

CODE

COMMENTARY

FOREWORD

This part of the Code deals with safety from fire. It specifies the demarcation of fire zones, restrictions on construction of buildings in each fire zone, classification of buildings based on occupancy, types of building construction according to fire resistance of the structural and non-structural components and other restrictions and requirements necessary to minimise danger to life from fire, smoke, fumes or panic before the buildings can be evacuated. The Code recognizes that safety of life is more than a matter of means of exits and accordingly deals with various matters which are considered essential to the safety of life.

Fire protection techniques have to be based on the fire behavior characteristics of different materials and structural elements of buildings. The activities pursued by the occupants of buildings must also be taken into consideration for assessing the extent of hazards, and method should then be devised by which the hazards could be minimised. An indefinite combination of variables is involved in the phenomenon of fire, all of which cannot be quantified. The requirements of this Code should, therefore, be taken as a guide and an engineering design approach should be adopted for ensuring a fire safe design for buildings. It would also be necessary for this purpose to associate qualified and trained fire protection engineers with the planning of buildings, so that adequate fire protection measures could be incorporated in the building design right from the beginning.

Absolute safety from fire is not attainable in practice. The objective of this part is to specify measures that will provide that degree of safety from fire which can be reasonably achieved. The Code endeavours to avoid requirements that might involve unreasonable hardships or unnecessary inconvenience or interference with normal use and occupancy of buildings, but insists upon compliance with minimum standards for fire safety necessary in public interest. For ensuring compliance of fire protection equipments/installations to the laid down quality requirements, it is desirable to use such equipments/installation duly certified under the BIS Certification Marks Scheme.

While providing guidelines for minimising chances of occurrence of fire through passive fire protection

FOREWORD

A broad overview of the contents of the Foreword (as shown on the left), is outlined below:

- (i) Part-4 of NBC deals with the requirements necessary to minimise danger to life and property from fire and adopts an integrated approach.
- (ii) Fire Protection techniques should be based on fire characteristics of building materials and elements of structure, and requirements of the Code should be adopted in toto for ensuring a fire safe design and construction of buildings.
- (iii) For this, qualified and trained fire experts have to be closely associated with the building industry, right from the planning and design stage of the building. (This aspect has been strongly advocated by the Standing Fire Advisory Council, Govt. of India also, which is the highest policy making body for the Fire Protection Services in the country.
- (iv) While the Code prescribes only the minimum standards of fire protection and fire safety of buildings, both in the interests of the occupants of the buildings and also in the public interests, nothing in the Part prohibits adoption of higher standards. Also, it will be necessary for all concerned to comply with all requirements of fire safety as prescribed in fire-related legislative provisions.
- (v) Detailed coverage has been provided about the Halon Phase-Out policy guidelines as well as the development and adoption of the Standards on Halon Alternatives. In fact, this subject has been dealt with in detail under Commentary Section F-5.3. As mentioned therein, 12 new Indian Standards on Halon Alternatives are already under publication, as ascertained from the BIS, and 19 existing Indian Standards, where there are references on Halon, are under revision/upgradation.
- (vi) The final revised version of Part-4 NBC is under print and expected to come out soon by June 2005 (according to BIS sources) The material projected in the 'Code' part of this document is a reproduction of the final revised version of NBC Part 4, which was sent for printing, as obtained from the BIS.

CODE**COMMENTARY**

measures, this part does not intend to cover all aspects of general fire prevention including sources of ignition. Nor does it cover the prevention of accidental personal injuries during the course of normal occupancy of buildings.

This part while recognising that panic in a building on fire may be uncontrollable, deals with the potential panic hazard through measures designed to prevent the development of panic. Experience indicates that panic seldom develops even in the presence of potential danger, so long as occupants of buildings are moving towards exits which they can see within a reasonable distance and with no obstruction or undue congestion in the path of travel. However, any uncertainty as to location or adequacy of means of egress, the presence of smoke or fumes and the stoppage of travel towards the exit, such as may occur when one person stumbles and falls on stairs, may be conducive to panic. Danger from panic is greater when a large number of people are trapped in a confined area.

Experience has shown that concealed spaces within a building such as space between ceiling and false ceiling, horizontal and vertical ducts, etc, tend to act as flues/tunnels during a fire. Provision should, therefore, be made to provide fire stopping within such spaces.

Nothing in this part of the Code shall be construed to prohibit better types of building construction, more exits or otherwise safer conditions than the minimum requirements specified in this part.

Compliance with this part shall not be construed as eliminating or reducing the necessity for other provisions for safety of persons using a building or structure under normal occupancy conditions. Nor shall any provisions of this Code be construed as requiring or permitting any addition that may be hazardous under normal occupancy conditions.

One of the major points brought out in this part is the limitation of heights and areas of buildings based on fire safety of the occupants. Individual municipal corporations are free to alter Table 19 based on local conditions, but the ratios of areas as maintained in the Table for different occupancies and types of construction shall be adhered to.

Advantage has been taken of the developments, particularly in fire resistance rating of materials, designating types of construction in a rational manner and relating the area limitations of different occupancies to different types of construction.

CODE

Halons (halogenated hydrocarbons) which exhibit exceptional fire fighting and explosion prevention/suppression characteristics have been found to possess high ozone depleting potential. They come under Group II of Annex A of the Montreal Protocol on Substances that Deplete the Ozone Layer, the international environment agreement for phasing out ozone depleting substances. Due to increasing evidence that the ozone layer is getting depleted at a faster rate than thought earlier, the development countries accelerated their phase-out schedule with a view to achieving 100 percent phase-out of halons by 1 January 1994, instead of the earlier target date of 1 January 2000 after which only essential use of halons was allowed. For developing countries like India, the total phase-out of halons is to be achieved by 1 January 2010, as per the Montreal Protocol, unless a decision is taken in between to hasten up the phase-out of ozone depleting substances. India, having become a signatory to the Protocol in June 1992, is committed to abide by the Montreal Protocol decisions. In accordance with Ministry of Environment and Forests, Government of India, Ozone Depleting Substances(Regulations), Rules, 2000, the manufacture of halon based fire extinguishers and extinguishing systems have been phased out by 1 January 2001. Meanwhile, the practical implications of the phasing out of the halons cover, by the large, the following aspects:

- (a) Availability of halons will be restricted;
- (b) Non-standard halon extinguishers, like aerosol type, shall not be permitted;
- (c) Discharge of halons for training/testing, etc shall not be permitted;
- (d) All efforts shall be made for avoiding minimising halon emissions at various levels such as production, fire equipment manufacture, use, service and maintenance;
- (e) Since 'drop-in' substitutes for halons are not likely to be available on a commercial scale in the near future, wherever possible, instead of halon, use of suitable alternative extinguishing media/methods will be resorted to even accepting some trade-offs, if necessary; and
- (f) Halons shall be restricted for 'essential uses' only, for protection of critical fire, explosion, risk areas which would otherwise result in serious impairment of an essential service to society, or pose an unacceptable threat to life, the environment, or national security.

COMMENTARY

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COMMENTARY

NOTE - Detailed instructions which will be issued by the Government of India from time to time for implementation of the Country Programme for the phasing out of Ozone depleting substances (ODS) and regarding permitting use of halons for applications till the availability of proper substitutes, shall have to be complied with.

The first version of this part was formulated in 1970 and first revision was brought out in 1983. Subsequently the first revision of this part was modified in 1997 through Amendment No. 3 to 1983 version of the Code. This modified version of this part included few tables for the fire resistance ratings of various building components such as walls, columns, beams and floors. The requirements for wet riser, downcomer, automatic sprinkler installation, high velocity (10-15 lpm/s) water spray or foam generating system, etc, for buildings were modified. Annex giving guidelines for selection of fire detectors had been deleted and relevant Indian Standards on fire alarm system and smoke detectors had been referred. Also, Annex for determination of fire loads and fire load density for arriving at the classification of occupancy hazard and calorific values of some common materials were included. Annex for broad classification of industrial and non-industrial occupancies into low, Moderate and high hazard, had also been included.

As a result of implementation of this part, some useful suggestions have emerged. This draft revision has, therefore, been prepared to take care of the same. The significant modifications incorporated include:

- (a) The text has now been divided into the following broad clauses :
 - (1) Fire Prevention - covering aspects of fire prevention pertaining to design and construction of buildings on passive fire protection measures, also describing the various types of building materials and their fire rating.
 - (2) Life Safety - covering life safety provisions in the event of fire and similar emergencies, also addressing construction and occupancy features that are necessary to minimise danger to life from fire, smoke, fumes or panic.
 - (3) Fire Protection - Covering the significant appurtenances and their related components and guidelines for selecting the correct type of equipment and installation meant for fire protection of the building, depending upon the classification and type of the building.

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- (b) The classification of building based on occupancy has been elaborated, with:
 - (1) Starred hotels now covered as a new subdivision A-6 under occupancy Group A Residential.
 - (2) Heritage structures and archeological monuments now covered under subdivision D-3 occupancy Group D Assembly buildings.
 - (3) Mixed Assembly Occupancies-D-6 and underground/elevated railways now covered as a new subdivision D-7 under occupancy Group D Assembly buildings.
 - (4) TV stations now covered under subdivision E-5 of occupancy Group E Business buildings.
- (c) The minimum capacity of smoke exhaust equipment has been increased to 12 air changes per hour.
 - d) For the external stairs for exit requirements, the width and treads have been increased to 1250 mm and 250 mm respectively.
 - e) Under the requirements for institutional buildings the clear width of all required exits which serve as egress from hospital or infirmary section has been increased from 1.5 m to 2 m. Also, provision of patient -lift has been included.
 - f) Due cognizance of halon phase out programme has been taken, while specifying provisions in this draft with respect to fire protection using fire extinguishers/systems.

NATIONAL BUILDING CODE OF INDIA

PART 4 FIRE AND LIFE SAFETY-2005

(Second Revision of SP 7-Part 4)

CODE

COMMENTARY

1. SCOPE

This part covers the requirements for fire prevention, life safety and fire protection of buildings. The code specifies construction, occupancy and protection features that are necessary to minimise danger to life and property from fire.

2. TERMINOLOGY

2.0. For purpose of this part, the following definitions shall apply.

2.1. Automatic Fire Detection and Alarm System:

Fire Alarm system comprising components for automatically detecting a fire, initiating an alarm of fire and initiating other actions as appropriate.

Note:- This system may also include manual fire alarm call points.

2.2. Automatic Sprinkler System:

A system of water pipes fitted with sprinkler heads at suitable intervals and heights and designed to actuate automatically, control and extinguish a fire by discharge of water.

F2. TERMINOLOGY

F2.1. Automatic Fire Detection and Alarm System

- a) Partial coverage by this system is not desirable. The detectors have to be properly installed, maintained and tested to ensure adequate fire protection. Both audible and visual alarms are used to alert the occupants through a central control panel.

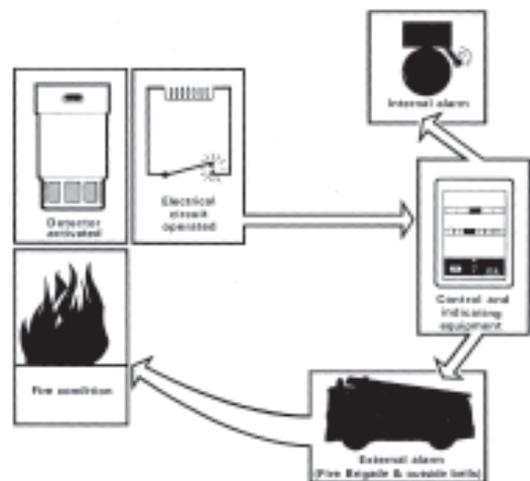


Fig-01(a) Typical Automatic Fire Alarm System.
(Fig-01(b) is given under clause F4.18.)

- b) “ The initiation of other actions” as stated in the definition, is achieved by interfacing of other control devices in the building, like elevator control, fire door control, HVAC systems control etc. of the fire alarm systems. NFPA 72 requires that all fire protection systems in a protected premises, be connected to the fire alarm system.

F2.2. Automatic Sprinkler System:

- a) Automatic sprinklers have the unique properties of automatic detection of fire (since they incorporate thermo-sensitive devices), control and extinguishment of fire by automatically releasing water of activation in specific patterns and quantities over designated areas. The system has come to be universally recognised as the most effective fire protection installation for the building/premises, which need protection. Large area, high rise, assembly, hotels, warehouses, manufacturing facilities and such other buildings, will benefit substantially by its provision. The fact that sprinkler system sounds the fire alarm alerting the occupants of a fire condition, and since sprinkler discharge can con-

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2.3. Building:

Any structure for whatsoever purpose and of whatsoever materials constructed and every part thereof whether used as human habitation or not and includes foundations, plinth, walls, floors, roofs, chimneys, plumbing and building services, fixed platform, varandah, balcony, cornice or projection, part of a building or anything affixed thereto or any wall enclosing or intended to enclose any land or space and signs and outdoor display structures. Tents, Shamianahs, tarpaulin shelters, etc, erected for temporary and ceremonial occasions with the permission of the Authority shall not be considered as building

2.4. Building, Height of:

The vertical distance measured in the case of flat roofs, from the average level of the ground around and contiguous to the building to the terrace of the last livable floor of the building adjacent to the external wall; and in the case of pitched roof up to the point where the external surface of the outer wall intersects the finished surface of the sloping roof, and in the case of gables facing the road, the mid point between the eaves level and the ridge. Architectural features serving no other function except that of decoration, shall be excluded for the purpose of measuring heights.

2.5. Combustible Material:

The material which either burns itself or adds heat to a fire. When tested for non-combustibility in accordance with accepted standard [F(1)]

2.6. Covered Area:

Ground area covered by building immediately above the plinth level. The area covered by the following in the open places is excluded from covered area (see Table 19) (given at the end)

- (a) Garden, rockery, well and well structures, plant nursery, water-pool, swimming pool (if un covered), platform round a tree, tank, fountain, bench, Chabutara with open top and unenclosed on sides by walls and the like;
- (b) Drainage culvert, conduit, catch-pit, gully pit, chamber, gutter and the like;
- (c) Compound wall, gate, un-storeyed porch and portion, slide, swing, uncovered staircases, ramp areas covered by Chajja and the like; and

COMMENTARY

trol, suppress and even extinguish a fire, contributes largely to life safety as well.

- b) However, sprinkler system fails to serve their intended purpose, if they are put to non-automatic mode.

F2.3 Building:

- a) The definition of building as given in Parts 2, 3 & 4 of NBC is self explanatory.

Note: For information only:- The definition of building is quite elastic in various International Codes. In all American Codes (including Uniform Fire Code 2003, International Building Code 2003) the definition adopted is: "Any structure used or intended for supporting or sheltering any use or occupancy". A reference to a building includes part of the building also.

- b) A building need not necessarily be inhabited. Temporary structures need not be construed as buildings.

F2.4. Building, Height of:

It is to be mentioned that building height has been given various definitions in different local Building Regulations and Codes. The definition adopted in Parts 2, 3 & 4 of NBC is a widely accepted one, and generally in conformity with international practice.

F2.6. Covered Area:

Areas excluded from covered area calculations should be taken special note of, particularly during completion of relevant documents and reports.

CODE

- (d) Watchman's booth, pump-house, garbage shaft, electric cabin or substations, and such other utility structures meant for the services or the building under consideration.

Note:- For the purpose of this part covered area equals the plot area minus the area for open spaces in the plot.

2.7. Down comer:

An arrangement of fire fighting within the building by means of down comer pipe connected to terrace tank through terrace pump, gate valve and non return valve and having mains not less than 100mm internal diameter with landing valves on each floor landing. It is also fitted with inlet connections at ground level for charging with water by pumping from fire services appliances and air release valve at roof level to release trapped air inside.

2.8. Dry Riser:

An arrangement of fire fighting within the building by means of vertical rising mains not less than 100mm internal diameter with landing valves on each floor/landing, which is normally dry but is capable of being charged with water usually by pumping from fire service appliances.

2.9. Emergency Lighting:

Lighting provided for use when the supply to the normal lighting fails.

2.10. Emergency Lighting System:

A complete but discrete emergency lighting installation from standby power source to the emergency lighting lamp(s), for example, self contained emergency luminaire or a circuit from central battery generator connected through wiring to several escape luminaries.

2.11. Escape Lighting:

That part of emergency lighting which is provided to ensure that the escape route is illuminated at all material times (for example, at all times when persons are on the premises), or at times the main lighting is not available, either for the whole building or the escape routes.

2.12. Fire Door:

A fire-resistive door approved for openings in fire separation walls.

COMMENTARY

F2.7. Down comer:

Difference between a down comer and a dry riser is that down comer is connected to an over head tank and a terrace pump; whereas dry riser remains dry normally. It can be charged with water from ground level by fire brigade on their arrival by making connection via fire brigade inlets provided at the bottom of such dry risers.

F2.9. Emergency Lighting:

Requirements for installation, operation and maintenance of emergency systems circuits and equipments are given in National Electric Code(NEC).

F2.10. Emergency Lighting System:

Normally, a DG set or a trickle charged battery bank is provided for this.

F2.11. Escape Lighting:

All the passive and active fire protection requirements as per Regulations and Codes, will be of no use in terms of life safety of the occupants, in the absence of emergency lighting.

F2.12. Fire Door:

For the purpose of compartmentation or segregation between occupancies, one fire door each on either side of a wall opening is required for providing the same fire resistance as that of the fire wall. At times, it is also called as fire check door. For any other purposes like segregation of staircase or lift lobbies and service shafts, only one fire door will serve the purpose.

CODE

COMMENTARY

2.13. Fire Exit:

A way out leading to an escape route. Having panic bar hardware provided on the door

F2.13. Fire Exit:

This can either be a doorway or even a horizontal exit. For means of egress, please refer to 2.27.

2.14. Fire Lift:

The lift installed to enable fire services personnel to reach different floors with minimum delay, having such features as required in accordance with this Part.

F2.14. FireLift :

This lift can be used even by building occupants except during fire emergencies. This is a lift designed to have additional protection with controls to enable it to be used under the direct control of the fire service during fires.

2.15. Fire Load:

Calorific energy, of the whole contents contained in a space, including the facing of the walls, partition, floors and ceilings.

F2.15. Fire Load:

It is the measure of the maximum heat that will be released if all the combustibles in a fire area burn. It is expressed in kJ/kg (one kJ is approx. equal to 1 btu). Inclusion of wall linings, wooden or combustible partitions, floors and ceilings in the definition, should be taken special note of.

2.16. Fire Load Density:

Fire load divided by floor area.

F2.17. Fire Resistance Rating:

Information Note.A/F2.17 (for information only)

2.17. Fire Resistance Rating:

The time that a material or construction will withstand the standard fire exposure as determined by fire test done in accordance with the standard methods of fire tests of materials/ structures.

A.1 Fire Resistance Rating is at times referred to as "Fire Endurance Rating" also. While the actual time is recorded in the nearest integral minutes, fire resistance ratings are given in standard intervals. The usual fire resistance ratings for all types of structural members doors and windows are 15 mins., 30 mins., 45 mins., 1hr., 1½ hrs., 2 hrs., 3 hrs. and 4 hrs.

2.18. Fire Resistance:

Fire resistance is a property of an element of building construction and is the measure of its ability to satisfy for a stated period some or all of the following criteria:

A.2 However, in actual practice several factors affect the standard fire resistance specified; Eg:

- (a) Resistance to collapse
- (b) Resistance to penetration of flame and hot gases, and
- (c) Resistance to temperature rise on the unexposed face up to a maximum of 180°C and / or average temperature of 150°C

i) The amount of combustible material per unit of floor area in various types of buildings (the fire load density);

ii) The height of the top floor above ground, which has a bearing of ease of escape (evacuation) and fire fighting operations, and consequences should large scale collapse occur.

iii) Occupancy types, which again reflects the speed of evacuation;

(iv) The existence of basements, since basement fires may lead to accumulation of smoke and heat build up, which may, in turn, affect the duration of fire as well as make fire fighting difficult;

(v) The number of storeys in the building; if a single storey, escape is direct and structural failure is unlikely.

2.19. Fire Separation:

The distance in meters measured from the external wall of the building concerned to the external wall of any other building on the site, or from other site, or from the opposite side of street or other public space to the building for the purpose of preventing the spread of fire.

CODE

2.20. Fire separating wall:

The wall provides complete separation of one building from another or part of a building from another or part of a building from an other part of the same building to prevent any communication of fire or heat transmission to wall itself which may cause or assist in the combustion of materials on the side opposite to that portion which may be on fire.

2.21. Fire Stop:

A fire resistant material or construction having a fire resistance rating of not less than the separating elements installed in concealed spaces or between structural elements of a building to prevent the spread/propagation of fire and smoke through walls, ceilings and the like as per the laid down criteria.

COMMENTARY

Information Note. No.B/2.18.

The fire resistance of an element is the time in minutes from the start of the test until failure occurs under any one of the criteria set out in 2.18(a), (b) or (c). viz.,

- (a) Resistance to collapse(stability)
- (b) Resistance to penetration of flame(integrity)
- (c) Resistance to temp. rise on unexposed face(insulation)

For example:

A test result showing: stability-120; integrity-120; insulation-15, would mean that a specimen failed in respect of insulation after 15min. but complied with the other two criteria for at least 120min.

F2.20. Fire separating wall:

They have minimum fire resistance of 4-hrs. Combustible materials on the other side of the fire separating wall can be segregated before the wall collapses, and the fire enters the segregated compartment. This reduces the overall damage and material losses.

F2.21. Fire Stop:

- (a) This is actually a seal provided to close the opening or imperfection of fit or design between elements or components to eliminate the possibility of fire and smoke passing through them. These fire stops fill the openings around penetrating items such as cable trays, conduits, ducts, pipes etc. through the wall or floor openings. (fig. 5 at page 32)
- (b) Provision of non combustible "sleeving" is also resorted to as an alternative to proprietary seals for penetration of pipes of lead, aluminium, aluminium alloy, fibre cement or UPVC upto a specified nominal internal diameter.

Information Note 'C'/ 2.21 (for information only)

C.1 Proprietary fire stopping and sealing systems which have been shown by test to maintain the fire resistance of the wall or other elements, are available and may be used. Other fire stopping materials include:

- cement mortar
- gypsum-based plaster
- cement or gypsum vermiculite/perlite mixes
- glass fibre, crushed rock, blast furnace slag, or ceramic based products (with or without resin binders), and
- intumescent mastics

C.2 These may be used in situations appropriate to the particular material. Not all of them will be suitable in every situation.

CODE

2.22. Fire Tower:

An enclosed staircase which can only be approached from the various floors through landings or lobbies separated from both the floor areas and the staircase by fire-resisting doors, and open to the outer air.

2.23. Fire Resisting Wall

A fire resistance rated wall, having protected openings, which restricts the spread of fire and extends continuously from the foundation to at least 1 m above the roof.

2.24. Floor Area Ratio:

The quotient obtained by dividing the total covered area (plinth area) of all floors by the area of the plot;

$$\text{FAR} = \frac{\text{Total covered area of all floors}}{\text{Plot area}}$$

2.25. High Rise Building:

For the purpose of this Part, all buildings 15m and above in height shall be considered as high rise buildings.

2.26. Horizontal Exit:

An arrangement which allows alternative egress from a floor area to another floor at or near the same level in an adjoining building or an adjoining part of same building with adequate fire separation.

2.27. Means of Egress:

A continuous and unobstructed way of travel from any point in a building or structure to a place of comparative safety.

2.28. Occupancy or or Use Group:

The principal occupancy for which a building or a part of a building is used or intended to be used. For the purpose of classification of a building according to the occupancy, an occupancy shall be deemed to include subsidiary occupancies which are contingent upon it.

2.29. Plinth Area:

The built-up covered area measured at the floor level of the basement or of any storey.

2.30. Pressurization:

The establishment of a pressure difference across a barrier to protect a stairway, lobby escape route, or room of a building from smoke penetration.

COMMENTARY

F2.22. Fire Tower

These are applicable for multi-storeyed buildings (over 8 storeys or 24m in height) and are considered as the safest escape route.

F2.24. Floor Area Ratio (FAR)

This is also referred to as Floor Space Index (FSI). The comparative floor area ratios of various occupancies with explanatory notes are given in Table 19. The FAR values are subject to modification by the local authorities on justifiable grounds.

F2.25. High Rise Building :

For measurement of heights of buildings please refer to definition of 'Building, Height of' under 2.4. Definition of high rise buildings given in this Code is of great importance because it has to be ideally adopted by all Building Codes in all the states of India.

F2.26. Horizontal Exit:

- (a) Horizontal exits are particularly useful during fire emergencies in hospitals (health care occupancies) for evacuation of bedridden patients or patients suffering from immobility. Adjoining compartments into which horizontal evacuation is done should also have a floor area sufficient to accommodate evacuees from the adjoining compartment.
- (b) Sometimes, progressive horizontal evacuation may also have to be adopted depending on the emergency situation and the facilities available (fig 13 at page 51)

F2.27. Means of Egress:

- (a) The definition given here is quite simple, easy to understand and covers the basic requirements. This is the terminology used in USA also. In certain other countries like UK, it is referred to as "Means of Escape" or "Means of Exit". Means of Egress in buildings constitutes perhaps the most important component of the National Building Code as a whole, in so far as life safety of the occupants is concerned.

F2.28. Occupancy or Use Group:

It is to be noted that in the case of mixed occupancy, the actual occupancy classification of the building or premises will be on the basis of the principal occupancy class. The occupancy shall be deemed to include subsidiary or ancillary occupancies which are contingent on it. As per NBC, the term "alteration" of the building includes "a change from one occupancy to another or a structural change" (NBC page 1-2)

F2.30 & Pressurisation & Pressurisation Level

CODE

2.31. Pressurization Level:

The pressure difference between the pressurised space and the area served by the pressurised escape route, expressed in pascals(Pa)

2.32. Roof Exits:

A means of escape on to the roof of a building where the roof has access to it from the ground. The exit shall have adequate cut-off within the building from staircase below.

2.33. Site Plot:

A parcel (piece) of land enclosed by definite boundaries.

2.34. Stack Pressure:

Pressure difference caused by a temperature difference creating an air movement within a duct, chimney or enclosure.

2.35. Travel Distance:

The distance to be travelled from any point in a building to a protected escape route, external escape route or final exit.

COMMENTARY

F2.31. The technique adopted is to create a higher pressure in an escape route by mechanical ventilation, thus preventing the ingress of smoke

and toxic gases into the protected area. The most common method is by use of centrifugal or axial fans driven by an electric motor. The basic design considerations are:

- (a) The pressure required in the escape route and the leakage paths. To be effective, the system should operate when required at a higher pressure than that developed by the fire and weather conditions.

F2.32. Roof Exits

Under certain circumstances when the other normal means of exit provided inside the building like stair cases become smoke logged, roof exits will be the only means of escape.

F2.34. Stack Pressure

Smoke moves from an area of higher pressure to one of lower pressure. Pressure differences may be caused by buoyancy from the fire, stack effect, wind and forces from building heating, ventilating and air-conditioning systems. In tall buildings, these factors are complicated by the **stack effect**, which is the vertical natural air movement from the building caused by the differences in temperature and densities between the inside and outside air. This stack effect plays a vital role in smoke movement.

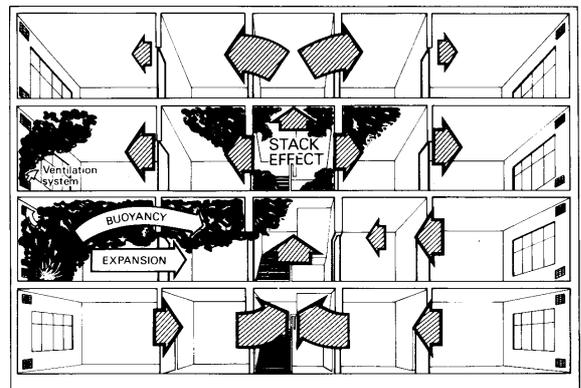


Fig. 2 Smoke Movement and Stack Effect in a Multi-Storey Building.

F2.35. Travel Distance:

Safe exit for the occupants in a building on fire, requires a safe path of escape from the fire in the shortest possible time. This path, which should be as short as possible, and easily negotiable, should be ready for use in case of emergency.

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2.36. Ventilation:

Supply of outside air into, or the removal of inside air from an enclosed space.

2.37. Venting Fire

The process of inducing heat and smoke to leave a building as quickly as possible by such paths so that lateral spread of fire and heat is checked, fire fighting operations are facilitated and minimum fire damage is caused.

2.38. Volume to Plot Area Ratio (VPR)

The ratio of volume of building measured in cubic metres to the area of the plot measured in square metres and expressed in metres.

2.39. Wet Riser

An arrangement for fire fighting within the building by means of vertical rising mains of not less than 100 mm diameter with landing valves on each floor/landing for fire fighting purposes and permanently charged with water from a pressurised supply.

Note:- For definition of other terms, reference shall be made to good practice, Annex-F 2

3. FIRE PREVENTION

3.1. Classification of Buildings Based on Occupancy.

3.1.1. General Classification:

All buildings, whether existing or hereafter erected, shall be classified according to the use or the character of occupancy in one of the following groups:

Group A	Residential
Group B	Educational
Group C	Institutional
Group D	Assembly
Group E	Business
Group F	Mercantile
Group G	Industrial
Group H	Storage
Group J	Hazardous

3.1.1.1. Minor occupancy incidental to operations in another type of occupancy shall be considered as part of the main occupancy, and shall be classified under the relevant Group for the main occupancy.

Example of buildings in each Group are given in 3.1.2 to 3.1.10

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F2.36. Ventilation:

This is more important for people awaiting evacuation to sustain their lives. This is an important requirement in building design and construction for replacement of stale, noxious or contaminated air inside, with clean air from outside. This can be achieved either through natural or mechanical means.

F2.37. Venting Fire

It deals with removal of heat and smoke from building to facilitate fire fighting and evacuation efforts. Smoke logging and mushrooming of hot gases can be prevented, or at least minimised, by early venting. This prevents the pre-heating of other areas by convection, thereby restricting the spread of fire.

F2.39. Wet Riser

Difference between this and a dry riser, is that wet risers are permanently charged with water by a fire pump from a permanent water supply (which can either be an underground water tank or an elevated water tank at the terrace), whereas, the dry riser has to be fed with water by fire brigade after their arrival. Landing valves are nothing but internal hydrants fitted with standard instantaneous female couplings and may be of single or double outlet types.

F3. FIRE PREVENTION

To start with, it will be relevant to make a reference to the 4th para under FORWARD regarding FIRE PREVENTION Coverage in this part.

F3.1. Classification of Buildings based on Occupancy

Occupancy classification of buildings as per the International standards are also by and large similar to this.

For information only:

According to Building Regulations of UK, they are known as "Purpose Groups" instead of occupancies. However, it will be a matter of interest to note that "Historical Buildings" (which includes Heritage and Archaeological monuments), because of their national/international importance and the irreplaceable high value of these special structures and their contents, are grouped under a separate occupancy class in a few other International Standards, due to the following reasons:

- (i) they may be situated in isolated locations where fire service cover may not be easily available;
- (ii) their unusual fire hazard potential in some cases;
- (iii) easy susceptibility to fire of combustible structural elements and contents due to age, disuse and deterioration;
- (iv) they also may be subject to rehabilitation by way of repairs, renovations, modifications etc;

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3.1.2. Group A Residential Buildings:

These shall include any building in which sleeping accommodation is provided for normal residential purpose with or without cooking or dining or both facilities, except any building classified under Group C.

Buildings and structures under Group A shall be further subdivided as follows:

- Subdivision A-1 Lodging or Rooming houses
- Subdivision A-2 One or two-family private dwellings
- Subdivision A-3 Dormitories
- Subdivision A-4 Apartment houses (flats)
- Subdivision A-5 Hotels
- Subdivision A - 6 Hotels (Starred)

- (a) Subdivision A-1-Lodging or rooming houses: These shall include any building or group of buildings under the same management, in which separate sleeping accommodation for a total of not more than 40 persons (beds), on transient or permanent basis, with or without dining facilities but without cooking facilities for individuals is provided. This includes inns, clubs, motels and guest houses.

A lodging or rooming house shall be classified as a dwelling in subdivision A-2 if no room in any of its private dwelling units is rented to more than three persons.

- (b) Subdivision A-2-One or Two family private dwellings: These shall include any private dwelling which is occupied by members of one or two families and has total sleeping accommodation for not more than 20 persons.

If rooms in a private dwelling are rented to outsiders, these shall be for accommodating not more than three persons per room.

If sleeping accommodation for more than 20 persons is provided in any one residential building, it shall be classified as a building in subdivision A-1, A-3 or A-4, as the case may be.

- (c) Subdivision A-3 -Dormitories: These shall include any building in which group sleeping accommodation is provided, with or without dining facilities for persons who are not members of the same family, in one room or a series of associated rooms, under joint occupancy and single management; for example, school and college dormitories, students', and other hostels and military barracks.

- (d) Subdivision A-4-Apartment Houses (flats): These shall include any building or structure in which living quarters are provided for three or

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- (v) a majority of these historic buildings do not have even the basic fire protection measures incorporated into them;
- (vi) since many of the provisions in the local Building Codes may not be in a position to be implemented in their case, they require special assessment, adopting true fire engineering principles.
- (vii) In this Code, Heritage and Archeological Monuments have been included under Subdivision D-3 in Group D - Assembly Buildings

F3.1.2. Group A-Residential Buildings:

Main criteria for being classified under this category is that it must provide sleeping accommodation. Inclusion of hotels and star hotels in this Group, should be taken special note of;

- (a) Sub Division A-1 Lodging or Rooming Houses: Lodging houses under this category accommodates 40 or less persons and provide sleeping accommodation to them in which not more than 3 persons are accommodated in a room.

If number of persons exceed 40, these are to be grouped under A-5.

- (b) Sub Division A-2-One or Two Family Private Dwellings:

These are small residential complexes, housing not more than 20 persons where no room is rented out to more than 3 persons, and where not more than one or two families live.

Building housing three or more families, are to be grouped under A-4.

- (c) Sub Division A-3 - Dormitories: These include students' and other hostels and military barracks.

- (d) Sub Division A-4-Apartment Houses (Flats): The criteria for being grouped under this is three or more families living in one apartment house.

- (e) Sub Division A-5-Hotels: The main criteria for being grouped under this is that they must accommodate more than 40 people.

Even inns, motels, clubs or guest houses also come under this category. There is an Indian Standard, IS13716-1993 "Fire Safety in Hotels - Code of practice", according to which buildings under the same management, in which more than 15 persons are provided with sleeping accommodation, are taken as hotels.

- (f) Sub Division A-6 - Hotels (starred): This is a new sub division, which has been included in the present revision.

Information Note: D/F3.1.2 (For information only)
In this context, it is worth mentioning that Government of India, Dept. of Tourism, had issued a Notification No. HRACC(1)2000 dated 24/3/2003, containing revised classification norms for hotels in Star categories.

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more families, living independently of each other and with independent cooking facilities; for eg., apartment houses, mansions and chawls.

- (e) Subdivision A-5 Hotels:
These shall include any building or a group of buildings under single management, in which sleeping accommodation, with or without dining facilities, for hotels classified up to 4 star category.
- (f) Subdivision A-6 Hotels (starred)-These shall include the hotels duly approved by the concerned authorities as Five Star and above Hotels.

3.1.3. Group B: Educational buildings:

These shall include any building used for school, college, other training institutions or day-care purposes involving assembly for instruction, education or recreation for not less than 20 students.

Buildings and structures under Group B shall be further subdivided as follows:

Subdivision B-1:

Schools up to senior secondary level

Subdivision B-2:

All other/training institutions

- (a) Subdivision B-1. Schools upto Senior Secondary Level :
This subdivision shall include any building or group of buildings under single management which is used for students not less than 20 in number.
- (b) Subdivision B-2. All Others/Training Institutions:
This subdivision shall include any building or a group of buildings under single management which is used for students not less than 100 in number.

In case of temporary buildings/structures which are utilised for educational purposes, the provisions of 3.2.5.3 shall apply. If residential accommodation is provided in the schools/institutions, that portion of the occupancy shall be classified as a building in subdivision A-3.

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The hotel classifications will be in the following categories:

- (i) Star Hotels: 5 star Deluxe, 5-star, 4 star, 3-star 2-star and 1-star
- (ii) Heritage Hotels: Heritage Grand, Heritage Classic and Heritage.

According to the above Notification, for classification of project approvals in the 5-Star Deluxe, 5-star, 4-star and all the 3 heritage categories, the application along with the requisite fees are to be sent to Dept. of Tourism, Govt. of India, HO in New Delhi, and for the 3-star, 2-star and 1-star categories, the application along with the requisite fees are to be sent to the Regional Directors, Indian Tourism Offices concerned.

Detailed checklist for various facilities and services required for each star category as well as the procedure for application etc. are given in the same Notification.

Hotels will qualify for classification as Heritage Hotels provided a minimum 50% of the floor area was built before 1935, and no substantial change has been made in the facade.

F3.1.3 Group B Educational Buildings:

Schools with students less than 20 do not come under Group B

- (a) Sub Division B-1 Schools upto Senior Secondary Level:
Number of students in this group is between 20 and 100. This also includes nurseries, kindergarten schools etc.
- (b) Sub Division B-2- All others /Training Institutions:
This also covers all types of training institutions including defence, para-military, police, fire service, administration and such other professional/technical training institutions under one single management.

Number of students in this group is 100 and more. Fire and life safety hazards in the training establishments coming under this sub division will obviously be more than those under Sub Division B-1.

For requirements in regard to fire and life safety for schools housed in temporary structures, please refer to IS 8758-1993, 'Recommendations for fire precautionary measures in the construction of temporary structures and pandals'. The life and fire hazard potential in such temporary structures are very high, and such premises should not be utilised as educational buildings.

After the recent tragic School building fire in Kumbhakonam, Tamil Nadu, on 16th July 2004 which resulted in the death of 93 children and injuring several more, strict instructions have been issued by Central as well as State Govt. authorities prohibiting the use of temporary structures for educational purposes.

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3.1.4. Group C Institutional Buildings:

These shall include any buildings or part thereof, which is used for purposes such as medical or other treatment or care of persons suffering from physical or mental illness, disease or infirmity, care of infants, convalescents or aged persons and for penal or correctional detention in which the liberty of the inmates is restricted. Institutional buildings ordinarily provide sleeping accommodation for the occupants.

Buildings and structures under Group C shall be further subdivided as follows:

Subdivision C-1 Hospitals and Sanatoria

Subdivision C-2 Custodial institutions

Subdivision C-3 Penal and Mental institutions

- (a) Subdivision C-1 Hospitals and Sanatoria-This subdivision shall include any building or group of buildings under single management, which is used for housing persons suffering from physical limitations because of health or age, for example, hospitals, infirmaries, sanatoria and nursing homes.
- (b) Subdivision C-2 Custodial institutions: This subdivision shall include any building or group of buildings under single management, which is used for the custody and care of persons, such as children, convalescents and the aged; for example, homes for the aged and infirm, convalescent homes and orphanages.
- (c) Subdivision C-3 Penal and mental institutions: The subdivision shall include any building or a group of buildings under single management, which is used for housing persons under restraint, or who are detained for penal or corrective purposes, in which the liberty of the inmates is restricted, for eg., jails, prisons, mental hospitals, mental sanatoria and reformatories.

3.1.5. Group D Assembly Buildings:

These shall include any building or part of building, where number of persons not less than 50 congregate or gather for amusement, recreation, social, religious, patriotic, civil, travel and similar purposes; for example, theatres, motion picture houses, assembly halls, auditoria, exhibition halls, museums, skating rinks, gymnasiums, restaurants, places of worship, dance halls, club rooms, passenger stations and terminals of air, surface and marine public transportation services, recreation piers and stadia, etc.

Buildings under Group D shall be further subdivided as follows:

F3.1.4. Group C-Institutional Buildings:

Main occupancies here are used for medical care, child care, home for the aged, and as jails and mental asylum homes.

The common feature in all these, is that liberty of inmates is restricted.

- (a) Sub Division C-1 Hospitals & Sanatoria: This is an important group covering a wide range of health care institutions.
- (b) Sub Division C-2 Custodial Institutions: Childrens' homes and homes for the aged are grouped under C-2.
- (c) Sub-Division C-3 Penal & Mental Institutions: Jails, prisons, mental hospitals etc, are grouped under this category.

F3.1.5. Group D-Assembly Buildings:

- (a) The governing criteria for a building to be classified under Assembly buildings is congregation of 50 or more people in a common place;
- (b) Since an Assembly occupancy can involve the safety of a large number of people, running to even several thousands, the density of the occupant population as well as the nature of the seating arrangements present the major safety problems. No other occupancy experiences occupant loads of such density;
- (c) Such high occupant densities produce problems in the physical movement and behaviour of the occupants, the capacity of the exits, the maintenance of adequate aisles of adequate width, and also the promptness and method of alerting occupants in case of emergency;
- (d) Another important factor is the unfamiliarity of the crowd of occupants generally with the layout of the premises, exit locations, escape paths etc.;
- (e) Besides, Assembly occupancies such as theatres, concert halls, night clubs and some restaurants usually function in near-total darkness;
- (f) All the above factors have the necessary potential to lead to panic conditions, which can not only seriously hamper the orderly egress of the crowd from the Assembly premises, but can also result in enhancing the casualty figures drastically;
- (g) Safe exit or evacuation of occupants from a building requires a safe path of escape from the fire or other hazardous environment. A good means of egress design, especially for Assembly occupancies or assembly areas, is a challenging task even for well qualified and experienced architects, which call for a high level of understanding of human factors, especially reaction of people in life-sustaining emergencies, movement of a crowd of people on level surfaces, on stairs, ramps, narrow aisles etc., exit width approaches, flow rate densities, apart from all the active fire protection measures required for ensuring prompt alerting as well as safe evacuation of the occupant crowd.

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Subdivision D-1: Buildings having a theatrical or motion picture or any other stage and fixed seats for over 1000 persons.

Subdivision D-2: Buildings having theatrical or motion picture or any other stage and fixed seats up-to 1000 persons.

Subdivision D-3: Buildings without a permanent stage having accommodation for 300 or more persons but no permanent seating arrangement.

Subdivision D-4: Buildings without a permanent stage having accommodation for less than 300 persons with no permanent seating arrangement.

Subdivision D5: All other structures including temporary structures designed for assembly of people not covered by sub divisions D1 to D4, at ground level.

Subdivision D-6: Buildings having mixed occupancies providing facilities such as shopping, cinema theatres, and restaurants.

Subdivision D-7 All other structures, elevated or underground, for assembly of people not covered by subdivisions D-1 to D-6.

- (a) Subdivision D-1:
This subdivision shall include any building primarily meant for theatrical or operatic performances and exhibitions and which has raised stage, proscenium curtain, fixed or portable scenery or scenery loft, lights, motion picture houses, mechanical appliances or other theatrical accessories and equipment, and which is provided with fixed seats for over 1000 persons.
- (b) Subdivision D-2:
This subdivision shall include any building primarily meant for use as described for subdivision D-1, but with fixed seats up to 1000 persons.
- (c) Subdivision D-3:
This subdivision shall include any building, its lobbies, rooms and other spaces connected thereto, primarily intended for assembly of people, but which has no theatrical stage or permanent theatrical and / or cinematographic accessories and has accommodation for 300 persons or more; for eg., dance halls, night clubs, halls for incidental picture shows, dramatic, theatrical or educational presentation, lectures or other similar purposes having no theatrical stage except a raised platform and used without permanent seating arrangement, art galleries exhibition halls, community halls, passenger terminals and heritage and archeological monuments.

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F3.1.5.

Sub Division D-1: This sub-division includes comparatively large size buildings or part buildings catering for assembly of over 1000 persons, where fixed seats are provided.

Note: (for information only): It will be of interest to know that according to Uniform Fire Code (NFPA-1-2003), in Assembly occupancies having occupant loads exceeding 1000, trained crowd managers/supervisors are required to be provided, except for Assembly occupancies for religious worships, for crowds not exceeding 2000. Also, in the same Uniform Fire Code, seats in the Assembly occupancies accommodating more than 200 persons are required to be securely fastened to the floor except where such fastening is impracticable as in the case of restaurants, night clubs, dance halls etc.

Sub Division D-3

It is heartening to note that Heritage and Archaeological monuments have been included under this Sub Division in this edition. However, considering their national/international importance, irreplaceable high value of their structures and contents, and the obligatory need for their preservation, it is felt these historical monuments should have been considered as a separate occupancy class, as is the generally accepted international practice. These special buildings and structures, because of their normally isolated location, age, peculiar type of construction and highly combustible materials, contents and decorative materials, present unique fire protection challenges. They, therefore, demand a thoroughly imaginative and innovative performances-based approach for design and installation of fire protection and life safety systems, if they are to be saved from the ravages of fire as had been the experience the world over.

It is imperative that the authorities concerned are fully aware of the above requirements, and take appropriate actions for their preservation well in time.

Sub Division D-4:

Apart from the difference in the number of seats in groups D-3 and D-4, sub division D-4 is less hazardous than D-3.

Sub Division D-5:

(a) These are outdoor occupancies or temporary structures like circus tents, where a large number of people gather for a short duration. The life hazards in such occupancies are high.

Since subdivision D-5 includes "any building or structure, permanent or temporary meant for Assembly of people", the scope of their application is quite wide, and warrants strict and close scrutiny by Code implementation authorities.

(b) From past and continuing experience, it is an established and alarming fact that Assembly

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- (d) Subdivision D-4:
This subdivision shall include any building primarily intended for use as described in subdivision D-3, but with accommodation for less than 300 persons with no permanent seating arrangements.
- (e) Subdivision D-5:
This subdivision shall include any building or structure, permanent or temporary, meant for assembly of people not covered by subdivisions D-1 to D-4; for eg., grandstands, stadia, amusement park structures, reviewing stands and circus tents.
- (f) Subdivision D-6:
This subdivision shall include any building for assembly of people provided with multiple services/facilities like shopping, cinema theatres and restaurants, for eg., **multiplexes**
- (g) Subdivision D-7:
The subdivision shall include any building or structure permanent or temporary meant for assembly of people not covered by D-1 to D-6, for eg., underground or elevated railways.

3.1.6. Group E Business Buildings:

These shall include any building or part of a building which is used for transaction of business (other than that covered by group F and part of buildings covered by 3.1.1.1) for keeping of accounts and records and similar purpose, professional establishments, service facilities, etc. city halls, town halls, court houses and libraries shall be classified in this group so far as the principal function of these is transaction of public business and keeping of books and records.

Business buildings shall be further sub-classified as follows:

Subdivision E-1: Offices, banks, professional establishments like offices of architects, engineers, doctors, lawyers and police stations;

Subdivision E-2: Laboratories, research establishments, libraries and test houses;

Subdivision E-3: Computer installation;

Subdivision E-4: Telephone exchanges;

Subdivision E-5: Broadcasting stations and T.V stations

3.1.7. Group F Mercantile Buildings:

These shall include any building or part of a building, which is used as shops, stores, market, for display and sale of merchandise, either wholesale or retail,

occupancies of temporary types, which are erected in large numbers and constructed of varied combustible materials in rural and urban areas in our country at all times of the year, for social, religious, political, recreational, commercial etc. congregations of people, have the worst record of loss of lives due to major fires. It has also been established that these heavy death tolls have been due to flagrant violations of the fire and life safety norms for such structures and pandals. This is an area which calls for more strict control and supervision on the part of Code enforcement authorities.

Sub Division D-6: This is a new subdivision which includes Mixed Occupancies known generally as ‘Multiplexes’ which abound in several fire and life hazards. More details on Multiplexes can be seen under F. 3.1.11 and F.3.4.7.

Sub Division D-7: This is also a new addition in this Code which includes underground or elevated rail systems which have their own distinct fire and life hazards

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Mercantile buildings shall be further sub classified as follows:

Subdivision F-1:

Shops, stores, departmental stores, markets, with area up to 500 m²;

Subdivision F-2:

Shops, stores, departmental stores, markets, with area more than 500 m².

Subdivision F-3:

Underground shopping centres. Storage and service facilities incidental to the sale of merchandise and located in the same building shall be included under this group.

3.1.8. Group G Industrial Buildings:

These shall include any building or part of a building or structure, in which products or materials of all kinds and properties are fabricated, assembled, manufactured or processed; for example, assembly plants, industrial laboratories, dry cleaning plants, power plants, generating units, pumping stations, fumigation chambers, laundries, buildings or structures in gas plant, refineries, dairies and saw-mills etc.

Building under Group G shall be further subdivided as follows:

Subdivision G-1:

Buildings used for low hazard industries.

Subdivision G-2:

Buildings used for moderate hazard industries.

Subdivision G-3:

Building used for high hazard industries.

The hazard of occupancy, for the purpose of the code shall be the relative danger of the start and spread of fire, the danger of smoke or gases generated, the danger of explosion or other occurrences potentially endangering the lives and safety of the occupants of buildings.

Hazard of occupancy shall be determined by the authority on the basis of the fire loads of the contents, and the processes or operations conducted in the building, provided, however, that where the combustibility of the building, the flame spread rating of the interior finish or other features of the building or structure are such as to involve a hazard greater than the occupancy hazard, the greater degree of hazard shall govern the classification.

For determination of fire loads and fire load density for arriving at the classification of occupancy hazard, guidance regarding the calorific values of some common materials, is given at Annex-A.

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F3.1.6. Group E: Business Buildings:

Inclusion of Broadcasting and TV stations, Telephone Exchanges, Test Houses, City Halls, Town Halls, Laboratories and Research Establishments, Courts and Libraries in this Group, needs to be specially noted.

F3.1.7

- (a) Hazards of shopping centres increase with their size, as evacuation of occupants and fire fighting become more difficult in large departmental stores.

Underground shopping centres are considered still more hazardous, because of difficulties in smoke extraction and fire fighting efforts. Also, evacuation becomes difficult as there is hardly any access for natural sun light in basements, and electricity is normally turned off in case of a fire.

- (b) In some of the international standards, apart from area of the building, number of storeys is also taken as a factor for reckoning sub divisions.

F3.1.8 Group G Industrial Buildings:

Eg. Buildings housing G-1 industries may need to comply with Group G-2 requirements if combustible interior finish materials are used, thereby increasing fire load of the building.

In case of mixed occupancies, housing G-1, G-2 & G-3 industries together, in the absence of partition walls and double fire doors between occupancies, it will be necessary to design the entire building on the basis of G-3 requirements.

- (a) **Sub Division G-1:**

This covers Low Hazard industries like Engineering Workshops, Ceramic factories etc.

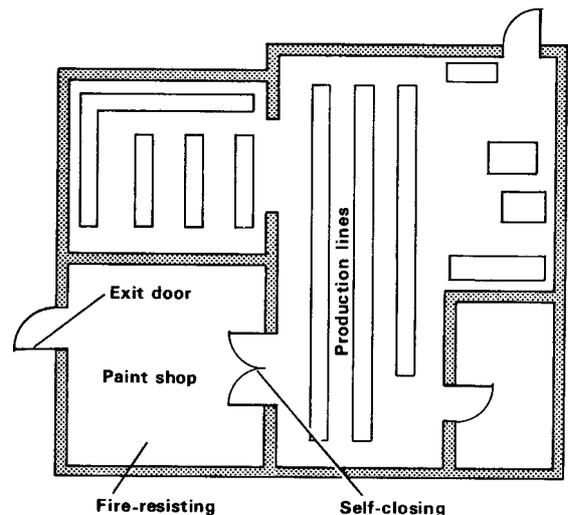


Fig. 3 Layout of a typical Engineering Workshop, showing compartmentation/segregation of a hazardous area like paint shop.

- (b) **Sub Division G-2:**

This covers Moderate Hazard industries like Aluminium factories, Cold Storages, Electric Generating Stations etc.

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A broad classification of industrial and non-industrial occupancies into low, moderate and high hazard classes is given at Annex B, for guidance. Any occupancy not covered in Annex-B, shall be classified in the most appropriate class depending on the degree of hazard.

Where different degrees of hazard of occupancy exist in different parts of building, the most hazardous of those shall govern the classification for the purpose of this Code, except in cases where hazardous areas are segregated or protected as specified in the Code.

- (a) Subdivision G-1: This subdivision shall include any building in which the contents are of such comparative low combustibility and the industrial processes or operations conducted therein are of such a nature that there are hardly any possibilities for any self-propagating fire to occur and the only consequent danger to life and property may arise from panic, fumes or smoke, or fire from some external source.
- (b) Subdivision G-2: This subdivision shall include any building in which the contents or industrial processes or operations conducted therein are liable to give rise to a fire which will burn with moderate rapidity or result in other hazardous situation and may give off a considerable volume of smoke, but from which neither toxic fumes nor explosions are to be feared in the event of fire.
- (c) Subdivision G-3: This subdivision shall include any building in which the contents or industrial processes or operations conducted therein are liable to give rise to a fire which will burn with extreme rapidity or result in other hazardous situation, or from which poisonous fumes or explosions are to be feared in the event of fire. For fire safety in petroleum and fertilizer plant, good practice [F.3] may be referred.

3.1.9. Group H Storage Buildings:

These shall include any building or part of a building used primarily for the storage or sheltering (including servicing, processing or repairs incidental to storage) of goods, ware or merchandise (except those that involve highly combustible or explosive products or materials), vehicles or animals; for eg., warehouses, cold storage, freight depots, transit sheds, store houses, truck and marine terminals, garages, hangars, grain elevators, barns and stables. Storage properties are characterised by the presence of relatively small number of persons in proportion to the area. Any new use which increases the number of occupants to a figure comparable with other classes of occupancy,

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(c) Sub Division G-3:

This covers High Hazard industries like Cotton Waste factories, Explosive factories, Fire Works manufacture, Petroleum Refineries, Oil Installations etc.

- (d) The Bureau of Indian Standards, under its Fire Safety Sectional Committee, CED-36, had formulated several Indian Standards on Codes of practices on Fire Safety of various industries prescribing detailed guidelines on fire safety and fire protection requirements for such industries.(given in Annex-F)

F3.1.8. Fire load:

Fire load is the measure of the maximum heat that would be released if all combustibles in a given fire area, burn. The calorific value is the heat of combustion of a material or substance. In a typical building, the fire load includes combustible contents, interior finish and structural elements. Fire load in a building has a significant influence in the severity, rate of fire spread and duration of fire subject to prevailing ventilation conditions.

F3.1.9. Group H Storage Buildings:

- (a) The fire load in this occupancy class will vary according to the type of material(s) stored. In these types of occupancies, generally material hazards are more than life hazards.
- (b) It is possible that materials of various fire hazard characteristics may be stored in the same building in which case, proper segregation and compartmentation is required to be ensured.
- (c) Inclusion of storage of animals, marine terminals, aircraft hangars and grain elevators in this group, should be taken special note of;
- (d) These become special risks during non-working hours, because generally they remain unoccupied

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shall change the classification of the building to that of the new use; for eg., hangars used for assembly purposes, warehouses used for office purposes, garage buildings used for manufacturing, etc.

3.1.10. Group J Hazardous Buildings:

These shall include any building or part of a building, which is used for the storage, handling, manufacture or processing of highly combustible or explosive materials or products which are liable to burn with extreme rapidity and (or) which may produce poisonous fumes or explosions on storage/handling, manufacturing or processing. These include highly corrosive, toxic or noxious alkalis, acids or other liquids or chemicals producing flames, fumes and explosive, poisonous, irritant or corrosive gases; and materials producing explosive mixtures of dust which result in the division of matter into fine particles subject to spontaneous ignition. Examples of buildings in this class are those buildings which are used for :

- (a) Storage under pressure of more than 0.1 N/mm² and in quantities exceeding 70m³, of acetylene, hydrogen, illuminating and natural gases, ammonia, chlorine, phosgene, sulphur dioxide, carbon dioxide, methyloxide and all gases subject to explosion, fume or toxic hazard, cryogenic gases, etc.
- (b) Storage and handling of hazardous and highly flammable liquids, liquifiable gases like LPG, rocket propellants, etc.
- (c) Storage and handling of hazardous and highly flammable or explosive materials, other than liquids; and
- (d) Manufacture of artificial flowers, synthetic leather, ammunition, explosives and fireworks.

NOTE- A list of hazardous substances giving quantities, for which or exceeding which owners handling such substances are required to be covered under the -Public Liability Insurance Act, has been notified under Govt of India, Ministry of Environment and Forest Notification No.GSR 347 (E) dated 01 August 1996.

3.1.11. Any building not covered by Annex B or 3.1.8. shall be classified in the group which most nearly resembles its existing or proposed use.

3.1.12. Where change in the occupancy of any building places it in a different group or in a different subdivision of the same group, such building shall be made to comply with the requirements of the code for the new group or its subdivision.

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during this period;

- (e) Therefore, installation of fire alarm systems and sprinklers in such occupancies can be of great advantage.

F3.1.10. Group J Hazardous Buildings:

- (a) Hazardous Buildings involve highly combustible, those susceptible to spontaneous combustion and explosive materials which are dangerous from fire and life safety considerations;
- (b) Toxic, poisonous and corrosive fumes are injurious to human health and may prove fatal also;
- (c) Fire and life safety deals with protection of both human lives and property, and hence the buildings storing, handling, manufacturing or processing hazardous materials are placed in this group of buildings posing the highest hazard;
- (d) As per Public Liability Insurance Act, owners of these industries are required to take out a Compulsory Liability Insurance Policy with Insurers in India, whereby surrounding population/community at large, are compensated if they are affected by a leak, fire or explosion in these industries.

F3.1.11. In many of our major cities, Multiple occupancies, or what are commonly known as "Multiplexes" have come up, which are buildings having independent occupancies like Shopping Centre, Cinema, Restaurants etc., simultaneously in one building complex. These multiple occupancies contain high fire and life hazard potential, and hence call for stringent fire prevention and fire protection measures, which should engage due attention and care from the local authorities concerned.

F3.1.12

- (a) This most important aspect is often overlooked many a times inadvertently, but with serious consequences.
- (b) If new occupancy is more hazardous than the old one, the building must be made to comply with requirements of the new occupancy.
- (c) As is the international practice, as well as in our metro cities like Delhi and Mumbai, mandatory provisions should be included in all local Building Bye-laws/Urban Development Control Regulations, to the effect that the owner or the occupier shall apply in writing to the local authorities concerned for any alteration, modification, extension etc., of the building along with necessary drawings, specifications etc., and obtain necessary clearance for the same from the authorities concerned.

F3.1.14. Similarly, after completion of the work also, a Completion Certificate should be countersigned by the designated authorities after inspection.

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3.1.13. Where the new occupancy of a building is less hazardous, based on life and fire risk, than its existing occupancy, it shall not be necessary to conform to the requirements of the Code for the old group or its subdivisions.

3.1.14. A certificate of occupancy shall be necessary, as required under Part 2 Administration, before any change is effected in the character of occupancy of any building.

3.2. Fire Zones:

3.2.1. Demarcation:

The city or area under jurisdiction of the authority shall, for the purpose of the Code, be demarcated into distinct Zones, based on fire hazards inherent in the buildings and structures according to occupancy (see 3.1), which shall be called as 'Fire Zones'.

3.2.2. Number and Designation of Fire Zones:

3.2.2.1. The number of fire zones in a city or area under the jurisdiction of the authority depends upon the existing layout, types of building construction(see 3.3), classification of existing buildings based on occupancy(see 3.1) and expected future development of the city or area. In large cities or areas, three fire Zones may be necessary, while in smaller ones, one or two may be adequate.

3.2.2.2 The fire zones shall be made use of in land use development plan and shall be designated as follows:

- (a) Fire Zone No. 1,
- (b) Fire Zone No. 2, and
- (c) Fire Zone No.3

3.2.2.2.1. Fire Zone No. 1:

This shall comprise areas having residential (Group A), educational (Group B), institutional (Group C), assembly (Group D), small business (Subdivision E-1) and retail mercantile (Group f) buildings or areas which are under development for such occupancies.

3.2.2.2.2. Fire Zone No.2:

This shall comprise business (subdivision E-2 to E-5) and industrial buildings (Subdivision G-1 and G-2), except high hazard industrial buildings (Subdivision G-3) or areas which are under development for such occupancies.

3.2.2.2.3. Fire Zone 3.

This shall comprise areas having high hazard industrial buildings (subdivision G-3), Storage

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F3.2 Fire Zones:

F3.2.2.2.1. Fire Zone No.1:

Occupancies listed under Fire Zones 2 & 3 cannot be allowed in Fire Zone No.1.

F3.2.2.2.2 Fire Zone No.2

Occupancies listed under Fire Zones 1& 3 cannot be allowed in Fire Zone No.2

F3.2.2.2.3 Fire Zone No.3

Occupancies listed under Fire Zones 1 & 2 cannot be allowed in Fire Zone No.3

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buildings(Group H) and buildings for hazardous uses (Group J) or areas which are under development for such occupancies.

3.2.3. Change in the Fire Zone Boundaries:

When the boundaries of any Fire Zone are changed, or when it is intended to include other areas or types of occupancies in any Fire Zone, it shall be done by following the same procedure as for promulgating new rules or ordinances or both.

3.2.4. Overlapping Fire Zones:

3.2.4.1. When any building is so situated that it extends to more than one Fire Zone, it shall be deemed to be in the Fire Zone in which the major portion of the building or structure is situated.

3.2.4.2. When any building is so situated that it extends equally to more than one fire zone, it shall be deemed to be in the fire zone having more hazardous occupancy buildings.

3.2.5. Temporary Buildings or Structures:

3.2.5.1. Temporary buildings and structures shall be permitted only in Fire Zones No. 1 and 2 as the case may be, according to the purpose for which these are to be used, by special permit from the Authority for a limited period subject to such conditions as may be imposed in the permit.

3.2.5.2. Such buildings and temporary structures shall be completely removed on the expiry of the period specified in the permit.

3.2.5.3 Adequate fire precautionary measures in the construction of temporary structures and PANDALS shall be taken in accordance with good practice Annexe-F (4).

3.2.6 Restrictions on the Type of Construction for New Buildings:

3.2.6.1 Buildings erected in Fire Zone No.1 shall conform to construction of Type 1,2,3 or 4.

3.2.6.2 Buildings erected in Fire Zone No.2 shall conform to construction of Type 1, 2 or 3.

3.2.6.3 Buildings erected in Fire Zone No.3 shall conform to construction of Type 1, or 2.

3.2.7. Restrictions on Existing Buildings:

The existing buildings in any fire zone shall not be required to comply with the requirement of the Code unless these are altered, or in the opinion of the Authority such building constitutes a hazard to the safety of the adjacent property or the occupants of the building itself or is an unsafe building. In the event of alteration, it shall be necessary to obtain permission of the Authority for such alteration consistent with fire

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F3.2.5.1. Temporary Buildings or Structures:

- (a) These structures are themselves so hazardous that they cannot be allowed under Fire Zone No.3, which is reserved for high hazard industrial & storage buildings
- (b) As mentioned earlier under 3.1.5(e) & (f), from past and continuing experience, it is an established and alarming fact that temporary structures and buildings of various types and sizes are erected in large numbers in urban and rural areas in our country. They are constructed from a variety of combustible and hazardous materials throughout the year for social, religious, political, recreational, commercial etc congregations of people, and number of them get involved in major fires causing heavy loss of lives. These tragic incidents had happened as a result of gross violation of the safety norms prescribed for such temporary structures and pandals.

F3.2.6.3. Buildings used for hazardous industrial and storage occupancies need better construction to take care of their inherent hazards, and hence this requirement

F3.2.7 Restrictions on existing buildings:

- (a) The first part of this sub clause regarding non-requirement of Code compliance for the existing buildings, is highlighted in many of our local Building Codes/Regulations, whereas the latter part of the clause implying compliance of the Code (NBC Part IV), **even for existing buildings which are hazardous or unsafe**, which is repeated under sub clause 3.8 of Part II Administration of NBC, is either diluted, ignored or omitted in many of them.
- (b) Besides, the term “existing building” is defined in many Codes/Regulations as buildings which had existed prior to the date of enforcement of the Code/Regulation concerned. As and when these Codes/Regulations undergo revision, the definition of existing building remains the same although the date of enforcement gets shifted to a subsequent date. The end result had been that the so called “existing buildings” which enjoy the benefit of exemptions from several important provisions of the Code/Regulation including fire and life safety provisions, continue to do so, thereby not only making the Code enforcement process difficult but, more importantly, adding to the number of hazardous and unsafe buildings in the area, which are dangerous to human life, health, property and public welfare.
- (c) To avoid the perpetuation of such unsatisfactory and precarious conditions, it is imperative that the following correctional steps are implemented by all concerned authorities:
 - (i) A suitable date may have to be identified for notification of the applicability of the Code/Regulation (cut -off date for applicability), which has to be adhered to even when the Code/Regulation concerned gets revised. This is what has been done

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in the case of Delhi Building Bye-laws, which clearly stated that all buildings constructed after 2nd March 1987, have to follow the Delhi Building Bye-laws 1983, and the old buildings are governed by Delhi Fire Services Act where they have to incorporate 12 basic fire protection requirements.

- (ii) The existing buildings and structures should be inspected for fire and life safety requirements and the provisions of the Code made applicable to them where any one of the following conditions exist:
 - a change of use or occupancy of the building structure;
 - renovations/modifications, reconstruction or additions have been made;
 - the building/structure has been re-located;
 - the building is found lacking in basic requirements of fire and life safety measures;
 - the building/structure is considered **unsafe** and a threat to life, health and welfare of the occupants and (or) members of the public.

(d) Unsafe Building:

In this connection, it is mentioned that very clear and stringent instructions as to how the authorities concerned should deal with “unsafe buildings” in their jurisdiction are contained in Part 2, Administration of NBC. This clause even includes provisions for giving Notice to Owner/Occupier, as well as for actions to be taken by the authority in the event of disregard of Notice by the Owner/Occupier.

Considering the importance of the contents of this clause, which will contribute substantially to the upgradation of fire and life safety standards, especially in the urban areas in our country, the same is reproduced below for information and guidance:

Clause 15 of Part 2, NBC -UNSAFE BUILDING

“15.1. All unsafe buildings shall be considered to constitute danger to public safety and shall be restored by repairs or demolished or dealt with as otherwise directed by the Authority.”

“15.2. Examination of unsafe building:

The Authority shall examine or cause to be examined every building reported to be unsafe or damaged, and shall make a written record of such examination.”

“15.3. Notice to Owner/Occupier:

Whenever the Authority finds any building or portion thereof to be unsafe, it shall, in accordance with established procedure for legal notice give to the owner and occupier of such building written notices stating the defects thereof. This notice shall require the owner or the occupier within a stated time either to complete specified repairs or improvements or to demolish and remove the building or portion thereof.”

“15.3.1. The Authority may direct in writing that the building which in his opinion is dangerous, or has no provision for exit if caught fire, shall be vacated immediately or within the period specified for the purpose;

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provided that the Authority concerned shall keep a record of the reasons for such action with him.

If any person does not comply with the orders of vacating a building, the Authority may direct the police to remove the person from the building and the police shall comply with the orders.

“15.4. Disregard of Notice:

In case the owner or occupier fails, neglects, or refuses to comply with the notice to repair or to demolish the said building or portion thereof, the Authority shall cause the danger to be removed whether by demolishing or repair of the building, or portion thereof or otherwise.”

“15.5. Cases of Emergency:

In case of emergency, which, in the opinion of the Authority involves imminent danger to human life or health, the decision of the Authority shall be final. The Authority shall forthwith or with such notice as may be possible, promptly cause such building or portion thereof to be rendered safe or removed. For this purpose, the Authority may at once enter such structures or land on which it stands, or abutting land or structure, with such assistance and such cost as may be deemed necessary. The Authority may also get the adjacent structures vacated and protect the public by an appropriate fence or such other means as may be necessary.”

“15.6. Costs:

Costs incurred under 15.4 & 15.5 shall be charged to the owner of the premises involved. Such costs shall be charged on the premises in respect of which or for the benefit of which the same have been incurred and shall be recoverable as provided under the laws(See Note).

Note: The cost may be in the form of arrears of taxes.”

Information Note No. E/F3.2.7 (For information only)

E.1 What has been mentioned above, has been the international practice also.

As per NFPA 5000-2003, Unsafe Buildings are those which are:

- (i) deficient in means of egress;
- (ii) has a potential hazard from fire or natural or man-made threats;
- (iii) dangerous to human life or public welfare by reasons of illegal or improper use, occupancy or maintenance;
- (iv) non compliance with the provisions of the applicable Codes;
- (v) Significantly damaged by fire or explosion or other natural or man-made cause;
- (vi) incomplete buildings for which building permits have expired;
- (vii) buildings having deteriorated structural elements or partially destroyed buildings;
- (viii) unsanitary buildings

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hazard (see Part 2 Administration).

Alterations/Modifications/Renovations shall be accomplished so as to ensure conformity with all the safety requirements of the new buildings. Such alterations shall not in anyway bring down the level of fire and life safety below that which existed earlier. Any addition or alterations or construction of cubicles or partitioning for floor area exceeding 500 m² for all high rise buildings shall be with approval of local fire authority.

3.3 Types of Construction:

3.3.1 General:

The design of any building and the type of materials used in its construction are important factors in making the building resistant to a complete burn-out and in preventing the rapid spread of fire, smoke and fumes, which may otherwise contribute to the loss of lives and property.

The fire resistance of a building or its structural and non-structural elements is expressed in hours against a specified fire load which is expressed in kcal/m², and against a certain intensity of fire. The fire-resistance test for structural elements shall be done in accordance with good practice [F(5)]. For the purpose of the code, the types of construction according to fire resistance shall be classified into four categories, namely, Type-1 construction, Type - 2 construction, Type 3 construction and Type 4 construction. The fire resistance ratings for various types of construction for structural and non-structural members shall be as given in Table 1. (given at the end).

For buildings 15m in height or above non-combustible materials should be used for construction and the internal walls of staircase enclosures should be of brick work or reinforced concrete or any other material of construction with minimum of 2h rating. The walls for the chimney shall be of Type-1 and Type-2

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F3.3.1 General:

- a) IS: 1809-1979 deals with methods of testing structural members of different material for their fire safety. For fire resistance ratings required for various structural and non-structural members to be used for different classes of construction, please refer to Tables 2-18 (given at the end).
- b) The fire resistance (also described as "fire endurance") is the time duration the member or assembly can withstand the fire test without failure.

The usual fire resistance ratings for structural assemblies, members, doors etc. are: 1/2 hr., 1hr., 2hrs., 3hrs. & 4 hrs. A 1hr. rating indicates that the assembly/member can withstand the standard test for minimum 1hr. without failure by any one of the failure criteria listed in the fire test protocol (as given under 2.18. For eg., A test result showing:

- Stability - 120
- Integrity - 120 (See Note below)
- Insulation - 15

would mean that a specimen failed in respect of insulation after 15 mins., but complied with the other 2 criteria for atleast 120 mins.

Note: (for information only)

These were the 3 criteria originally adopted from BS 476 Part 8. However, BS 4422 Part-2, which was subsequently published, replaced these 3 terms with:

- (i) resistance to collapse (for stability)
- (ii) resistance to flame penetration (for integrity)
- (iii) resistance to excessive temperature rise on the unexposed face (for insulation).
- (c) Building design and construction concepts and practices, besides ensuring the safety of buildings against the effects of fire outbreaks, have also to cater to the structural stability requirements of earthquake resistance (especially in earthquake prone zones) as well as to wind loads. These are adequately covered in Part VI, NBC, "Structural Design", and other relevant Indian Standards.
- (d) Apart from the above, special requirements with regard to design and construction of certain building components to provide a "barrier free environment" in public buildings, so as to facilitate more easy access, movement and use of physically challenged/ disabled persons, are also to be ensured. Detailed guidelines on these aspects are contained in Annex-E of Part-III of NBC, "Development Control Rules and General Building Requirements". A copy of Govt. of India Ministry of UD and PA (Delhi Division) Notification dated 28th August 2002 incorporating suitable modifications to Delhi Building Byelaws 1983 in this regard, is given at Annex-H for information and guidance.

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construction depending on whether the gas temperature is above 200°C or less.

3.3.2. It is required that an element / component shall have the requisite fire resistance rating when tested in accordance with the accepted standard [4(1)]. The Tables 2 to 18 provide available data regarding fire resistance ratings of various building components such as walls, columns, beams and floors. Fire damage assessment, post fire structural safety assessment of various structural elements of the building and adequacy of the structural repairs can be done by the fire resistance ratings mentioned in the Tables.

3.3.3. Steel Construction:

Load bearing steel beams and columns of buildings having total covered area of 500m² and above shall be protected against failure/ collapse of structure in case of fire. This could be achieved by use of appropriate methodology using suitable fire resistance rated materials along with suppression system (C-Table 14, Table 15 and also accepted standards [F(5)].

3.4. General Requirements of All individual Occupancies:

3.4.1. General:

All buildings shall satisfy certain requirements which contribute, individually and collectively, to the safety of life from fire, smoke, fumes and panic arising from these or similar causes. There are, however, certain general principles and common requirements which are applicable to all or most of the occupancies.

3.4.2 Exceptions and deviations:

Exceptions and deviations to the general provisions of requirements of individual occupancies are given as applicable to each type of occupancy in 6.1 to 6.9 In case of practical difficulty or to avoid unnecessary hardship, without sacrificing reasonable safety, the authority may grant exemptions from the Code.

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F3.3.2. Even at the cost of repetition, uses of these Tables 2-18 need special mention as follows:

- to assess the stability of building damaged by fire;
- before declaring a building damaged by fire which has undergone repairs, as safe.

F3.3.3 Steel Construction:

- (a) Unprotected structural steel loses its strength at high temperatures. Often, a temperature of 1100°F(593°C) is taken as the critical temperature of the structural steel at which temperature it loses about two thirds of its strength. Unprotected light weight sections, such as those found in trusses and open-web joints, can collapse even after 5 to 10 mins. exposure in major fires.
- (b) Encasement of structural steel member has been a very common and satisfactory method of insulating steel to increase its fire resistance. Encasement of structural steel members can be done utilising concrete, lath and plaster, gypsum board or sprayed mineral fibres. Another method is by installing “membrane barriers” or sheet steel membrane



Fig. 04. Steel work affected by fire.

F3.4. General Requirements of all individual Occupancies:

F3.4.1. General:

Three main hazards, those of fire, smoke or fumes and panic from which human life and property are to be saved, need to be particularly noted. The whole of Part 4 NBC aims to tackle these problems in case of a fire emergency.

F3.4.2 Exceptions and Deviations:

- a) Exceptions and deviations to the general provisions of fire and life safety requirements for individual occupancies are given in the following classes of occupancies:

- 6.2- Educational Buildings
- 6.3-Institutional Buildings
- 6.4-Assmby Buildings
- 6.5- Business Buildings
- 6.6-Mercantile Buildings
- 6.7-Industrial Buildings

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3.4.3. Occupation of Buildings under Construction:

3.4.3.1. A building or portion of building may be occupied during construction, repairs, alterations or additions, only if all means of exit and fire protection measures are in place and continuously maintained for the occupied part of the building.

3.4.3.2. A high rise building during construction shall be provided with the following fire protection measures, which shall be maintained in good working condition at all the times:

- a) Dry riser of minimum 100mm diameter pipe with hydrant outlets on the floors constructed with a fire service inlet to boost the water in the dry riser and maintenance should be as per the requirements laid down in good practice [F(6)].
- b) Drums filled with water of 2000 liters capacity with two fire buckets on each floor;
- c) A water storage tank of minimum 20000 liters capacity, which may be used for other construction purposes also.

3.4.4. Maximum Height:

Every building shall be restricted in its height above the ground level and the number of storeys, depending upon its occupancy and the type of construction. The height shall be measured as specified in Part 3 Development Control Rules and General Building Requirements. The maximum permissible height for any combination of occupancy and types of construction should be necessarily be related to the width of street fronting the building, or floor area ratios and the local fire fighting facilities available. For fire protection requirements of high rise buildings. Annex 'C' may be referred.

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6.8-Storage Buildings

- b) In so far as Part 4 of NBC is concerned, these exceptions and deviations wherever specified, have been included after due care and thought to take into account particularly the change(s) in the use or utilisation on the part of the occupancy, like a basement.
- c) Over and above the exceptions and deviations in all the 7 classes of occupancies, "Additional Precautions" as necessary in each of the classes have been specified. These provide useful information and guidance for the proper implementation of the Code provisions.
- d) However the second part of this sub clause empowering the Authority for granting 'exemptions' from the Code provisions has more often been misused in so far as the implementation of the local Codes and Regulations are concerned. This has invariably been due to the pressure and influence exerted by vested interests over the Authorities concerned.
- e) There had been some judicial interventions also to nullify certain unjustified and irrational exemptions granted by State Govts/ Local Authorities. For instance, in August 2000, the Supreme Court had quashed some 62 Govt. Orders issued by Tamil Nadu Govt. between 1/7/1971 and 29/1/1998 under Section 113 under the Tamil Nadu Town & Country Planning Act 1971, granting exemptions to a large number of buildings from the 1971 Act provisions, including illegal constructions.

F3.4.3. Occupation of Buildings Under Construction:

- (a) Detailed Instructions on "Safety Against Fire and Fire Protection for Buildings under Construction" are given in Part-7 "Constructional Practices and Safety" under NBC, which is also currently under revision. Besides, useful guidance material is also available in IS:13416 Part 5 1994 "Recommendations and Preventive Measures against Hazards in Work places Part-5 Fire Protection"
- (b) This is a very important requirement to be followed in case of buildings under construction.

Classification of buildings under construction or repairs gets temporarily downgraded because of opening up of walls, roofs etc.

F3.4.4 Maximum Height:

Maximum height restrictions of buildings are primarily governed by the class of occupancy. They are given under notes of Table-23.(given at the end) The same information is repeated below:

- Buildings above 15m. : Not permitted for occupancies A1, A2, G3, Groups H & J
- Buildings above 30 m: Not permitted for Groups B, C, D & F
- Buildings above 18 m: Not permitted for G-1 & G-2 Occupancies.
- Buildings above 60 m: Not permitted for A3 & A4 Occupancies.

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3.4.5. Floor Area Ratio:

The comparative floor area ratios for different occupancies and types of construction are given in Table-19 (see also part 3 Development Control Rules and General Building Requirements).

3.4.5.1. Each portion of a building, which is separated by one or more continuous fire resisting walls, having a fire resistance of not less than 2 h., extending from the foundation to 1 m above the roof at all points, may be considered to be a separate building for the calculation of maximum permissible height and the floor area, provided openings, if any, in the separating wall are also protected by fire assemblies of not less than 2 h.

3.4.6. Open Spaces:

The open spaces around or inside a building shall conform to the requirements of Part-3 Development Control Rules and General Building Requirements.

3.4.6.1. For high rise buildings, the following additional provisions of means of access to the building shall be ensured (see Part 3 Development Control Rules and General Building Requirements):

- (a) The width of the main street on which the building abuts shall not be less than 12m and one end of this street shall join another street not less than 12m in width;
- (b) The road shall not terminate in a dead end; except in the case of residential building, up to a height of 30m.
- (c) The compulsory open spaces around the building shall not be used for parking; and
- (d) Adequate passageway and clearances required for fire fighting vehicles to enter the premises shall be provided at the main entrance; the width of such entrance shall be not less than 4.5 m. If an arch or covered gate is constructed, it shall have a clear head-room of not less than 5m.

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- No height restrictions for buildings in A5, A6 & Group E

F3.4.6 Open Spaces

In Part-3 NBC clause 5 deals with community open spaces and amenities, clause 6 with requirements of plots, and clause 8 with open spaces within a plot.

Some of the salient data specified in these clauses are appended below for information and guidance:
“Clause 5 Part 3 NBC-Community Open Spaces and Amenities.

“In Residential and Commercial Zones, the following minimum provisions shall be made for community open spaces(for recreational purposes):

- (a) 15% of the area of the lay-out; or
- (b) 0.3 to 0.4 ha/1000 persons; for low income housing the open spaces shall be 0.3ha/1000 persons.

In Industrial Zone: In all industrial plots measuring 1000m² or more in area, 10% of the total area shall be provided”.

“5.5 Other amenities:

- For all types of educational institutions, minimum areas for the institutional buildings, residential accommodation, playfield area, area for the institution etc., have been spelt out based on student strength;
- For LPG godowns, one gas godown for 40000 to 50000 population has been prescribed;
- Similarly, the scales for Petrol Pumps have been given;
- One Fire Station or Sub Fire Station within 1km to 3kms. for every 200,000 population has been prescribed with the following requirements;
- Area for Fire Station with essential residential accommodation-1.00 ha;
- Area for Sub Fire Station with essential residential accommodation - 0.60 ha”.

F3.4.6.1.

- (a) The details of means of access for building/plot are given under clause-4 of Part-3 NBC.
- (b) Apart from the requirements given under (a), (b), (c) & (d) here, the additional requirements given under clause 4.6 of Part-3 are:

“The approach to the building and open spaces on all its sides upto 6m width and the layout of the same shall be done in consultation with the Chief Fire Officer of the city, and the same shall be of hard surface capable of taking the mass of fire engine weighing upto 45 tonnes. The said open space shall be kept free of obstructions and shall be motorable”.

“The main entrance to the plot shall be of adequate width to allow easy access to the fire engine and in no case shall it measure less than 6 m.....
 If the main entrance at the boundary wall is built over, the minimum clearance shall be 4.5m. A turning

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3.4.7. Mixed Occupancy:

When any building is used for more than one type of occupancy in so far as fire safety is concerned, it shall conform to the requirements for the occupancies of higher hazard. Unless the high hazard area is separated by separating walls of 4h rating, the occupancies shall not be treated individually.

3.4.8. Openings in separating Walls and Floors:

At the time of designing the openings in separating walls and floors, particular attention shall be paid to all such factors as will limit fire spread through these openings and maintain fire rating of the structural member.

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radius of 9m. shall be provided for fire tender movement”.

- c) If entrance gate is of lesser dimension, fire engine with their ladders cannot negotiate them in case of emergency.
- d) In one particular case of a textile mill in Mumbai, the entrance arch of the mill had to be demolished before fire engines could enter, causing serious aggravation of the fire resulting in total loss of that property.

F3.4.7. Mixed Occupancy:

Mixed occupancy clause of buildings warrant an in-depth assessment of the nature and types of fire as well as life safety hazards existing in such buildings. A mixed occupancy implies a multiple occupancy where the occupancies are intermingled or, where in one building 2 or more classes of occupancies exist.

Information note No. F/F3.4.7:

F.1 A typical example of a mixed occupancy is a covered mall building, which is a single building enclosing a number of tenants and occupancies such as mercantile units, restaurants, entertainments and amusement facilities, offices, clinical laboratories etc. This can be a high rise building also.

F.2 In many of our cities, the number and variety of such mixed or multiple occupancies are increasing fast. A recent development is the growth of so-called “multiplexes”, which are in fact one multi-level building complex, having multiple occupancies like cinema theatre, shopping complex, hotel/restaurants, and may be a few other ancillary occupancies. The unusually high fire and life hazards in such multiplexes can well be imagined. Consequently, the design and construction of the building, as well as the fire protection and life safety measures incorporated in the building, shall be of very high standards. Equally important shall be the requirement for regular inspection and maintenance of the various safety features incorporated in the building. Necessary guidance and advice in regard to the above requirements should be sought from the local fire authorities, including guidance and assistance for conducting practical training sessions and mock drills for the staff involved.

F-3 Considerable progress had been made in the developed countries in specifying/recommending details of various fire protection requirements for such mixed occupancy premises of different combinations. This information is available for guidance purposes in NFPA and UK standards and publications.

F3.4.8 Openings in Separating Walls & Floors

It is imperative that the openings in the separating walls and floors have to be properly closed or sealed with fire doors or fire stops using materials of adequate fire resistance, if the separating walls and floors have to effectively fulfil their designated role of compartmentation, by providing and maintaining the required fire rating of the structural member.

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3.4.8.1. For types 1 to 3 construction, a doorway or opening in a separating wall on any floor shall be limited to 5.6 m² in area with a maximum height/width of 2.75 m . Every wall opening shall be protected with fire-resisting doors having the fire rating of not less than 2h in accordance with accepted standard [F(7)]. All openings in the floors shall be protected by vertical enclosures extending above and below such openings, the walls of such enclosures and all openings therein being protected with a fire-resisting assembly as specified in 3,4.9.

3.4.8.2. For Type 4 construction, openings in the separating walls or floors shall be fitted with 2 hr fire-resisting assemblies.

3.4.8.3. Openings in walls or floors which are necessary to be provided to allow passages of all building services like cables, electrical wirings, telephone cables, plumbing pipes etc. shall be protected by enclosure in the form of ducts/ shafts having a fire resistance of not less than 2 hr. The inspection door for electrical shaft/ducts shall be not less than 2hrs. and for other services shafts/ ducts, the same shall have fire resistance not less than 1hr. Medium and low voltage wiring running in shafts/ducts, shall either be armoured type or run through metal conduits. Further, the space between the conduits pipes and the walls/ slabs shall be filled in by a filler material having fire resistance rating of not less than one hour.

Note:- In case of buildings where it is necessary to lower or lift heavy machinery or goods from one floor to the other, it may be necessary to provide larger openings in the floor. Such openings shall be provided with removable covers which shall have the same strength and fire resistance as the floor.

3.4.8.4. Vertical Opening:

Every vertical opening between the floors of a building shall be suitably enclosed or protected, as necessary, to provide the following:

- a) Reasonable safety to the occupants while using the means of egress by preventing spread of fire, smoke, or fumes through vertical openings from floor to floor to allow occupants to complete their use of the means of egress. Further, it shall be ensured to provide a clear height of 2100mm in the passage/ escape path of the occupants.
- (b) Limitation of damage to the building and its contents.

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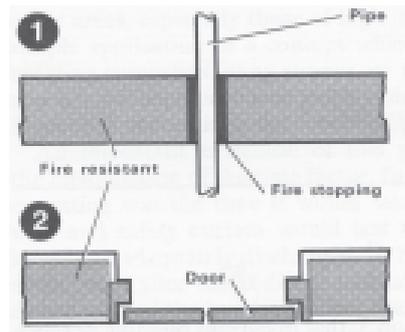


Fig. 05. Use of Fire Stops (i) and Fire Doors (ii) or closing openings in separating walls.

F3.4.8.1. In case the opening size exceeds 5.6m², fire resisting doors designed to protect them need to be adequately strengthened. Normally doors with larger panel areas, tend to buckle in fire conditions.

F3.4.8.4. Vertical opening:

- a) In a building fire vertical openings like stairs and lift shafts acts as flues or chimneys conveying flames hot gases and smoke vertically and serve as channels for easy spread to the upper levels. Hence, the need for enclosure or protection of such vertical shafts to prevent fire spread to other areas and floors served by them.

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3.4.9. Fire Stop or Enclosure Of Openings:

Where openings are permitted, they shall not exceed three-fourth the area of the wall in case of an external wall, and they shall be protected with fire resisting assemblies or enclosure, having a fire resistance equal to that of the wall or floor in which these are situated. Such assemblies and enclosures shall also be capable of preventing the spread of smoke or fumes through the openings so as to facilitate the safe evacuation of building in case of a fire {see also accepted standard [F(8)].

3.4.10. Electrical installations:

For requirements regarding electrical installations from the point of view of fire safety, reference may be made to good practice [F(9)] (see also NBC Part-8 Building Services, Section 2 Electrical and allied installations).

3.4.11. Air-conditioning and Ventilation:

Air-conditioning and Ventilation requirements of different rooms or areas in any occupancy shall be as given in Part-8 Building Services, Section 1 Lighting and Ventilation, and Section 3 Air-conditioning, Heating and Mechanical Ventilation.

3.4.11.1. Air-conditioning and Ventilation System shall be so installed and maintained as to minimise the danger of spread of fire, smoke or fumes from one floor to other from outside to any occupied building or structure (See C.1.17).

3.4.11.2. Air-conditioning and ventilating systems circulating air to more than one floor or fire area shall be provided with dampers designed to close automatically in case of fire, and thereby preventing spread of fire or smoke and shall be in accordance with the accepted standards [F(10)]. Such a system shall also be provided with automatic controls to stop fans in case of fire, unless arranged to remove smoke from a fire, in which case these shall be designed to remain in operation.

3.4.11.3. Air-conditioning system serving large places of assembly (over 1000 persons), large departmental stores or hotels with over 100 rooms in a single block shall be provided with effective means for preventing circulation of smoke through the system in case of a fire in air filters or from other sources drawn into the systems, and shall have smoke sensitive devices for actuation in accordance with the accepted standards [F(12)].

3.4.11.4. From the fire safety point of view, it shall be **necessary** to provide separate air handling units for the various floors so as to avoid the hazards

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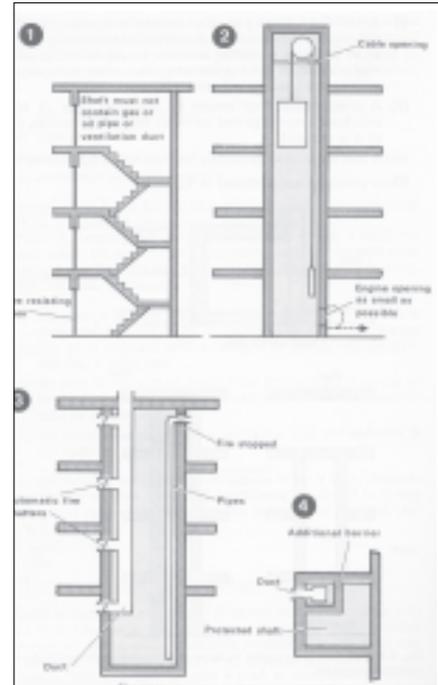


Fig. 06. Protected Shafts (i) Staircase Shaft (ii) Lift Shaft (iii & iv) Shaft for vent ducts

- b) Door openings at every floor level leading to staircases or lifts/lift lobbies should be protected by single fire doors for safe evacuation of occupants in case of fire emergency.

F3.4.9. Fire stop or enclosure of openings:

Total areas of windows and door openings in external walls of a building should not exceed 75% of wall area for stability of structure and for reducing exposure hazards to adjoining property.

F3.4.10 Electrical Installations:

Since faulty or non-standard electrical installations account for over 25% of fire outbreak in buildings, it is highly essential that provisions contained in IS 1646 of 1997, "Code of Practice for Fire Safety of Buildings (General): Electrical Installations" and the other references quoted are scrupulously complied with. It is also equally important that these installations are periodically inspected and maintained, to ensure perfect serviceability at all times.

F3.4.11.1. Any system of mechanical ventilation should be designed to ensure that in a fire the air movement in the building is directed away from the protected escape routes and exits, or that the system is closed down as necessary.

F3.4.11.4. Centralised air-conditioning system can engulf the entire building, i.e., all its floors, as fire can easily spread via airconditioning ducts and airconditioning plants via supply and return air ducts. It is, therefore recommended that separate airconditioning plants be provided for each of the floors.

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arising from spread of fire and smoke through the air-conditioning ducts. The requirements of air-conditioning ducts shall be in accordance with good practice.[F (11)]

3.4.11.5. For normal operation, air changes schedule shall be as given in Part-8 Building Services, section 3 Air-conditioning, heating and mechanical ventilation.

3.4.12. Smoke Venting:

3.4.12.1 Smoke venting facilities for safe use of exits in windowless buildings, underground structures, large area factories, hotels and assembly buildings (including cinema halls) shall be automatic in action, with manual controls in addition.

3.4.12.2. Natural draft smoke venting shall utilise roof vents or vents in walls at or near the ceiling level; such vents shall be normally open, or, if closed, shall be designed for automatic opening in case of fire, by release of smoke sensitive devices.

3.4.12.3. Where smoke venting facilities are installed for purposes of exit safety, these shall be adequate to prevent dangerous accumulation of smoke during the period of time necessary to evacuate the areas served, using available exit facilities with a margin of safety to allow for unforeseen contingencies. It is recommended that smoke exhaust equipment should have a minimum capacity of 12 air changes per hour. Where mechanical venting is employed, it shall be fire safe.

3.4.12.4. The discharge apertures of all natural draft smoke vents shall be so arranged as to be readily accessible for opening by Fire Service personnel.

3.4.12.5. Power operated smoke exhausting systems shall be substituted for natural draft vents only

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F3.4.12. Smoke Venting:

- (a) In a fire, smoke, heat and toxic gases build up over time to create untenable conditions for human survival. This critical time can be as short as two or three mins.
- (b) It has been the experience that the primary hazards to humans in a building fire have been from smoke and toxic gases.

Nearly three fourths of all building related fire deaths are from inhalation of the smoke and toxic gases produced in fires rather than from exposure to flame or heat.

- (c) Smoke venting, therefore, plays an important role in achieving fire and life safety objectives in buildings by facilitating fire fighting, by preventing fire spread, to reduce life and material hazards from smoke and heat, and also to improve conditions for fire fighting.
- (d) Fire or smoke vents fitted on roofs of buildings help to vent the products of combustion when there is a fire. They are generally automatic in operation and fitted to single storey buildings like industrial, commercial, storage or assembly premises. (Figures of a typical roof venting system, along with components are given below):

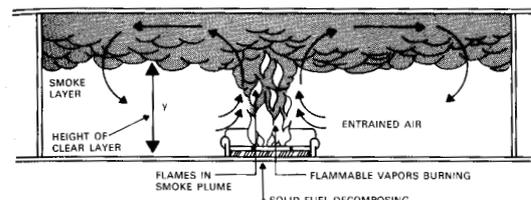


Fig. 07. Smoke movement in buildings.

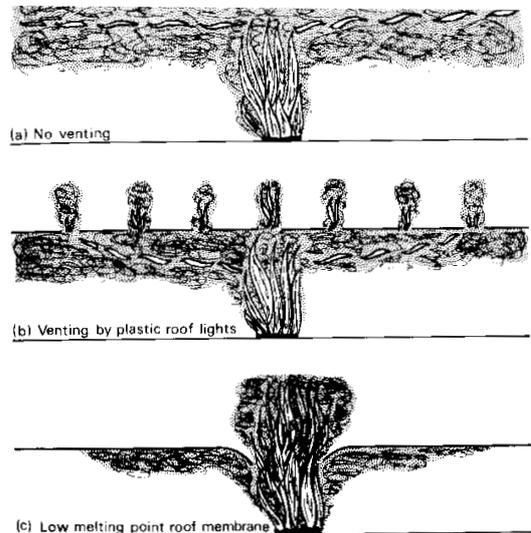


Fig. 08. Effect of venting on flames beneath a ceiling.

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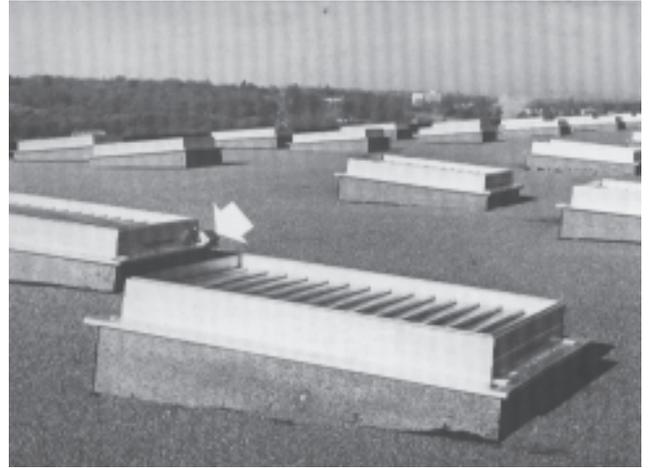


Fig. 09. Automatic Fire Vents on the roof of a warehouse

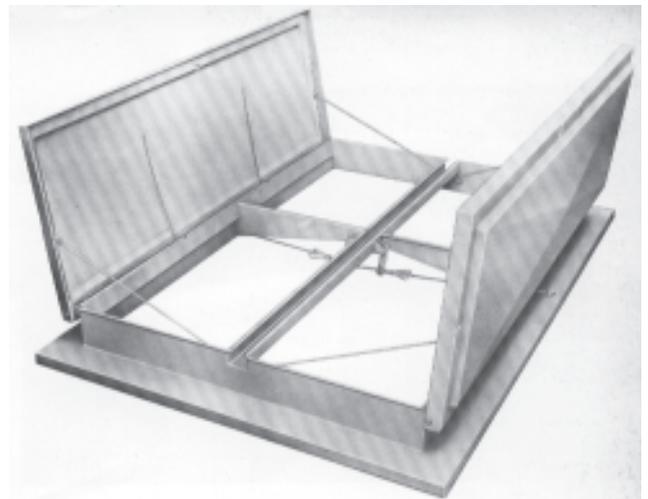


Fig. 10. A twin-door roof vent operated by a fusible link.



Fig. 11. Fireman's over-ride control for testing operation of fire vent installation, or for manual operation, when desired

The operation of the roof vents can be by:

- (i) making the vents out of polythene-based plastic (thermo-plastic) material, which melts and falls away at a relatively low temperature of approx. 300°C in a fire; or

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by specific permission of the authority.

3.4.13. Heating:

Installation of chimney and heating apparatus shall be in accordance with good practice [F(13)7].

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- (ii) by using heat or smoke detectors for automatic vent control. The simplest and most common method of detection used is the fusible link.
- e) In order that the roof venting system is effective, it is essential that there are facilities for sufficient air inlets
- (f) In fact, it is necessary that the area of air inlets shall be atleast equal to the total area of the roof inlets.
- (g) For premises housing goods which cause smoky fires, a higher ratio will be desirable. In some cases of 'smouldering' fires, it may be necessary to open the fire vents even before the temperature set for automatic operation of the vents. This is achieved by provision of 'Fireman's Override Controls' at suitable locations.
- (h) Automatic fire venting through use of roof vents is not generally applicable in multi-storey buildings. In such buildings, specially designed mechanical ventilation systems (making use of 'exhaust' ventilation, 'plenum' ventilation and 'balanced' ventilation 'methodologies') or pressurisation methods have to be resorted to.
- (i) Any system of mechanical ventilation should be designed to ensure that in a fire, the air movement in the building is directed away from the protected escape routes or exits, or the system (or a section of it) is closed down.

F3.4.12.4. Natural draft vent discharge control equipment must be made accessible to Fire Brigade personnel for venting out fire and smoke, so that fire fighting evacuation becomes easy. Such vents are normally provided above staircases and lift enclosure roofs and/or in their external walls.

F3.4.12.5 It is not understood as to why this requirement of special permission of the authority is included here.

F3.4.13 Heating:

- (a) Heating systems, appliances and associated equipments are among the most common causes of fires in buildings, as they generally operate at temperatures above the Ignition Temperature of many common materials.
- (b) For all practical purposes, heating system can comprise of two types: (i) direct systems or (ii) indirect systems.
- (c) Each type of fuel and heating system components is associated with its potential fire hazards.
- (d) Apart from the heating system, portable heaters, which are commonly used, also constitute a fire hazard, especially when they are overturned.
- (e) Besides, all portable heaters should be equipped with an automatic shut-off that activates when the unit is tilted or turned-over.

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3.4.14 Additional precautions:

In addition to the factors covered by 3.4.2 to 3.4.12 there are certain aspects, applicable to particular occupancies only, which may affect the spread of fumes and thus the safe evacuation of the building in case of fire. Some such aspects are:

- (a) Interior finish and decoration;
- (b) seating aisles, railings, turnstiles and revolving doors in places of assembly;
- (c) Service equipment and storage facilities in buildings other than storage buildings; and
- (d) Hazards on stage, in waiting spaces, projection booths, etc. in theatres and cinemas.

3.4.15. Surface Interior Finishes:

3.4.15.1. The use of combustible surface finishes on walls (including facade of the building) and ceilings affects the safety of occupants of a building. Such finishes tend to spread the fire even though the structural elements may be adequately fire resistant, serious danger to life may result. It is therefore essential to take adequate precautions to minimise spread of flame on such walls, facade of building and ceiling surfaces.

The finishing materials used for various surfaces and decor shall be such that it shall not generate toxic smoke/fumes.

3.4.15.2. The susceptibility to fire of various types of wall surfaces is determined in terms of the rate of spread of flame. Based on the rate of spread of flame, surfacing material shall be considered as divided into four classes as follows (see also good practice [F(14)]).

- Class 1 surfaces of very low flame spread
- Class 2 Surfaces of low flame spread
- Class 3 Surfaces of medium flame spread
- Class 4 Surfaces of rapid flame spread

3.4.15.3. The uses for which surface materials falling into various classes shall be adopted in building construction are given below:

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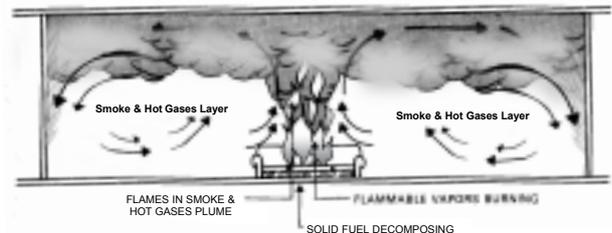
F3.4.14. Additional Precautions:

- (a) The special aspects mentioned herein are mostly those affecting life safety of occupants. These aspects have been dealt with in more details under each particular occupancy concerned also.
- (b) Services like boilers, substations, DG rooms, A/c plants, kitchens etc., which provide support to occupancies in high rise buildings are normally located in basements.
- (c) Similarly, many a time, an occupancy normally used for residence or shop, when partly used as a godown, assumes altogether different proportions from fire safety point of view, and needs to be dealt with differently as will be seen later on in this Code.

F3.4.15. Surface Interior Finishes:

- (a) Building interior finishes, particularly wall and ceiling linings, play a vital role in the fire growth and eventually in the fire size. Interior finishes or linings, also provide a large unbroken surface over which flame spreads. The flame from the interior finish may release sufficient thermal energy for the formation of a hot gas layer which may become thick, attaining a temperature around 600°C, and starts descending from the top. At this stage, all the combustible contents as well as the furnishings in the room may simultaneously get ignited, which is known as "flash-over" or full fire involvement. This can happen even in a few minutes.

Fig. 12. Effects of Wall Linings (Interior Finish) on fire-with 'flash over' potential (as explained in 3.4.15.(a) above)



- (b) Use of combustible interior finishes (interior linings) such as low density fibre board ceilings, wood panneling, textile wall coverings, vinyl wall coverings, cellular polyurethane and polystyrene materials, and combustible floor coverings, had resulted in several heavy death toll fires in the past.

Information Note No. G/F3.4.15. (for information only)

- G.1. Interior finish affects the fire in four ways: (i) It affects the rate of heat build-up to a 'flash-over' condition (ii) It contributes to flame spread over the surface, (iii) It adds to the intensity of fire by contributing additional fuel, and (iv) It produces toxic gases and smoke that adds to life hazard and property damage. The fourth factor is the most important since it affects occupant life safety seriously.

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Class-1	Class-2	Class-3
May be used in any situation	May be used in any situation, except on walls, facade of the building, staircase and corridors	May be used only in living rooms and bed rooms (but not in rooms on the roof) and only as a lining to solid walls and partitions; not on staircases or corridors or facade of the building.

Note- Panelling (lining) shall be permitted in a limited area. It shall not be permitted in a vestibule.

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G.2. Interior finish has been considered to be the primary cause for the heavy loss of lives in the following major fire tragedies in the world:

	Date	Place	Deaths
(i)	28 Nov 1942	Coconut Grove Night Club, Boston, USA	492
(ii)	1 Nov 1970	St. Laurent Night Club, France	146
(iii)	25 Dec. 1971	Hotel Fire, Seoul, Korea	165
(iv)	2 Aug 1973	Summerland Leisure Centre, Isle of Man, England	50
(v)	1 Feb 1974	Sao Paulo, Brazil	227
(vi)	14 Nov 1977	Flippines Hotel, Manila Philippines	47
(vii)	28 May 1977	Beverly Hills Night Club Kentucky, USA	165
(viii)	1 Feb 1981	Stardust Disco, Dublin	48
(ix)	27 Nov. 1994	Night club, China	234
(x)	18 March 1996	Ozone Disco, Manila	162

G.3. In the above listed major fires, besides interior finish, which was the principal factor, one or more of other factors like design deficiencies, unenclosed staircases, delayed response, and lack of training also contributed to the calamities.

F3.4.15.2. (Rate of Spread of Flame):

- (a) What is given here is the Classification ratings for interior finish/wall and ceiling lining materials based on the rate of spread of flame as specified in IS: 12777:1989, 'Method for Classification of Flame Spread of Products'. The test prescribed in this IS is based on the improved test method developed in U.K. However, in this Standard, only the rate of flame spread, one of the factors which contribute to fire growth is determined.
- (b) In this connection, the concluding sub-clause 10.1 (k) of IS 12777:1989 is significant, which says, "The test report shall include the following....(k) The statement: "The test results relate only to the behaviour of the tested specimens of the product under the particular conditions of the test, and they are not intended to be the sole criterion for assessing the potential fire hazard of the product in one"
- (e) In fact, the potential fire hazard of the product or the material(s) used in interior finish, or wall, ceiling and floor linings envisages all the following factors:
 - (i) rate of flame spread (rate of burning);
 - (ii) rate of generation of heat flux (rate of heat release);
 - (iii) rate of smoke release; (covering smoke optical density, rate of smoke release and total smoke release);
 - (iv) rate of toxic gases release; and

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- (v) potential room fire growth contribution.
- (d) To test or determine the fire hazard potential of any product or material used in interior finish, it will be necessary to evaluate or conduct appropriate tests for all the above mentioned factors pertaining to the product or material. Then only the assesment whether the particular product or material can be safely applied for use in the designated area (escape route, corridor etc.) can be reckoned as a correct conclusion.

Information Note No. H/F3.4.15.2(for information only)

H.1. In so far as the Indian scenario is concerned, at present, the only test for evaluating the fire potential of a material used for 'interior finish' is the test for rate of flame spread, as laid down in IS-12777-1989, which is only one of the five factors enumerated above. As a matter of fact, it is only rational to expect that tests for evaluation of the smoke and toxic gases releases will also be included on priority, since these are the prime factors which have been instrumental in causing more loss of lives in a building or a confined fire.

H.2. It is relevant that a mention about this requirement has been made under clause 18.2 of IS-1642-1989, "Fire Safety of Buildings(General): Details of Conbstruction-Code of Practice", which reads like this: ".....Any materials used for various surfaces and decor should be such that the flame spread rating should not be more than the values given in 18.3 to 18.6, and in addition, **should not generate toxic smoke/fumes**". However, the methods for evaluation of these parameters (or the tests for assesment) are yet to be incorporated in our standards.

H.3. U.K. Practice:

Wall and Ceiling Linings (same as interior finish), including Classification of Linings are covered under Section-7 and Appendix A of Approved Document B-2000 edition of U.K. Building Regulations, which has come into force from 1st July 2000. Under this, it has been mentioned that.....'Two properties of lining materials that influence fire spread are the rate of flame spread over the surface when it is subjected to intense radiant heating, and the rate at which the lining material gives off heat when burning. The guidance in this Document provides for control of internal fire spread through control of these properties. **This Document does not give guidance on other properties such as the generation of smoke and fumes**".

H.4. The classification normally adopted for the surface linings for walls and ceilings range from 1, 2 & 3. However, the highest product performance classification for lining materials is Class 0, on fullfilling certain specific requirements, although Class 0 is not a classification identified in any British Standard test.

H.5. The principal British Standard dealing with various types of tests on building materials is BS 476: Fire Tests on Building Materials and Structures. This main BS has 24 different Parts, each one being an independant Standard by itself, concerning various

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tests and methods on different fire related properties on vast range of building materials.

H.6. As mentioned earlier, the classifications for surface spread of flame of products are-1,2,3 or 4 with Class-1 being the highest (this is as per Indian Standard also).

According to the U.K. Document, a 'thermoplastic' material means any synthetic polymeric material which has a softening point below 200°C if tested to BS 2782 Part-1.

H.7. USA Practice:

As per NFPA 101, Life Safety Code, 'interior finishes' are the exposed interior wall, ceiling and floor surfaces of a building. Any wall covering of minimum 1/28 inch thick must be treated as an interior finish.

H.8. The first NFPA Code for fire testing of interior wall finishes was adopted in 1955, which was NFPA 255, Method of Testing Surface Burning Characteristics of Building Materials. The test method adopted in NFPA 255 (same as ASTM E-84, and UL-723 standards) is the well-known Steiner Tunnel Test, which had been the standard test for interior wall finishes ever since it was first developed by the Underwriters Laboratories Inc., in the early 1940s. The smoke density and the flame spread rate are recorded in this test.

H.9. With the development of 'carpeted walls' (because of their acoustic properties and durability), these materials were increasingly being used for lining the walls and ceilings, besides of course, the normal use as floor coverings. However, a series of major Hotel fires occurred in the US in the beginnings of eighties, where the main factors contributing to the fire spread were the highly combustible plastic decorative trim and mirrored plastic ceiling panels and highly combustible carpeting on the walls and ceilings.

H.10. As a sequel to the fresh fire experience, focus was diverted to the concept of 'heat release' rather than 'flame spread'. This led to the development of NFPA 265, Fire Tests for Evaluating Room Fire Growth-Contribution of Textile Wall Coverings, which adopted a full scale **Room Corner Test** for interior finish textile material, which was more representative of actual field installations. But, smoke generation property was excluded. However, this drawback was also eliminated in the 1998 edition of NFPA 265 which incorporated tests for measurement of smoke optical density, rate of smoke release and also total smoke release. This was a unique feature which was not available in many other international standards.

H.11 Subsequently, NFPA 286, 'Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth', a more comprehensive Code was adopted in 2000 to cover a wide range of fire performance characteristics of interior finish materials in an enclosure or room. **It can determine the potential extent to which the interior finish materials contribute to fire growth in a room, including the heat and smoke released, the**

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3.4.15.4. Materials of Class 4 which include untreated wood fibre boards may be used with due fire retardant treatment as ceiling lining, provided the ceiling is at least, 2.4 m from the top surface of the floor below, and the wall surfaces conform to requirements of class [see Note under 3.4.15.3]. Class 4 materials shall not be used in kitchens, corridors and staircases. Some materials contain bitumen and, in addition to risk from spread of fire, emit dense smoke on burning; such materials shall be excluded from use under these conditions, and shall also not be used for construction of ceiling where the plenum is used for return air in air-conditioned buildings [see also 5.1.7(m)].

3.4.15.5. When frames, walls, partitions or floors are lined with combustible materials, the surfaces on both sides of the materials shall conform to the appropriate class, because there is considerable danger from fire starting and rapidly spreading within the concealed cavity unknown to the occupants whose escape may be hampered thereby. For detailed information on materials and details of construction with their fire resistance rating, reference may be made to good practice [F(15)].

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combustion products released, and the potential for fire spread beyond the room.

H.12. The fire performance of textile wall coverings is addressed specifically in NFPA 265, 'Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings'. Some interior finish materials such as expanded vinyl wall coverings are required to be tested in the same manner as textile wall coverings.

H.13. In USA the change-over from the old Steiner Tunnel Test to the new Room Corner Test has brought about revolutionary changes in the upgradation of life and fire safety standards in so far as interior finishes are concerned.

H.14. Several IS on Thermal Insulation Materials, including Rigid Polyurethane (PUR) and Polyisocyanurate (PIR) foams, rigid phenolic foams etc., are given in Part-5, Buildings Materials, NBC. Here again, another IS, viz., IS-13286-1992, 'Methods of Test for Surface Spread of Flame for Thermal Insulation Materials' is also mentioned.

The types of interior finish/internal lining materials presently in use are numerous, and include such common materials like gypsum, plaster, wall board, wood, plywood panels, particle boards, fibrous ceiling tiles, plastics and a variety of wall coverings. Collectively, these serve several functions: aesthetic, acoustic and insulating, and also as protection against wear and abrasion.

H.15. Thermally thin products, such as wood panelling 6.5 mm (1/4 in) thick or less, will tend to spread flame more rapidly when the panelling is installed over studs or strips with air space rather than would be the case if installed over a solid substrate.

H.16. Sprayed-on cellular or foam plastics used for insulation or decorative effects may rapidly spread flames. The use of such products should be permitted only if the fire behaviour can be substantiated under actual fire conditions.

H.17. Specimen thickness can also affect flame spread. Thinner sections of the same material often will spread flame more rapidly. For instance, flame spread rate remains constant for acrylic (polymethyl methacrylate) with a thickness greater than approx. 10mm (3/8 in). Decreasing thickness increases the rate of flame spread for acrylic. NFPA 101, Life Safety Code, specifies use of the NFPA 253 Flooring Radiant Panel Test for floor coverings in exits and corridors of certain occupancies.

F3.4.15.4. Materials of the class-4 flame spread are the worst ones for use in buildings, and hence their use is to be strictly prohibited unless they are given proper fire retardant treatment.

F3.4.15.5. This is equally true for false ceilings and false floors also.

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3.4.16. Glazing:

3.4.16.1. Building of Types 1 to 4 construction shall employ one of the two types of glazing described in 3.4.16.2 and 3.4.16.3 except that Type 4 construction may have the alternative of hardwood sashes or frames or both.

3.4.16.2. Wired glass shall comply with the following requirements:

- (a) *Wired Glass*- The wired glass shall be of minimum half hour fire resistance rating.
- (b) *Sashes and Frames*- The Sashes or Frames or both shall be entirely of iron or other suitable metal such as stainless steel, securely bolted or keyed into the wall, except in case of panels in internal doors.
- (c) *Setting of Glass*- The panels of glass shall be set in rebates or grooves not less than 6.0mm in width or depth, with due allowance for expansion, and shall be secured by hard metal fastenings to the sashes or frames independently of any cement or putty used for weather proofing purposes.

3.4.16.3. Electro-copper glazing shall comply with the following requirements:

- (a) *Electro copper glazing*-The electro-copper glazing shall be of minimum half hour fire resistance rating.
- (b) *Sashes and Frames* - The sashes or frames or both shall be entirely of iron or other hard metal, securely bolted or keyed into the wall, except when in panels in internal doors.
- (c) *Fixing of Sectional lights* - The sectional lights shall be set in rebate or grooves not less than 6.5mm in width or depth, with due allowance for expansion and shall be secured by hard metal fastenings to the sashes or frames independently of any lead, cement or putty used for weather-proofing purposes.

3.4.16.4. Maximum permissible area shall be 5m² for protection by wired glass or electro copper glazing.

3.4.16.5. Casement:

Hard metal casements, not exceeding 0.8m² fitted with wired glass or electro-copper glazing in accordance with 3.4.16.2 and 3.4.16.3, secured to the frames by hard metal hinges not more than 600mm apart and by fastening at top, centre and bottom shall be permissible.

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Wall linings and floor coverings of combustible nature aggravate fires which are already raging, and hence such wall linings and floor covering materials must be made to conform to Class-1 flame spread characteristics.

F3.4.16. Glazing:

These come under the broad classification of 'glazed elements'.

Information Note No.I /F3.4.16. (for information only)

- (i) As per U.K. standards, there is no restriction on the use or amount of glass, where the relevant performances can be met in terms of integrity and insulation (except for some restrictions on the use of glass in fire fighting stairs and lobbies).
- (ii) In NFPA 5000-2003, 'glazing' is defined as glass or transparent or translucent plastic sheet used in windows, doors, sky lights or curtain walls. This includes even decorative glass, and not necessarily functional.
- (iii) For fire door and fire window assemblies, the total glazing area shall not exceed 35% of wall. In USA glass walls are permitted for atriums under automatic sprinkler protection.
- (iv) Nowadays, fire resistant glass, providing fire resistance even upto 2 to 3 hrs., are available in the market. Glass or glazing is used extensively in building construction. Hence, there is scope for inclusion of more clauses of a regulatory nature for this material in Part-4 NBC.
- (v) If the supporting frame work to hold wired glasses is of combustible nature, eg. of wood, the support would be lost in case of a fire at a very early stage, and the wired glasses would fall off defeating the very purpose for which they are provided.

F3.4.16.4. If the opening protected is more than 5m² the glass loses its fire resisting property. It will give way soon, nullifying the very purpose for which it is installed.

CODE

3.4.17. Skylights:

3.4.17.1. Wired glass for skylights or monitor lights shall comply with the following requirements:

- a) *Wired Glass for skylights or Monitor Lights-* The wired glass for skylights or monitor lights shall be of minimum half hour fire resistance rating.
- b) *Frames and Glazing-* The frames shall be continuous and divided by bars spaced at not more than 700 mm centres. The frames and bars shall be of iron or other hard metal and supported on the curb either of metal or of wood covered with sheet metal. The toughened glass shall be secured by hard metal fastenings to the frame and bars independently of any lead, cement or putty used for weather-proofing purposes.

3.4.18 Louvers:

Louvers wherever provided shall be of minimum half hour fire resistance rating.

3.4.19. Glass of facade for high rise buildings etc. shall be of minimum one hr. fire resistance rating.

4. LIFE SAFETY

4.1 GENERAL:

Every building shall be so constructed, equipped, maintained and operated as to avoid undue danger to life and safety of the occupants from fire, smoke, fumes or panic during the time period necessary for escape.

4.2 General Exit Requirements:

4.2.1 An exit may be a doorway, corridor; passage-way(s) to an internal staircase, or external staircase, or to a verandah or terrace(s), which have access to the street, or to the roof of a building or a refuge area. An exit may also include a horizontal exit leading to an adjoining building at the same level.

4.2.2. Lifts and escalators shall not be considered as exits.

4.2.3. Every exit, exit access or exit discharge shall be continuously maintained free of all obstructions or impediments to full use in the case of fire or other emergency.

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F3.4.17.1 Half an hour is the minimum fire resistance that is expected of a reasonably good building element.

F3.4.19. If this is not observed, glasses will shatter and fly off in case of a fire, injuring pedestrians passing by on the surrounding streets.

F4. LIFE SAFETY:

4.1 GENERAL:

For ensuring the life safety of occupants from a fire, the following are the requirements in general:

- (i) Provision of adequate No. of properly designed, unobstructed means of exit of adequate capacity which are available at all times;
- (ii) Availability of alternate means of exit for use, if the already chosen one is inaccessible due to fire, heat, smoke and toxic gases;
- (iii) Protection of the entire rescue path against fire, heat, smoke and toxic gases during the egress time based on occupant load, travel distance and exit capacity;
- (iv) Adoption of compartmentation and all other adequate passive fire protection measures to ensure the safe egress/evacuation of the occupants in case of fire;
- (v) Provision of adequate and reliable fire alarm systems in the building to alert the occupants;
- (vi) Provision of refuge areas where total evacuation of occupants is not contemplated;
- (vii) Adequate illumination and marking of the means of egress;
- (viii) Formulation, organisation and practice of effective evacuation drill procedures.

These requirements are covered in the various provisions enumerated under clause 4.2, General Exit Requirements.

F4.2 General Exit Requirements:

F4.2.1 Here, the various elements constituting the Means of Exit/Means of Egress/Means of Escape have been mentioned. However, the main three distinct constituents of Means of Egress are generally recognised as (i) the exit access, (ii) the exit and (iii) the exit discharge, which are brought out clearly in sub clause 4.2.3 of the Code.

F4.2.2.

- (a) In case of failure of electricity, lifts and escalators tend to suddenly stop in between floors creating chaotic conditions. This is the reason why generally lifts and escalators are not advised to be used as exits.
- (b) Also, if lifts are not properly fire separated by fire resistant shafts/lift lobbies and fire doors at every entrance, they create a stack effect carrying the fire from floor to floor.
- (c) Generally, lifts and escalators are not to be used as

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exits because there is always the danger of occupants getting trapped in lifts which get immobilised due to fire or due to electrical failure.

(d) Use of lifts for evacuation under certain emergency conditions - (Ref. Annex - E of this Code)

Under Annex-E, 'Guidelines for Fire Drill and Evacuation Procedures for High Rise Buildings', provision exists for consideration of using elevators for emergency evacuation (Ref. E-9.3.3.(f), which reads as follows -

'(f) In the event that stairways serving fire floor and/or floors above are unusable due to contamination or cut off by fire and/or smoke or that several floors above fire involve large numbers of occupants who must be evacuated, consideration may be given to using elevators in accordance with the following:

- (1) If the elevators servicing his floor also service the fire floor, they shall not be used. However, elevators may be used if there is more than one bank of elevators, and he is informed from the Fire Command Station that one bank is unaffected by the fire.
- (2) If elevators do not service the fire floor and their shafts have no openings on the fire floor, they may be used, unless directed otherwise.
- (3) Elevators manned by trained building personnel or firemen may also be used.
- (4) In the absence of serviceable elevator, the Fire Warden shall select the safest stairway to use for evacuation on the basis of the location of the fire and any information received from the Fire Command Station. The Fire Warden shall check the environment in the stairs prior to entry for evacuation. If it is affected by smoke, alternative stair shall be selected, and the Fire Command Station notified
- (5) The Fire Warden shall keep the Fire Command Station informed of the means being employed for evacuation by the occupants of his floor.'

The above instructions list out the various emergency conditions under which use of elevators for evacuation can be resorted to.

Similarly emergency evacuation of physically challenged persons by use of elevators has been advocated under E-9.3.5. also.

These points are quite pertinent to note. Hence, the word 'normally' may be added under 4.2.2.

Information Note No. J/F4.2.2.(for information only)

Lift Evacuation Strategy-Modern Trends

J.1. Building Codes throughout the world had all along

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been advocating the traditional 'evacuation by stairs' policy in fire affected buildings, especially, for high rise buildings. Years of experience have brought to focus certain facts arising from the use of staircases for evacuation in high rise buildings:

- Even normally healthy persons are liable to feel fatigued after about 5min. of going down stairs. (Research done in Hong Kong found that people begin to suffer fatigue when they have climbed down about 18 storeys or so).
 - Such fatigue can lead to the person getting dizzy, or slipping on the stairs, etc.
 - Research has found that it takes about 12 to 14 mins. to get down to the ground level using stairs from the 42nd floor of a high rise building, provided the travel is performed without a break.
 - From buildings over 100 storeys in height, evacuees may need about 5 to 6 rest stops while coming down from the topmost floor to the ground level. Hence, including the time spent for the rest stops, it may take approx. about 40 to 45 min. for any one to reach the ground level from the top storey, which prolonged duration is not acceptable from any point of view.
- J.2.** After the 11 Sept. 2001, WTC incident, many felt that had adequate Emergency Escape Lifts(EELs) were available at WTC, perhaps many more lives could have been saved.
- J.3.** Past experience combined with research studies conducted during the last two decades, has led to the development of a new concept of 'Emergency Elevator Evacuation System' in the developed countries.
- J.4.** Incidentally, British Standard, BS 5588. 'Fire Precautions in the Design, Construction and Use of Buildings, Part-5 Code of Practice for Fire fighting Stairs and Lifts', as well as Part-8, 'Code of Practice for Means of Escape for Disabled People' recommend the use of lifts/elevators in fire situations for evacuation of disabled persons, and also for fire fighters' use during fire fighting operations. The BS, as well as NFPA Codes, recommend the use of lifts under emergency situations, with provisions for special protection measures for this lift against fire, smoke and heat, plus provisions for fail-safe standby electrical power for operation of lifts, reliable two-way communication system for the lift cars and lift lobbies with fire control room etc. Further, an emergency lift control procedure is required to be developed for adoption in case of fire emergency.
- J.5.** The elevator lobby for Emergency Evacuation Lifts(EELs) should have a capacity of not less than 50% of the occupant load of the area served by the lobby. The lobby spaces should also include 1 or 2 wheel chair space of 76cm x 122cm(30 in x 48 in) for each 50 persons of the total occupant load served by that lobby. The EELs should be provided with fire fighters' emergency operation devices also.
- J.6.** The new concept is becoming increasingly popular in many advanced countries.

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- 4.2.4.** Every building meant for human occupancy shall be provided with exits sufficient to permit safe escape of occupants, in case of fire or other emergency.
- 4.2.5.** In every building or structure, exits shall comply with the minimum requirements of this Part, except those not accessible for general public use.
- 4.2.6.** No building shall be so altered as to reduce the number, width or protection of exits to less than that required.
- 4.2.7.** Exits shall be clearly visible and the route to reach such exits shall be clearly marked and signs posted to guide the occupants of the floor concerned. Signs shall be illuminated and wired to independent electrical circuits on an alternative source of supply. The sizes and colour of the exit signs shall be in accordance with good practice [F(16)]. The colour of the exit signs shall be green.
- Note:-** This provision shall not apply to A-2 & A-4 occupancies less than 15m in height.
- 4.2.8.** The floors of areas covered for the means of exits shall be illuminated to values not less than 1 ft candle (10 lux) at floor level. In auditoriums, theatres, concert halls and such other places of assembly, the illumination of floor exit/access may be reduced during period of performances to values not less than 1/5 ft candle (2 lux) .
- 4.2.9.** Fire doors with 2 hour fire resistance shall be provided at appropriate places along the escape route and particularly at the entrance to lift lobby and stairwell, where a funnel or flue effect may be created inducing an upward spread of fire, to prevent spread of fire and smoke.
- 4.2.10.** All exits shall provide continuous means of egress to the exterior of a building or to an exterior open space leading to a street.
- 4.2.11** Exits shall be so arranged that they may be reached without passing through another occupied unit.

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- J.7.** Incidentally, this new method has been incorporated in the design of the present-day tallest building in the world, ie., Petronas Twin Towers in Kuala Lumpur, Malaysia. Some of the main features of the emergency evacuation lift strategy incorporated in this super high rise building are:
- The twin towers have 29 double deck elevators, (each having a capacity of 22 persons) out of which certain double deck lifts are designed as fire lifts;
 - The 'sky lobbies' on levels 41 & 42 will serve as refuge floors and staging area for egress from the upper levels(upto 80 storeys);
 - The shuttle lifts(double decker lifts) provide express service between sky lobbies and ground levels;
 - Pressurisation of sky lobbies;
 - All lifts will be available for use in a phased evacuation mode in an emergency. Fire lifts are provided with emergency power supplies also.
- F4.2.3.** Exit access, exit itself, and the exit discharge are the three primary constituents of Means of Egress
- F4.2.4.** For number of exits required please see 4.6
- F4.2.6.** Even if adequate exits are provided at the initial stage, often at the time of renovation/alteration, knowingly or unknowingly, people do not give same attention to exit requirements. In view of the above this requirement assumes great significance.
- F4.2.7.**
- (a) These are some basic means of egress requirements for all high rise buildings. More details of these requirements appear subsequently.
 - (b) Normal colour used for exits is green. Illumination of exits and exit route signs, even when electricity is turned off, is very important to ensure orderly evacuation of occupants without chaos.
- F4.2.8.** All escape routes should have adequate artificial lighting (with values not less than 10 lux or one ft. candle at floor level) which should illuminate the entire route even if the main supply fails. This should cover all portions of exit access, exits and exit discharge.
- Required illumination shall be arranged so that the failure of any single lighting unit will not result in an illumination level of less than 2 lux(0.2 ft. candle).
- F4.2.10** All exits must lead to ground level in open space. People escaping from areas filled with fire and smoke will be all anxiety to reach open air where they can breath normally and become tension-free at the earliest.

CODE

4.3. Occupant Load:

For determining the exits required, the number of persons within any floor area or the occupant load shall be based on the actual number of occupants, but in no case less than that specified in Table 20. (given at the end)

4.3.1. Mezzanine.

The occupant load of a mezzanine floor discharging to a floor below shall be added to that floor occupancy and the capacity of the exits shall be designed for the total occupancy load thus established.

Notes:- (Under Table-20)

1. Occupant load in dormitory portions of homes for the aged, orphanages, insane asylums, etc., where sleeping accommodation is provided, shall be calculated at not less than 7.5 m² gross floor area per person.
2. The gross floor area shall include, in addition to the main assembly room or space, any occupied connecting room or space in the same storey or in the storeys above or below, where entrance is common to such rooms and spaces, and they are available for use by the occupants of the assembly place. No deductions shall be made in the gross area for corridors, closets or other sub divisions; the area shall include all space serving the particular assembly occupancy.

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F4.3 Occupant Load:

- (a) Occupant load in a building or area is an important factor for determination of the number of exits required as well as for capacities of exits.
- (b) The total capacity of the means of egress for any storey, balcony or other occupied space shall be sufficient for the occupant load thereof. The occupant load as arrived at from Table 20(at the end) is just for normal guidance and not to be taken as a firm requirement, since an unforeseen hazard might occur when an unusually large crowd is present.

Information Note No. K/F4.3 (for information only)

K.1 The occupant load in any building or portion of it shall be at least the number determined by dividing the floor area assigned to that use by the occupant load factor(floor area in m²/ person) indicated in Table 20. According to this Table, the occupant load factor or floor area in m²/ person varies between the highest value of 0.6 m²/ person for Assembly occupancy(D) with fixed/loose seats, dance floors etc., and 30 m²/ person for Storage occupancy(H).

K.2. Where fixed seating arrangements exist, as in theatres, conventions, lecture/entertainment/social functions etc. halls, certain problems do arise in the case of handicapped persons or people who require assistance for evacuation in the event of fire or other emergency. Likewise, unpredictable situations leading to panic, and sometimes to tripping down and stampede, may result in Assembly occupancies which have no fixed seating. Similar tragedies involving heavy casualties are possible (and had happen also) in huge Assembly gatherings in the open as in religious festivals and melas(Kumbh melas, for instance).

K.3. U.K. Practice:

K.3.1. Detailed legislative requirements and guidance materials in respect of Means of Escape are contained in U.K. Approved Document B(The Building Regulations 2000).

K.3.2. In these Regulations, the 'occupant load' is referred to as 'occupant capacity'. The occupant capacity of a room, storey, building or part of building is defined as:

- (a) the maximum number of persons it is designed to hold; or
- (b) the number calculated by dividing the area of room or storey(s)(m²) by a floor space factor(m² per person) as stipulated in a designated Table(note: Area 'excludes stair enclosures, lifts, sanitary accommodation and any other fixed part of the building or structure).

K.3.3. The floor space factors(same as occupant load factor as in our case), (m²/person), in respect of certain types of occupancies, are as below:

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Floor space factor (m² / person)

a) Standing spectator areas, bars without seating and similar refreshment areas	0.3
b) Amusement arcade, Assembly hall Dance hall, Pop Concert hall etc.	0.5
c) Concourse, Shopping Mall etc.	0.7
d) Committee Room, Conference Room etc.	1.0
e) Exhibition hall or Film/TV/Radio etc. Studio	1.5
f) Office	6.0
g) Kitchen/Library	7.0
h) Storage and Warehousing	30.0

Note: Alternatives to using the floor space factor values as given above are:

- (i) may be determined by adopting actual data taken from similar premises;
- (ii) the occupant capacity may be taken as the number of fixed seats provided;
- (iii) in all appropriate cases, the data should reflect the average occupant density at a peak time of the year.

K.4. USA Practice:

K.4.1. Several NFPA Codes like Life Safety Code (NFPA-101), Means of Egress Code(NFPA-101B), Building Construction and Safety Code(NFPA-5000-2003), Uniform Fire Code(NFPA-1-2003), besides International Building Code-2003 etc. have laid down detailed provisions and guidance for various factors relating to Means of Egress,Including Occupant Load.

K.4.2. Here also, it is stipulated that the occupant load in any building or portion thereof, shall be atleast the number determined by dividing the floor area assigned to that use by the occupant load factor for that use as specified in the designated Table.

K.4.3. The occupant load factor(m²/person) in respect of certain types of occupancies, as specified in NFPA Codes is as shown below:

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4.4. Capacities of Exits.

4.4.1. The unit of the exit width, used to measure the capacity of any exits shall be 500mm. A clear width of 250mm shall be counted as an additional half unit. Clear widths less than 250 mm shall not be counted for exit width.

Note:- The total occupants from a particular floor must evacuate within 2.5 minutes for Type-1 construction, 1 1/2 min for Type-2 construction and 1min for Type-3 construction. Size of the exit door/exit-way shall be calculated accordingly keeping in view the travel distance as per Table 22 (Given at the end).

4.4.2. Occupants per unit exit width shall be in accordance with Table 21(Given at the end).

Occupant load factor (m² / person)

a) Assembly use

a.1 Concentrated use, without fixed seating	0.65
a.2 Less concentrated use -do-	1.4
a.3 Bench-type seating	1person/45.7 linear cm
a.4 Casinos and similar gaming areas	1.0

b) Educational use

b.1 Class rooms	1.9
b.2 Shops, Laboratories etc.	4.6

c) Health Care use

c.1 Inpatient treatment departments	22.3
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d) Residential use

d.1 Hotels and Dormitories	18.6
d.2 Apartment Buildings	18.6

e) Business use

9.3

f) Storage use

NA

g) For waiting spaces, on the basis of 1 person for each 0.2 m² of waiting space area, exits shall be provided

Notes:

- i) Where the occupant load of an Assembly occupancy is greater than 6000, a life safety evaluation shall be performed;
- ii) Where exits serve more than one storey, the occupant load of each storey considered individually shall be permitted to be used in computing the capacity of the exits at that storey.

F4.3.1 Not only the area of auditorium but areas of all related utilities should be counted, like toilets, stairs, passages, lifts and waiting hall.

F4.4 Capacities of Exits:

F4.4.1.

- (a) Exit capacity is usually computed on the basis of unit of exit width which, as per Part-4 NBC, is reckoned as 50cms(approx. 20 inches).
- (b) The number of exits required for any occupancy is also arrived at based on this unit of exit width, on the assumption that body width of a normal person is 50cm and that much of minimum width is required for one person while passing through an escape route including stair cases, doors etc., which are components of means of egress or escape route.
- (c) The Note is presumably based on studies conducted by the Grading Committee in UK on evacuation times taken in actual fires. The time 2^{1/2} minutes was taken as the time necessary for the total evacuation of one storey to a protected stair way and not to a final exit.

CODE

COMMENTARY

- (d) The occupants per unit exit width to achieve this time for evacuation of total occupants from a floor will range from 25 to 50 persons for stairways. The reduction in the evacuation time to 1^{1/2} minutes for Type-2 construction and 1 minute for Type-3 construction is obviously because of the reduced fire resistance capability of these type of constructions, which necessitates more speedy evacuation of occupants to a place of safety.
- (e) In the case of high rise buildings, the time needed to evacuate just the floors immediately at risk to a final exit, will be much longer.

Information Note No. L/F4.4(for information only):

- L.1. The unit of exit width is based on the 'body ellipse' concept, which was used in other countries for developing design of pedestrian systems. Studies show that most adult men measure less than approx. 520 mm(20.7 inches) across the shoulder. The 'body ellipse' equals about 0.21m² (2.3 sq.ft.) which is an average person's maximum practical standing capacity of space.
- L.2. The design and capacity of passage ways, stair ways, doors and other components in the means of egress are related to the physical dimensions of the human body. People have a normal tendency to avoid bodily contact with others, especially while on the move. The movement of persons results in a swaying motion which varies with individuals, and also depending on whether the movement is on level surfaces, on stairs or in dense crowds. During movement on stairs or in dense crowds, the total body sway may reach almost 100mm(4 in) In theory. This indicates that a total width of about 760mm (30 in) would be required to accommodate a single file of persons going up or down stairs.
- L.3. London Transport Board had undertaken a research project on the movement of persons, and some of the conclusions from their Research Report No.95 will be of interest in this present context, which are listed below:
 - (a) crowding people into spaces less than 3 sq.ft. (0.28m²) per person under non-emergency conditions may create a hazard;
 - (b) under the psychological stresses during a fire, such crowding could contribute to crowd pressures resulting in injuries;
 - (c) on level surface, an average walking speed of 250 ft./min.(76m/min.) is attained under free-flow conditions, with 25 sq.ft. (2.3 m²)of space available per person;
 - (d) speeds below 145 ft./min. (44m/min.) show shuffling, which restricts motion, leading to a jam point with one person every 2 sq.ft.(0.18 m²);
 - (e) restricted movement on escape route under fire conditions can lead to non-adaptive behaviour of occupants, especially when there is more than one person every 3 sq.ft.(0.28m²);
 - (f) flow rates are directly proportional to width for exit

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4.4.3. Horizontal exit allowance:

When horizontal exit is provided in buildings of mercantile, storage, industrial, business and assembly occupancies, the capacity per storey per unit width of exit of stairways in Table-21 may be increased by 50% and in buildings of institutional occupancies it may be increased by 100%.

4.5. Arrangement of Exits:

4.5.1. Exits shall be so located that the travel distance on the floor shall not exceed the distance given in Table-22.

4.5.2. The travel distance to an exit from the dead end of a corridor shall not exceed half the distance specified in Table-22, except in assembly and institutional occupancies in which case it shall not exceed 6m.

ways over 4 ft. (1.2m) wide. It can be 50% greater in short passages less than 10 ft. (3.05m) than through a long passage of same width;

- (g) travel down stairways (of over 1.2m width) was determined at 21 persons/min./ft. (0.3m) of width, whereas upward travel was reduced to 19 persons/min./ft. of width;
- (h) proper egress design permits all occupants to reach a safe place before they are endangered by fire, smoke or heat;
- (i) a 32 in(813mm) doorway is considered the minimum width to accommodate a person in a wheel chair.

L.4 U.K. Practice:

- (a) The width of escape routes and exits depends on the number of persons required to use them. The Table given below provides guidelines for arriving at the widths of escape routes and exits for maximum number of persons.

Maximum No. of persons	Min. width(mm)
50	750
110	850
220	1050
more than 220	5 per person

- b) The total number of persons which 2 or more available exits can accommodate is found by adding the maximum no: of persons for each exit width. For eg., 3 exits, each 850mm wide, will accommodate 3 x 110=330 persons.

F4.4.3 Horizontal exit allowance:

This increase is permissible since evacuation through horizontal exits is easier, overall travel distance is less, is less cumbersome and more importantly, less time consuming. This is particularly suitable for adoption in hospitals. The concept of progressive horizontal evacuation allows progressive horizontal escape to be made into adjoining compartments or sub divisions of compartments. The object is to provide a place of relative safety nearby from which further evacuation can be made if necessary.

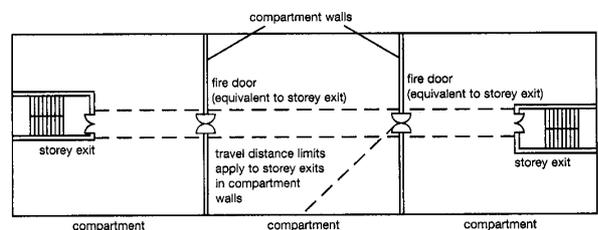


Fig. 13. Progressive Horizontal Evacuation

F4.5 Arrangements of Exits:

Travel distance is measured by way of the shortest route. If there is fixed seating or other fixed obstructions, it should be along the centre line of the seatways and gangways. If it includes a stair, it should be along the pitch line on the centre line of travel.

CODE

4.5.3. Whenever more than one exit is required for any room, space or floor of a building, exits shall be placed as remote from each other as possible and shall be arranged to provide direct access in separate directions from any point in the area served.

Notes:- (Under Table 22):

1. For fully sprinklered building, the travel distance may be increased by 50% of the values specified;
2. Ramps shall be protected with automatic sprinkler system and shall be counted and one of the means of escape;
3. Construction of type 3 or 4 is not permitted.

4.6. Number of Exits:

4.6.1 General:

The general requirements of number of exits shall supplement the requirement of different occupancies in 6.1 to 6.9.

4.6.2 .All buildings, which are 15m in height or above, and all buildings used as educational, assembly, institutional, industrial, storage and hazardous occupancies and mixed occupancies with any of the aforesaid occupancies, having area more than 500m² on each floor shall have a minimum of two staircases. They shall be of enclosed type; at-least one of them shall be on external walls of buildings and shall open directly to the exterior interior open space or to an open place of safety. Further, the provision or otherwise of alternative staircases shall be subject to the requirements of travel distance being complied with.

4.7 Doorways:

4.7.1. Every exit doorway shall open into an enclosed stairway or a horizontal exit of a corridor or passageway providing continuous and protected means of egress.

4.7.2. No exit doorway shall be less than 1000mm in width except assembly buildings where door width shall be not less than 2000mm. Doorways shall be not less than 2000mm in height.

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F4.5.2. A dead end is an extension of a corridor beyond an exit or an access to exits that forms a pocket in which occupants may get trapped. Those who happen to reach a dead end have to return back to reach the exit which delays escape time. It will be desirable to have a fire door in between normal corridor and the dead end portion.

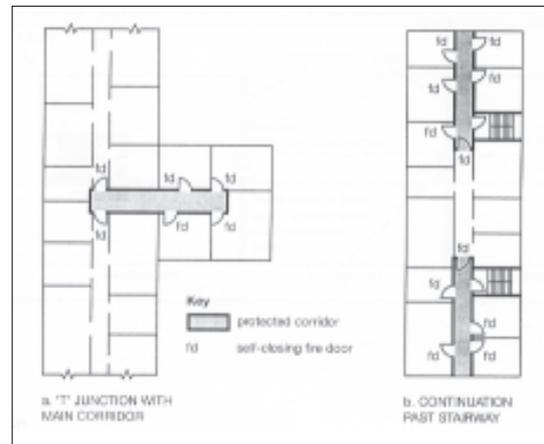


Fig. 14. Dead End Corridors.

F4.5.3. The intention is to ensure that even if one exit route becomes unusable due to fire or other emergency conditions, the other exits can be used for evacuation.

Reg. Note 2:

Basements do not receive natural light unlike upper floors and become pitch dark in the absence of electricity. Electricity is usually turned off immediately on detection of a fire. To facilitate speedy evacuation of people, travel distance recommended for basements are normally half than those for upper floors.

F4.6.2. These are just minimum requirements. The actual means of egress requirements, including staircases, for these types of occupancies have to be carefully assessed taking into account several factors like occupant load, type of occupancy, fire load density of the occupancy etc.

F4.7.1 Words, 'continuous' and 'protected means of egress' are significant.

At the end of an exit route a person must be able to find himself in open air without entering another occupied area enroute.

The word 'protected' implies that the entire escape route must be made fire and smoke free by providing fire resistant and smoke resistant doors for staircases and lift shafts, and pressurisation thereof.

F4.7.2. The width of a door(or doorway) is the clear width when the door is fully opened(upto 90°). For determining minimum door width, the door leaf width shall be used unless clear width is specified.

CODE

4.7.3 Exit doorways shall open outwards, that is, away from the room, but shall not obstruct the travel along any exit. No door, when opened, shall reduce the required width of stairway or landing to less than 900mm. Overhead or sliding doors shall not be installed.

Note- In the case of buildings where there is a central corridor, the doors of rooms shall open inwards to permit smooth flow of traffic in the corridor.

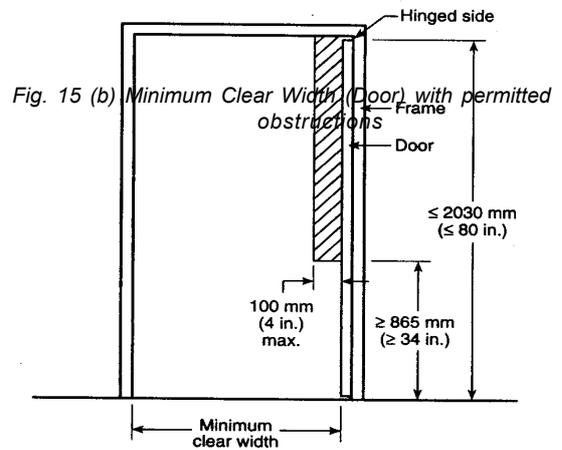
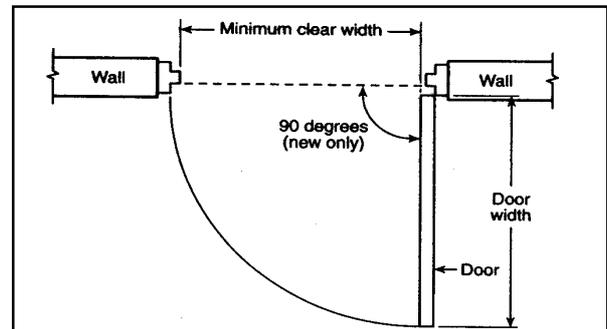
4.7.4. Exit door shall not open immediately upon a flight of stairs. A landing equal to at least the width of the door shall be provided in the stairway at each doorway. The level of landing shall be the same as that of the floor which it serves.

4.7.5. Exit doorways shall be operable from the side which they serve without the use of a key.

4.7.6. Mirrors shall not be placed in exit doors to avoid confusion regarding the direction of exit.

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Fig. 15 (a) Minimum Clear Width-Door



F4.7.3. Exit doors should be hung to open in the direction of escape, to open not less than 90°, but should in no way reduce the effective width of any escape route.

F4.7.4 In case there is level difference between the staircase landing and the feeding floor, not only it may create difficulty in fully opening the door, but may lead to falls and injuries to occupants in case of emergency evacuation.

F4.7.5. Locked exit doors in case of an emergency can cause stampede and kill quite a few people and hence exits must not be locked. Fastenings, if any, used should be of simple type that can be easily operated.

F4.7.6. If mirrors are installed, it adds to confusion and chaos in case of emergency evacuation of people.

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4.8. Corridors and Passageways:

4.8.1. Exit corridors and passageways shall be of width not less than the aggregate required width of exit doorways leading from them in the direction of travel to the exterior.

4.8.2. Where stairways discharge through corridors and passageways, the height of corridors and passageways shall be not less than 2.4 m.

4.8.3. All means of exit, including staircases, lifts lobbies and corridors, shall be adequately ventilated.

4.9. Internal Staircases:

4.9.1. Internal stairs shall be constructed of non-combustible materials throughout.

4.9.2. Internal stairs shall be constructed as a self-contained unit with an external wall of the building constituting at least one of its sides and shall be completely enclosed.

4.9.3. A staircase shall not be arranged round a lift shaft.

4.9.4. Hollow combustible construction shall not be permitted.

4.9.5. No gas piping, or electrical panels shall be allowed in the stairway. Ducting in the stairway may be permitted if it is of 1hr. fire resistance rating.

4.9.6. Notwithstanding the detailed provision for exits in accordance with 4.3, 4.4 and 4.5, the following minimum width shall be provided for staircases:

- (a) Residential buildings (dwellings) 1.0m
- (b) Residential hotel buildings 1.5m
- (c) Assembly buildings like auditorium, 2.0m theatres and cinemas
- (d) Educational buildings up to 30m 1.5m in height
- (e) Institutional buildings like hospitals 2.0m
- (f) All other buildings 1.5m

4.9.7. The minimum width of tread without nosing shall be 250 mm for internal staircase of residential buildings. This shall be 300 mm for assembly, hotels, educational, institutional, business and other buildings. The treads shall be constructed and maintained in a manner to prevent slipping.

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F4.8. Corridors and Passageways:

For information only:

As per international practice, if a corridor provides access to alternate escape routes, to avoid the risk of smoke spread, every corridor more than 12m long, which connects two or more storey exits, should be subdivided by self closing fire door(s) and any associated screens.

F4.8.2. Additionally, there should be no projection below this height(except for door frames).

F4.8.3. Exits not properly ventilated can cause suffocation to people being evacuated because a large number of people would be present in such enclosed place with no natural ventilation till they get out of it and reach open air.

F4.9. Internal Staircases

F4.9.1. A staircase constructed of combustible materials will itself burn and will become non-effective in case of a severe fire, and hence would defeat the very purpose for which it is created.

F4.9.2. In case they form a part of the escape route, they have to be treated as escape stairs and as a 'protected stairway' to enable them fulfill their role for safe evacuation of occupants during fire emergencies.

F4.9.3. Lift shafts tend to carry smoke and fire upwards. People escaping through stairs downwards must be safe from such smoke and fire, and hence this requirement.

F4.9.5. The reason for this is that these have fire hazard potential.

F4.9.6. The width of a stair is the clear width between the walls or balustrades. The values given here are generally comparable to international practice.

F4.9.7.

(a) Treads which are slippery can create chaos and stampede in case of emergency evacuation.

(b) As regards slip resistance of treads, it should be recognised that while going up or down stairs, a person's foot exerts a smaller horizontal force against treads than is normally exerted when walking on level surfaces. Hence, materials/methods usually used for slip resistance for floors are applicable for slip resistance of stair treads also. Infact, the walking surface of each element of means of escape(for the entire escape route) should be uniformly slip resistant. If stair treads are wet, there is an increased danger of slipping. A small wash or drainage slope on exterior stair treads is therefore desirable to shed water.

For information only-As per international practice, tread slope shall not exceed a slope of 1 in 48. There shall be no variation exceeding 4.8mm(3/16

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4.9.8. The maximum height of riser shall be 190mm for residential buildings, and 150mm for other buildings, and the number shall be limited to 15 per flight.

4.9.9. Handrails shall be provided at a height of 1000 mm to be measured from the base of the middle of the treads to the top of the handrails. Balusters/Railing shall be provided such that the width of stair case does not reduced (See Fig. 1).

Fig-1

4.9.10. The number of people in between floor landings in staircase shall not be less than the population on each floor for the purpose of design of staircase. The design of staircase shall also take into account the following:

- (a) The minimum headroom in a passage under the landing of a staircase and the staircase shall be 2.2m.
- (b) For buildings 15m in height or more, access to main staircase shall be through a fire / smoke check door of minimum 2-hr. fire resistance rating. Fire resistance rating may be reduced to 1hr. for residential buildings, except hotels and starred hotels.
- (c) No living space, store or other fire risk shall open directly into the staircase or staircases.
- (d) External exit door of staircase enclosure at ground level shall open directly to the open spaces or through a draught lobby, if necessary.
- (e) The main and external staircases shall be continuous from ground floor to the terrace level.
- (f) No electrical shafts /AC ducts or gas pipes, etc, shall pass through or open in the staircases, Lifts shall not open in staircase.
- (g) No combustible material shall be used for decoration/wall panelling in the staircase.
- (h) Beams/Columns and other building features shall not reduce the head room/ width of the staircase.
- (j) The exit sign with arrow indicating the way to the escape route shall be provided at a suitable height from the floor level on the wall, and shall be illuminated by electric light connected to corridor circuits. All exit way marking signs should be flush with the wall and so designed that no mechanical damage shall occur to them due to moving of furniture or other heavy equipments. Further, all landings of floor shall have floor

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in) in the width(depth) and also in the height of adjacent risers, and the tolerance between the largest and smallest riser(or tread) shall not exceed 9.5mm (3/8in) in any flight.

F4.9.8. The riser height shall be measured as the vertical distance between tread nosings.

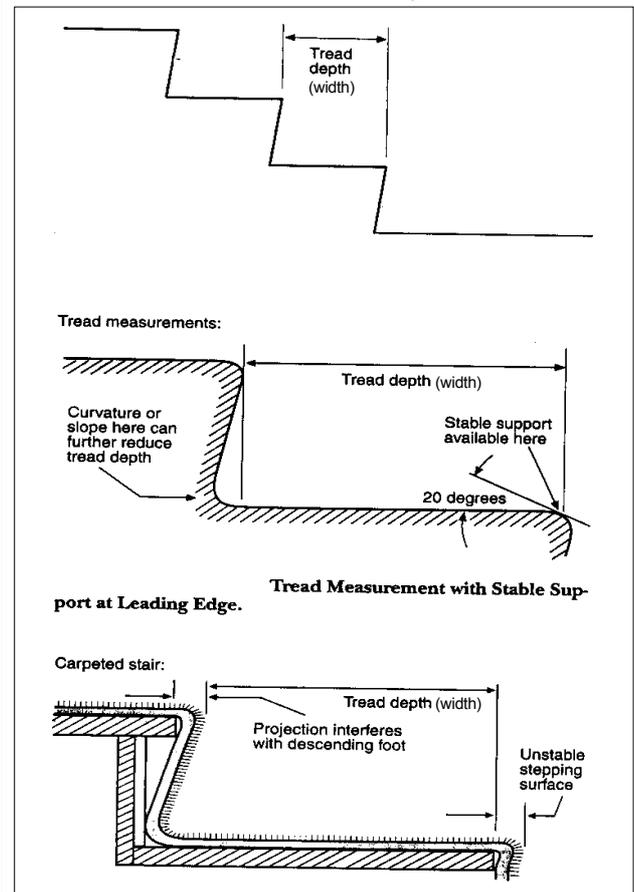


Fig. 16 . Measurement of Tread depth (width)

F4.9.10. Normally the maximum height of a tall person in our country can be taken as 2m. The clearance of 2.2m ensures the people would not get hurt in their heads when they are getting out of a fire affected building in an emergency.

- (a) The headroom on stairs shall be measured vertically above a plane parallel to and tangent with the most forward projection of the stair tread.
- (j) Illuminated exit signs in staircases, if damaged mechanically by moving furniture etc., defeat the very purpose for which they are provided.
- (k) Floor indicator boards help people getting down the stairs to know on which floor they are, and how far they are from the ground level where they will be safe from the fire. This also helps in reducing psychological pressure on them whilst being evacuated in case of a fire emergency.
- (m) In case of basement fire there is more likelihood of smoke accumulation. To minimise the possibility of smoke spread to the upper floors, these precautions are necessary.

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indicating boards prominently indicating the number of floor as per bye-laws. The floor indication board shall be placed on the wall immediately facing the flight of stairs and nearest to the landing. It shall be of size not less than 0.5 m x 0.5 m.

- (k) Individual floors shall be prominently indicated on the wall facing the staircases.
- (m) In case of single staircase it shall terminate at ground floor level and the access to the basement shall be by a separate staircase. The second staircase may lead to basement levels provided the same is separate at ground level by ventilated lobby with discharge points to two different ends through enclosures.

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Information note no. M/4.9.(for information only)

- M.1 An important aspect of means of escape in multi-storeyed buildings is the availability of a sufficient number of adequately sized and protected escape stairs. In high rise and other special buildings, provisions for access for the fire service may have to be made for which some escape stairs may also need to serve as fire fighting stairs.
- M.2. In mixed occupancies, it will be necessary to consider the effect of one risk on another. A fire in a shop or office could have serious consequences on a hotel use in the same building. In such cases completely separate routes of escape should be provided from each different occupancy in the building.

M.3. U.K. Scenario(some interesting features).

M.3.1. The minimum width of stairs will depend on the number of stairs provided, and whether the escape strategy is based on (i)simultaneous evacuation of building or part of the building or (ii)phased evacuation of building(as in high rise buildings).

M.3.2. Simultaneous Evacuation:

- (a) In a building designed for simultaneous evacuation, the escape stairs should have the capacity for all floors to be evacuated simultaneously. In calculating the width of the stairs, account is taken of the number of people temporarily housed in the stairways during the evacuation.
- (b) Where two or more stairs are provided, it should be assumed that one of them might not be available due to fire or smoke, and it is therefore necessary to ensure that the capacity of the remaining stair(s) is adequate for the number of persons who have to escape.
- (c) Where simultaneous evacuation is to be used, the capacity of the stairs of widths from 1000mm to 1800mm increases proportionately for the number of floors served. For eg.,

No. of Storeys	Maximum No. of Persons served by a stair of width		
	1000mm	1400mm	1800mm
2	190	335	435
6	350	555	735
10	510	775	1035

Notes: (i) Stairs with a rise of more than 30m should not be wider than 1400mm unless provided with a central hand rail (ii) Stairs wider than 1800mm should be provided with a central hand rail.

M.3.3 Phased Evacuation: (a) Phased evacuation is normally resorted to in the event of a major fire outbreak in a high rise building. The first people to

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be evacuated in this case are the handicapped persons or those with reduced mobility, and those most immediately affected by the fire, viz., those on the floor on fire and on the floor just above. Subsequently, depending on the need, two floors at a time, can be evacuated. This method is adopted for certain types of buildings, and where supporting facilities such as fire alarm systems designed for phased evacuation, are provided and maintained.

- M.3.4.** (i) Every internal escape stair should be a **protected stairway**(i.e., it should be within a fire resistant enclosure);
- (ii) Escape stairs need to have a satisfactory standard of fire protection if they are to fulfil their role as areas of relative safety during evacuation;
- (iii) A protected lobby should be provided between an escape stairway and a place of special fire hazard. The lobby should have not less than 4m² permanent ventilation, or protected from the ingress of smoke by a mechanical smoke control system.
- (iv) A lift well may be included in a protected stairway.

F5.3.5. Fire fighting shafts:

- (a) Buildings more than 18m in height, or with a basement of more than 10m below grade, should be provided with a fire fighting shaft. **This is a protected shaft having facilities like fire fighting lifts, fire fighting stairs and fire fighting lobbies.** These fire fighting shafts are designed to facilitate access of fire fighting personnel into high rise and other special hazard buildings. This facility enables the fire fighting personnel to reach the fire and conduct fire fighting operations without delay and in an efficient manner.

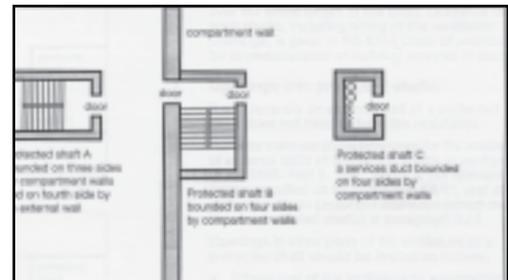


Fig. 17 Protected Shaft

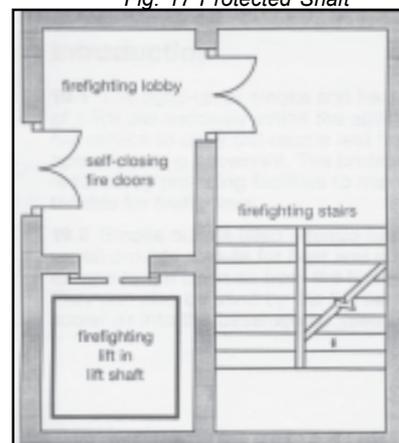


Fig. 18 Fire Fighting Shaft

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4.10. Pressurisation Of Staircases (Protected Escape Routes)

4.10.1. Though in normal building design, compartmentation plays a vital part in limiting the spread of fire, smoke will readily spread to adjacent spaces through the various leakage openings in the compartment enclosure, such as cracks, openings around pipes, ducts, airflow grills and doors, as perfect sealing of all these openings is not possible. It is smoke and toxic gases, rather than flame that will initially obstruct the free movement of occupants of the building through the means of escape (escape routes). Hence the exclusion of smoke and toxic gases from the protected routes is of great importance.

M.4. USA Scenario:

Some of the features are outlined below:

M.4.1. Any door in a means of egress shall be side-hinged or pivoted-swinging type. The forces required to fully open any door manually in a means of egress shall not be more than 67 N(15lbf) to release the latch, 133N(30lbf) to set the door in motion, and 67N(15lbf) to open the door to the minimum required width. Doors shall be arranged to be opened readily from the egress side whenever the building is occupied.

M.4.2. Every stair enclosure door shall permit re-entry into the interior of the building or an automatic release shall be provided to unlock all stair enclosure doors to permit re-entry on actuation of the building fire alarm system.

M.4.3. Assembly, Educational and Day Care occupancies having an occupant load of 100 or more persons are required to be provided with approved **panic or fire exit hardware**. A horizontal force not exceeding 67N(15lbf) should actuate the cross bar or push pad and latches.

M.4.4.

(i) Standard stairs shall have a minimum width of 1120mm(44 in) and 915mm(36 in) when total occupant load of all storeys is fewer than 50.

(ii) Stair treads and landings shall be solid, without perforations, and free of projections or lips that could trip stair users. If not vertical, risers shall be permitted to slope under the tread at an angle of not more than 30° from vertical, and the permitted projection of the nosing shall not exceed 38mm(1^{1/2} in). Tread slope shall not exceed 1 in 48. There shall be no variation exceeding 4.8mm(3/16 in) in depth of adjacent treads or in the height of adjacent risers.

M.4.5. All inside stairs serving as an exit or exit component shall be enclosed.

M.4.6. Escalators and Moving Walks shall not constitute a part of the required means of egress.

M.4.7. Fire escape stairs shall not constitute any of the required means of egress.

M.4.8. Elevators shall be capable of orderly shut downs during earthquakes.

M.4.9. Handrails shall be provided within 760mm (30 in) of all portions of the required egress width of stairs and ramps.

F4.10. Pressurisation of staircases (Protected Escape Routes)

a) The characteristics of smoke movements in tall buildings are different than in low buildings. In low buildings, smoke removal and venting practices are resorted to for combatting the smoke hazard. In high rise buildings the problem is further complicated by the stack effect, influence of external wind forces and

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4.10.2. Pressurisation is a method adopted for protected escape routes against ingress of smoke, especially in high-rise buildings. In pressurisation air injected into the staircases, lobbies or corridors, to raise their pressure in adjacent parts of the building. As a result, ingress of smoke or toxic gases into the escape routes will be prevented. **The Pressurisation of staircases shall be adopted for High Rise Buildings and buildings having mixed occupancy/ multiplexes having covered area more than 500 m².**

4.10.3. The pressure difference for staircases shall be as under:

Building Height	Pressure Difference	Pressure Difference
	Reduced operation (Stage 1 or a 2-stage system) (Pa)	Emergency Operation (Stage 2 of a 2-Stage System of Single Stage system) (Pa)
Less than 15m	8	50
15m or above	15	50

If possible, the same levels shall be used for lobbies and corridors, but levels slightly lower may be used for these spaces if desired. The difference in pressurisation levels between staircase and lobbies (or corridors) shall not be greater than 5 Pa.

4.10.4. Pressurisation system may be of two types:

- (a) **Single-stage**, designed for operation only in the event of emergency, and
- (b) **Two-stage**, where normally a level of pressurisation is maintained in the protected escape routes, and an increased level of pressurisation can be brought into operation in an emergency.

4.10.5 The normal air-conditioning system and the pressurisation system shall be treated as integral one, especially for a two stage system. When the emergency pressurisation is brought into action, the following changes in the normal air-conditioning system shall be effected.

- (iii) there is no danger of spread of smoke to other floors by the path of the extraction system which can be ensured by keeping the extraction fans running.

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the forced air movement caused by the building air handling equipment.

- (b) Although to some extent building compartmentation barriers such as walls, partitions, floors and doors (including smoke control door assemblies) provide some degree of smoke protection to areas remote from fire scene, there will be a certain amount of smoke leakage through these barriers. This is apparent from the fact that as per BS476, for fire doors a maximum smoke leakage limit of 3m³/m/hr. is allowed.
- (c) The common smoke management methods adopted for control of smoke hazards in building fires are-compartmentation, dilution (smoke removal, smoke exhaust or smoke extraction), air flow, smoke buoyancy and pressurisation.
- (d) The pressurisation systems most commonly used are pressurised stairwells (which is extended to the entire protected escape route) and zoned smoke control. Elevator smoke control is not common.
- (e) The three major design concerns with pressurised stairwells are: (i) varying pressure differences that occur over the stairwell height, (ii) large pressure fluctuations caused by doors being opened and closed and (iii) location of supply air inlets and fans.
- (f) **For information only:** It will be of interest to know that the pressurisation levels as prescribed in this Code is generally in conformity with those prescribed in BS 5588, Part-4:1998, Code of Practice for Smoke Control using Pressure Differentials.

As per US Standards (NFPA-5000-2003) the values are (i) design pressure difference across the barrier of not less than 0.05 in. water column (12.5Pa) in sprinklered building, or 0.10 in. water column (25Pa) in non-sprinklered buildings, and shall be capable of maintaining these pressure differentials under likely conditions of stack effect or wind.

For both mechanical ventilation and pressurised enclosure systems, the activation of the systems shall be initiated by a smoke detector installed in an approved location within 10ft. (3m) of the entrance to the smoke proof enclosure.

F4.10.5. Fires circulate through air-conditioning system in which air acts as carrier of fire, sometimes engulfing more than one floor or compartment of a building and hence this requirement.

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- (a) Any re-circulation of air shall be stopped and all exhaust air vented to atmosphere;
 - (b) Any air supply to spaces/areas other than escape routes shall be stopped;
 - (c) The exhaust system may be continued provided:
 - (i) the positions of the extraction grills permit a general air flow away from the protected escape route entry;
 - (ii) the construction of the ductwork and fans is such that, it will not be rendered inoperable by hot gases and smoke; and
- 4.10.6.** The pressurisation system can be interconnected with the automatic / manual fire alarm system for actuation.
- 4.10.7.** It will be desirable to have all the staircases in a building pressurised, if pressurisation system is to be resorted to. The use of pressurised and **Wherever a pressurised staircase is to be connected to an unpressurised area, the two areas shall be segregated.**
- 4.11. External Stairs:**
An external staircase is desirable to be provided for high-rise buildings.
- External stairs, when provided shall comply with the following:
- 4.11.1.** External stairs shall always be kept in sound operable conditions.
- 4.11.2.** All external stairs shall be directly connected to the ground.
- 4.11.3.** Entrance to the external stairs shall be separate and remote from the internal staircase..
- 4.11.4.** Care shall be taken to ensure that no wall opening or window opens on to or close to an external stairs
- 4.11.5.** The route to the external stairs shall be free of obstructions at all times.
- 4.11.6.** The external stairs shall be constructed of non-combustible materials, and any doorway leading to it shall have the required fire resistance.
- 4.11.7.** No external staircase, used as a fire escape, shall be inclined at an angle greater than 45° from the horizontal.
- 4.11.8.** External stairs shall have straight flight not less

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F4.10.6. This helps in actuating a staircase pressurisation system as soon as a fire is detected which facilitates safe evacuation of occupants.

F4.11. External Stairs:

It has to be remembered that external stairs serve only as an alternative of means of escape in addition to the main means of escape provided inside the building.

Unless they are enclosed, for very tall buildings, say exceeding 8 to 10 storeys, the use of these open (or partly open), external stairs may not be practicable and advisable for use for children and persons who are aged, infirm and those who are afraid of heights(those who are susceptible to vertigo)

Information Note No. N/F4.11(for information only)

N.1. Stairs can serve as exit access, exit or exit discharge. Whether inside the building or outside building, when used as an exit they must be in a proper fire resistant enclosure(or protected enclosure).

N.2.USA Practice: As per NFPA Codes, outside (external) stairs are permitted on following conditions:-

- (i) They should 'lead to roofs of other sections of a building or an adjoining building where the construction is fire resistive, and there is a continuous and safe means of egress from the roof';
- (ii) They should be 'arranged to avoid any impediments to the use of the stairs by persons having a fear of high places. For stairs more than 3 storeys in height, any arrangements intended to meet these requirements shall be not less than 4ft.(1.2m) in height'.
- (iii) They should be 'seperated from the interior of the building by construction with the fire resistance rating required for enclosed stairs with fixed or self closing opening protectives'.
- (iv) 'All openings below an outside stair shall be protected with an assembly having not less than a 3/4 hr. fire protection rating'.
- (v) 'Outside stairs and landings shall be designed to minimise water accumulation on their surfaces'. (to be protected from weather);
- (vi) They should be 'not less than 50% open on one side, and should be arranged to restrict the accumulation of smoke'.

N.3. U.K. Trends:

N.3.1. In the 80s, the general concept was, 'unenclosed external escape routes are not generally permitted in new buildings, but may be the only practicable means of affording alternative means of escape from existing premises'.

N.3.2. As per Approved Document-B, for Flats and Maisonettes, 'if the building(or part of the building) is served by a single access stair, that stair may be

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than 1250 mm wide with 250 mm treads and risers not more than 190mm. The number of risers shall be limited to 15 per flight

4.11.9 Handrails shall be of height not less than 1000mm and not exceeding 1200 mm. There shall be provisions of balusters with maximum gap of 150 mm.

4.11.10 The use of spiral staircase shall be limited to low occupant load and to a building not exceeding 9 m in height.

A spiral stair case shall not be less than 1500 mm in diameter and shall be designed to give adequate head room.

4.11.11. Unprotected steel frame staircase will not be accepted as means of escape. However, steel staircase in an enclosed fire rated compartment of 2hrs. will be accepted as means of escape.

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external, if it (i) serves a floor not more than 6m above the ground level, and (ii)meets the other required provisions'.

N.3.3. (a) For other buildings, 'If more than one escape route is available from a storey (or part of a building), some of the escape routes from that storey or part of the building may be by way of an external escape stair, provided that:

- (i) There is at least one internal escape stair from every part of each storey (excluding plant areas);
- (ii) In the case of an Assembly and Recreational abuilding, the route is not intended for use by members of the public; or
- (iii) In the case of an institutional building, the route serves only office or residential staff accommodation;
- (iv) All doors giving access to the stair should be fire-resisting and self-closing, except that a fire-resisting door is not required at the head of any stair leading downwards where there is only one exit from the building on to the top landing;
- (v) Any part of the external envelope of the building within 1800mm of (and 9m vertically below), the flights and landings of an external escape stair should be of fire resisting construction, except that the 1800mm dimension may be reduced to 1100mm above the top level of the stair if it is not a stair up from a basement to ground level;
- (vi) Any stair more than 6m in vertical extent is protected from the effects of adverse weather conditions.

F4.11.4. Flames can leap out of such doors and windows in external walls of affected building hampering evacuation and fire fighting operations and hence this requirement.

F4.11.6. Staircases made of combustible material like wood will itself burn in case of a severe fire losing the very purpose for which it was erected and hence this requirement.

F4.11.7. Angle greater than 45° makes climbing down from stairs difficult, especially for aged and infirm people and children.

F4.11.9. Too tall or too short handrails lose their utility when compared with height of average users. Too wide a gap between balusters may cause accidents like children slipping through them.

F4.11.10. A spiral staircase when used for evacuating people from upper floors to ground levels may cause vertigo to users, and hence this requirement.

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4.12. Horizontal Exits:

4.12.1 The width of horizontal exit shall be same as for the exit door ways.

4.12.2 A horizontal exit shall be equipped with at-least one fire/ smoke door of minimum one hour fire resistance of self closing type. Further, it is required to have direct connectivity to the fire escape staircase for evacuation.

4.12.3. For buildings more than 24m in height, refuge area of 15m² or an area equivalent to 0.3m² per person to accommodate the occupants of two consecutive floors, whichever is higher, shall be provided as under.

The refuge area shall be provided on the periphery of the floor or preferably on a cantilever projection and open to air at least on one side protected with suitable railings.

- a) For floors above 24m and up to 39m, one refuge area on the floor immediately above 24 m.
- b) For floors above 39m, one refuge area on the floor immediately above 39m and so on after every 15m. Refuge area provided in excess of the requirements shall be counted towards FAR.

Note- Residential flats in multi-stoeyed building with balcony need not be provided with refuge area. However, flats without balcony shall provide refuge area as given above.

4.12.4. Where there is a difference in level between connected areas for horizontal exits, ramps, not more than 1 in 10 m slope shall be provided; steps shall not be used.

4.12.5. Doors in horizontal exits shall be operable at all times from both sides.

4.13. FIRE TOWER.

Fire towers are the preferred type of escape route for storeyed buildings and these shall be considered as the safest route for escape. Their number, location and size shall depend on the building concerned and its associated escape routes.

4.13.1 In high rise buildings with over 8 storeys or 24m in height, at-least one required means of egress shall preferably be a fire tower.

4.13.2 The fire towers shall be constructed of walls with a two hr. fire resistance rating without openings other than the exit doorways, with platforms, landings and balconies having the same fire resistance rating.

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F4.12. Horizontal Exits:

Horizontal exits are to be treated as any other exit and hence are required to be fire and smoke free for safe evacuation of occupants.

F4.12.3. Being revised to reconcile with C-1-11

F4.12.4. Ramps are preferred over steps because people in a hurry to get evacuated may fall one over another and cause stampede over steps.

F4.12.5. Operation from both sides is required since the very purpose for which stairs are provided gets lost if they are locked either from inside or from outside.

F4.13.1. Fire towers are normally recommended for very tall buildings where normal means of escape become ineffective due to rapid spread of fire or smoke to upper floors which are sometimes at a height which are even beyond reach of the tall ladders used by fire brigade.

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4.14. Ramps

4.14.1. Ramps shall comply with all the applicable requirements of stairways regarding enclosure capacity and limiting dimensions except where specified in 6.1 to 6.9 for special uses and occupancies..

4.14.2. The slope of a ramp shall not exceed 1 in 10. In certain cases steeper slopes may be permitted but in no case greater than 1 in 8.

4.14.3. For all slopes exceeding 1 in 10 wherever the use is such as to involve danger of slipping, the ramp shall be surfaced with approved non-slipping material.

4.15. Fire Lifts

4.15.1. Where applicable, fire lifts shall be provided with a minimum capacity for 8 passengers and fully automated with emergency switch on ground level. In general, buildings 15m in height or above shall be provided with fire lifts.

4.15.2. In case of fire, only firemen or any member of fire service shall operate the fire lift. In normal course, lifts may be used by other persons.

4.15.3. Each fire lift shall be equipped with suitable intercommunication equipment for communicating with the control room on the ground floor of the building.

4.15.4. The number and location of fire lifts in a building shall be decided after taking into consideration various factors like building population, floor area, compartmentation etc.

4.16. Emergency and escape lighting:

4.16.1. Emergency lighting shall be powered from a source independent of that supplying the normal lighting, (See good practice [4(17)]).

- (a) Indicating clearly and unambiguously the escape routes;
- (b) Providing adequate illumination along such routes to allow safe movement of persons towards and through the exits;
- (c) Ensuring that fire alarm call points and fire fighting equipments provided along the escape routes can be readily located.

4.16.2. The horizontal luminance at floor level on the centerline of an escape route shall be not less than 10 lux. In addition, for escape routes up-to 2m wide, 50% of the route width shall be lit

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F4.14. Ramps:

F4.14.2. Ramps with slopes greater than those recommended render them difficult to be used, particularly by elderly people and children, and hence this requirement.

F4.14.3. People in a hurry to escape from fire and smoke whilst using ramps which are slippery, are likely to fall and cause chaos and hamper speedy evacuation efforts, and hence this requirement.

In fact, this requirement can be usefully adopted for all ramp surfaces.

For information only: To be considered safe, exit ramps must have a very gradual slope, especially so because they are meant for disabled people also.

As per international practice, the slope for walking surfaces in the means of egress should not exceed 1 in 20 (which is the same criteria stipulated for ramps meant for use by physically handicapped people, which applies to all buildings and facilities used by the public according to Annex E of Part-3 of NBC) and the maximum slope for ramps in means of egress stipulated in NFPA and other Codes is 1 in 12, and maximum rise for a single ramp is 30in(76cm). Ramps in means of egress are required to be enclosed or protected. Further, they must have landings located at the top, at the bottom and at doors opening into the ramp.

F4.15. Fire lifts:

F4.15.1 The general requirements for lifts are given later in this Part-4, under C-1.5, and also under Section-5, Part-8, NBC.

For fire fighting operations in high rise buildings, it will be almost impossible for fire fighters to carry their equipments to the upper floors of a tall building without the use of lift, which is much easier and quicker than carrying them up through stairs.

F4.15.2. In case of fire, firemen can commandeer the lift for their exclusive use. A switch in a glass fronted box marked 'Fireman's Switch' placed at ground level and by operation of this switch firemen can recall the lift if it is in normal operation and utilise the lift for their use.

4.15.3. In a major fire in a high rise building, fire fighting operations will involve large number of fire appliances and manpower, besides being prolonged. Under such circumstances, good fire ground communication facilities between the fire scene and Control Room are essential for ensuring operational efficiency.

F4.16. Emergency and escape lighting:

F4.6.1. In a building fire, in the early stages itself, the main electric supply to the building may fail or get put off,

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to a minimum of 5 lux.

4.16.3. The emergency lighting shall be provided to be put on within one second of the failure of the normal lighting supply.

4.16.4. Escape lighting luminaries should be sited to cover the following locations:

- (a) Near each intersection of corridors,
- (b) At each exit door,
- (c) Near each change of direction in escape route,
- (d) Near each staircase so that each flight of stairs receives direct light,
- (e) Near any other change of floor level,
- (f) Outside each final exit and close to it,
- (g) Near each fire alarm call point,
- (h) Near fire fighting equipment, and
- (j) To illuminate exit and safety signs as required by the enforcing authority.

Note- For the purpose of this clause near is normally considered to be within 2m measured horizontally.

4.16.5. Emergency lighting systems shall be designed to ensure that a fault or failure in any one luminaire does not further reduce the effectiveness of the system.

4.16.6. The luminaries shall be mounted as low as possible, but at-least 2m above the floor level.

4.16.7. Signs are required at all exits, emergency exits and escape routes, which should comply with the graphic requirements of the relevant Indian standards.

4.16.8. Emergency lighting luminaires and their fittings shall be of non-flammable type.

4.16.9. It is essential that the wiring and installation of the emergency lighting systems are of high quality so as to ensure their perfect serviceability at all times.

4.16.10. The emergency lighting system shall be capable of continuous operation for a minimum duration of 1 hour and 30 minutes even for smallest premises.

4.16.11. The emergency lighting system shall be well maintained by periodical inspections and tests so as to ensure their perfect serviceability at all times.

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besides the smoke generation from the fire further accentuating the obscuration of light.

Compliance of requirements under this clause not only facilitates safe and faster evacuation of occupants but facilitates speedy reactions to mobilisation of fire fighting force and their operations.

F4.16.2. These values for illumination have been arrived at after practical tests at approved laboratories.

For information only: As per NFPA Codes, the floors within the escape route are required to be illuminated to values of minimum 1ft. candle(10 lux) measured at the floor. Also, failure of any single lighting unit should not result in an illumination level of less than 0.2 ft. candle(2lux) in any designated area.

F4.16.3. The moment the normal lights go off, occupants may be plunged in darkness making them disoriented and the time needed for adaptation to the lower level of lighting may be too long. During this short interval, any attempt made by the occupants to move out in case of an emergency like fire, may lead to accidents. Hence, it is essential that the emergency lights, come on as quickly as possible.

F4.16.4. Escape lighting is required to provide adequate illumination for the entire escape route, to indicate the locations where emergency fire protection equipments are installed as well as to illuminate the exit and safety signs.

F4.16.6. If they are installed too close above the floor any one passing below them while carrying load can damage them and cause short circuits resulting in electrical fires.

F4.16.8. Plastic or acrylic covers of luminaires are generally of combustible nature and can add fuel to the fire causing short circuit and hence must be discouraged. Only metal covers should be used for lighting luminaires.

F4.16.9. Infact, the entire emergency lighting installation, including the cables, shall have the required fire resistance so that they remain unaffected by fire.

F4.16.10. Electricity is normally switched off as soon as a fire is detected to avoid short circuit.

1hr. 30. min. is assumed as a reasonable period of time within which evacuation of occupants in the building can be effected, and to bring the fire situation under control.

This is the reason while emergency lights should provide cover for at least 90 min.

F4.16.11. This is a common essential requirement for all the fire protection and safety equipment installations in the building.

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4.17. Illumination of means of exit:

Staircase and corridor lights shall conform to the following:

- (a) The staircase and corridor lighting shall be on separate circuits and shall be independently connected so that it could be operated by one switch installation on the ground floor easily accessible to fire fighting staff at any time, irrespective of the position of the individual control of the light points, if any. It should be miniature circuit breaker type of switch so as to avoid replacement of fuse in case of crises;
- (b) Staircase and corridor lighting shall also be connected to alternative supply. The alternative source of supply may be provided by battery continuously trickle charged from the electric mains; and
- (c) Suitable arrangements shall be made by installing double throw switches to ensure that the lighting installed in the staircase and the corridor does not get connected to two sources of supply simultaneously. Double throw switch shall be installed in the service room for terminating the stand by supply.

4.18. Fire Detection and Warning

In buildings of such size, arrangement or occupancy where a fire may not itself provide adequate warning to occupants, automatic fire detection and alarm facilities shall be provided, where necessary, to warn occupants early of the existence of fire, so that they may escape, and to facilitate the orderly conduct of fire exit drills.

4.18.1. The fire detection system shall be in accordance with accepted standards [F(17)]. Guidelines for selection of various types of fire detectors for different occupancies and their installation and maintenance shall be in accordance with [F(18)].

4.18.2. The requirements of fire detection and alarm systems are covered for each occupancy in Table-23(given at the end) and under 6.1 to 6.9. Attention is also drawn to such requirements in case of high rise buildings (15 m or more in height) as given in Annex C.

5 FIRE PROTECTION

5.1. Fire Extinguishers/Fixed Fire Fighting Installations:

5.1.1. All buildings depending upon the occupancy, use and height shall be protected by fire extinguishers, wet riser, down comer, automatic sprinkler installation, high / medium velocity water spray, foam, gaseous or dry powder systems in

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F4.17. Illumination of means of exit:

F4.17.1. The various requirements spelt out here shall enable the emergency lighting system to provide the required illumination automatically in the event of any interruption of normal lighting.

F4.18. Fire detection and warning:

In any fire, the first few minutes are very crucial. Fires are best tackled in their initial stages when they are small, or else they grow in exponential proportion causing large scale damage. This is where fire alarm system can play a very crucial role. Automatic fire detection and alarm systems are designed for automatically detecting any fire outbreak and for alerting the occupants of the building by raising audible and (or) visual alarms.

Normally, the control and indicating equipment operating the fire alarm system which conveys the alarm to a central control room which provides help in taking necessary help for fighting fire either using in-house facilities or by promptly calling the fire brigade.

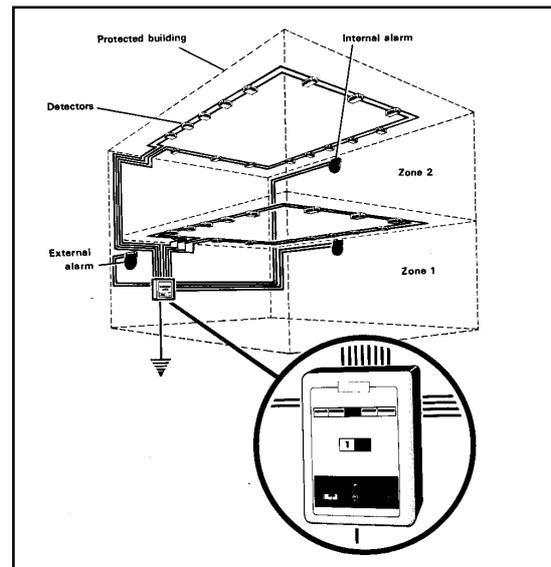


Fig-01(b) Automatic Fire Detection and Alarm System with Control and Indicator Panel

F4.18.1. The types of fire detectors for use in automatic fire alarm system referred to in these IS include heat detectors, smoke detectors, point heat detectors and multi-sensor fire detectors. Apart from the above, radiation(flame) detectors, of infra-red and Ultra-violet types, are also used for automatic fire alarm systems.

F5. FIRE PROTECTION

F5.1. Fire Extinguishers/Fixed Fire Fighting Installations

F5.1.1. The requirements of various first aid fire fighting equipment as well as other fire protection measures, equipment and systems or installations for different occupancies and premises depend on the nature,

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accordance with provisions of 5.1.2 to 5.1.9.

5.1.2. These fire extinguishers/fixed installations shall be in accordance with accepted standards F(20). The typical requirements of fire extinguishers/wet risers/down comers, installation and capacity of water storage tanks and fire pumps, etc shall be as specified in Table-23(given at the end). The requirements regarding size of mains /risers shall be as given in Table-24(given at the end).The typical arrangements of down comer and wet riser installations are shown in figure 2 and figure 3. The wet risers shall be designed for zonal distribution ensuring that unduly high pressures are not developed in risers and hose pipes.

(Fig-2)

(Fig-3)

5.1.3. In situations where one occupancy is provided with all the required fire protection arrangements but due to proximity of unprotected buildings around causing exposure hazard to the protected building, the protected building walls facing the unprotected building shall be made of the requisite fire resistance rated materials, or alternatively provided with water curtain/drencher system which can be actuated when necessary.

(Table 23-at the end)

size and complexity of the fire and life safety hazards involved. A critical evaluation/assessment of these requirements will be necessary for provision of these equipments and systems in the buildings concerned.

F5.1.2. (a) Table-23(given at the end) gives comprehensive details of minimum requirements of a variety of fire protection equipment, systems and ancillary requirements of water supplies for fire fighting, pumps etc., (active fire protection measures) for buildings coming under the entire range of occupancy classification of buildings covering all 9 Groups and 28 Subdivisions.

(b) It serves as an extremely valuable ready reckoner for reference and guidance for all the users of the Code. In fact, it can even be reckoned as the 'synopsis' of Part-4 of NBC in so far as active fire protection measures required for a building is concerned.

(c) Perhaps, it may also be true to mention that in so far as fire protection for a building is concerned, Table-23 in Part-4 NBC is the most frequently referred to pages in the whole of NBC, during planning, design, construction and inspection stages of a building under any Occupancy Group.

(d) Further, another interesting fact worthy of mention in this context is that in no other International Building Code/Fire Protection Code has a similar attempt been made so far for projecting the entire gamut of fire protection equipment and systems to be installed in buildings under various types of occupancies, in a comprehensive tabulated form. Hence, Table-23 in Part-4 NBC is a unique and valuable reference material for guidance and compliance, and its importance in the broader objective of upgradation of building fire safety standards cannot be over-emphasised.

F5.1.3. Ideal distance for fire separation between buildings should be taken as 15m.

While a sprinkler system protects a building from internal fire, 'drenchers', which are provided on roofs and over windows protect the building from radiant heat and exposure to fire in adjacent premises by providing a curtain of water over the roof, wall, and windows of the exposed building.

(See overleaf for figure of drencher system)

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5.1.4. First aid fire fighting appliances shall be provided and installed in accordance with good practice [F(20)]. The fire fighting equipments and accessories to be installed in building for use in fire fighting shall be in accordance with accepted standards contained in [F(20)] and shall be maintained periodically so as to ensure their perfect serviceability at all times.

5.1.5. In addition to wet riser or down comer first aid hose reels shall be installed on all the floors of buildings of 15m in height or more, and shall be in accordance with accepted standards [F(21)]. The first aid hose reel shall be connected directly to the riser/ down-comer main and diameter of the hose reel shall not be less than 19 mm.

5.1.6. Static Water Storage Tanks:

A satisfactory supply of water for the purpose of fire fighting shall always be available in the form of underground/terrace level static storage tank with capacity specified with arrangements for replenishment by means of alternative source of supply at the rate of 1000 litres per minute for underground static tank. When this is not practicable, the capacity of static storage tank(s) shall be increased proportionately in consultation with the local fire brigade.

The static storage water supply required for the above mentioned purpose shall entirely be accessible to the fire engines of the local fire service. Provision of suitable no: of manholes shall be made available for inspection, repairs, insertion of suction hoses etc. The covering slab shall be able to withstand the vehicular load of 45 tonnes equally divided as a four point load when the slab forms a part of pathway/driveway.

The domestic suction tank connected to the static water storage tank shall have an overflow capable of discharging 2250 litres per minute to a visible drain point from which by a separate conduit, the overflow shall be conveyed to a storm water drain .

- (a) To prevent stagnation of water in the static water storage tank, the suction tank of the domestic water supply shall be fed only through an overflow arrangement to maintain the level therein at the minimum specified capacity (See Fig.6)
- (b) The static water storage tank shall be provided with a fire brigade collecting head with 4 nos: 63 mm diameter (2 nos: 63mm diameter for pump with capacity 1400l/min.) instantaneous male inlets arranged in a valve box at a suitable

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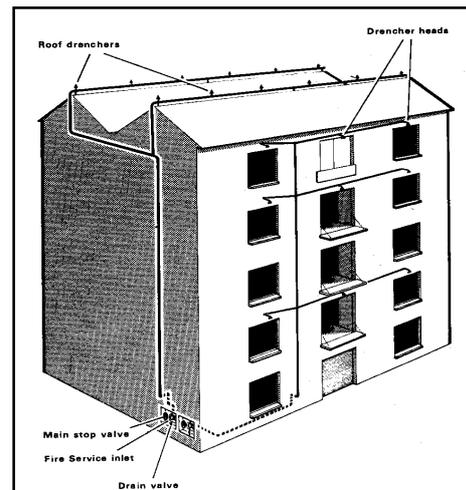


Fig-19 - Typical Drencher System for exposure protection of building

F5.1.4. First aid fire fighting equipment generally consist of fire extinguishers, fire buckets, hose-reels etc. which are readily available in the premises and can be operated even by occupants of the building to tackle fires in the incipient stage.

Periodical inspection and maintenance of these first aid fire fighting equipment, including fire extinguishers, is very important. Fire extinguishers must be subjected to hydrostatic pressure tests as per the frequency prescribed in the relevant Indian Standard, IS 2190-1992. Only ISI marked extinguishers should be installed and their type, capacity and make should comply with the requirements of IS:2190-1992.

F5.1.5. Where fires are not large enough to warrant use of hydrants, but are beyond the extinguishing capability of portable fire extinguishers or are prolonging fires, hose reels come handy to tackle such fires without undue water damage.

Most of the minor fires involving paper, cloth and such other carbonaceous materials(Class-A fires) can be extinguished by suitable portable fire extinguishers or hose reels. As can be seen in Table-23 in certain occupancy class of buildings which are below 15m in height, with large floor areas or greater amount of fire risks, hose-reels are authorised.

F5.1.6. Static Water Storage Tanks:

The capacity of the underground static water tanks for building fire fighting purposes, as prescribed in Table 23 of Part-4 NBC, had been a controversial item many a time, the objections originating mostly from builders, architects and users. With the chronic shortage of water(even for drinking purposes) all over our country, providing adequate water supplies for fire fighting is a major problem to be addressed. Unlike in other developed countries, where well maintained hydrant water mains are available in all cities and towns, we do not have such reliable hydrant water mains even in our metropolitan cities, not to speak of towns. This being so, the only other sources

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point at street level and connected to the static tank by a suitable fixed pipe not less than 150mm in diameter to discharge water into the tank when required at the rate of 2250 litres per minute, if tank is in the basement or not approachable for the fire engines.

(See Fig.6)

5.1.7 Automatic Sprinklers:

Automatic sprinklers shall be installed in :

- (a) Basements used as car parks or storage occupancy if the area exceeds 200m²;
- (b) Multi-level basements, covered upper floors used as car parks, and for housing essential services ancillary to a particular occupancy or for storage occupancy, excluding any area to be used for substation, A/C plant and DG set;
- (c) Any room or other compartment of a building exceeding 1125 m² in area, except as in (g) (See Note-1), if so advised by local authority;
- (d) Departmental stores or shops, if the aggregate covered area exceeds 500m²;
- (e) All non -domestic floors of mixed occupancy which constitute a hazard and are not provided with staircases independent of the remainder of the buildings;
- (f) Godowns and warehouses, as considered necessary;
- (g) On all floors of the buildings other than residential and educational buildings, if the height of the building exceeds 15m (45m in case of group housing and apartments) (See Note-1);
- (h) Dressing rooms, scenery docks, stages and stage basements of theatres;
- (j) In hotels, hospitals, industries, (low and moderate hazard), mercantile buildings, of height 15m and above;
- (k) In hotels below 15m, if covered area at each floor is more than 1000m²;
- (m) False ceiling voids exceeding 800mm in height (See Note-2) and;
- (n) Canteen provided in upper floors of D-1 and D-2 occupancies shall be sprinklered.

NOTES-

1. It is desirable that all high-rise buildings should be fully sprinklered irrespective of their height and occupancy. If selective sprinklering is adopted, there is real danger of a fire starting on one of the lower unsprinklered floors gathering momentum, spreading upwards from floor to floor through the

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available for taking water for fire fighting purposes are the underground static water tanks provided for the buildings (as per scales prescribed in Table-23 of Part-4 NBC), and the Water Tenders of various types available with the local Fire Brigades.

In a major high rise building/warehouse fire, enormous quantities of water will be required for fire fighting which may last for several hours, with anything from 25-40 fire appliances working. Under these circumstances, until and unless a better alternative like a well designed city fire hydrant mains system is available, it will not be advisable to consider any reduction in the underground static water storage tank capacities, as prescribed in Table-23 Part-4 NBC, in the interests of public fire safety.

To illustrate the requirement for increasing the capacity of static storage tanks, as prescribed in the last sentence of the first para under 5.1.6.... If the capacity of a tank specified for a particular occupancy in Table-23 is 1,00,000 ltr., and a pump of 2,250 lpm are prescribed, and if the inflow is practically nil, the capacity of fire water tank has to be increased to $1,00,000 + 2,250 \times 60 = 2,35,000$ ltr., for 60 min. fire fighting operations utilising the water from the underground static water tank, and the pump working at maximum output level.

Many a times Snorkel vehicles of the Fire Service have to be parked in the open spaces around high rise buildings for fire fighting operations. It is therefore necessary that the slab over fire water reservoir as well as the approach path are able to take the full load of such vehicles. 45 tonnes indicated here is the normal average gross vehicle weight of the heaviest fire fighting appliance like a Snorkel, Turn table ladder (TTL), etc.

Static water tank can be used for hardly an hour long fire fighting. It needs to be replenished with fresh water to enable it to supply water for fire fighting lasting for a few hours. It is, therefore, important to provide fire brigade inlet connections for these tanks whereby Water Tenders of fire brigade can replenish water used from these tanks from nearby water sources.

F5.1.7. Automatic Sprinklers:

General:

- (a) A sprinkler system is designed to check a fire in the initial stages and not to cope with a developed fire. A developed fire, beyond the scope of sprinklers, is tackled effectively by fire service intervention. In fact, it is essential that the work of fire service should supplement the automatic action of the sprinkler system to ensure that all pockets of fire are dealt with and that the water to the sprinkler system is not turned off until the fire service officer incharge gives instructions to that effect;

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unsprinklered floors and reaching the first sprinklered floor as a fully developed fire. **In such an event, the sprinklers can be rendered useless or ineffective.**

2. Use of false ceiling voids for storage or as return air plenums should be discouraged.
3. For areas having very high ceiling height and other special function areas, where automatic sprinklers cannot be provided, appropriate sprinklers / provisions shall be provided in consultation with local fire authorities.

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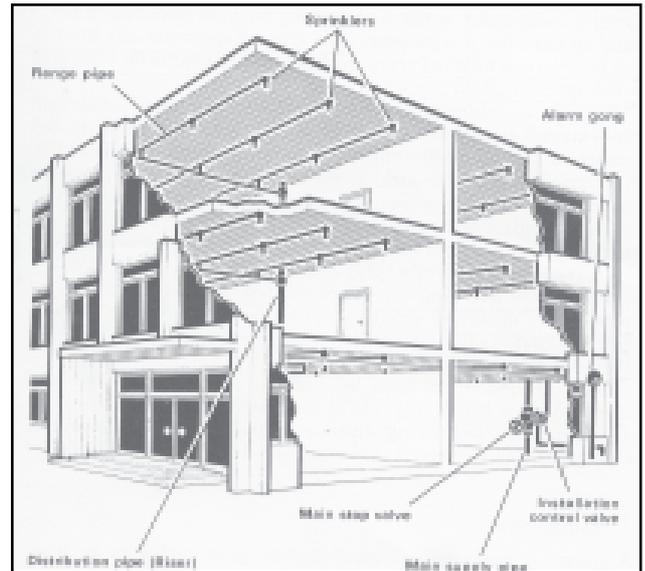


Fig-20. Layout of a typical Sprinkler Installation

- (b) When parts of buildings contain materials and processes for which water would be unsuitable as an extinguishing medium, these portions of the building can be isolated from the rest of the building by fire barriers (fire resistant walls, floors, doors, partitions etc.);
- (c) Sprinklers are of great benefit for ensuring life safety of occupants of building also, since sprinkler discharge helps substantially to control and extinguish the fire in the early stages itself, thereby diminishing the life hazard to the occupants. It has been reported that in buildings where sprinkler systems have been installed the chances of fatal occupant casualties and property losses per fire are reduced to about two-thirds, compared to buildings where sprinklers have not been installed;
- (d) When sprinklers do not produce satisfactory results, the reasons usually involve one or more of the following: (i) partial, antiquated, poorly maintained or inappropriate systems; (ii) explosions or flash fires that overpower the system before it can react; and (iii) fires very close to people who can be killed before a system can react;
- (e) If properly designed, installed and maintained, sprinkler systems remain among the best options for providing cost-effective life safety and property protection;
- (f) A sprinkler installation is planned on the basis of a **design point**. This means the maximum number of sprinklers that may be operated at one time in case of fire. Though an installation may have 500 or even 1000 sprinklers, the design point may be only 25. This means the installation is capable of dealing with a fire where upto 25 sprinkler heads are operated.
- (g) In our country also, TAC and Insurance Companies encourage the installation of sprinkler systems in buildings by giving substantial reduction in insurance

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premiums (even upto 50%) for buildings so equipped.

(h) **International experience:** (i) An analysis conducted in UK of a large number of fires in sprinkler-protected premises, provided the following statistics:

- 55% of fires were extinguished by the operation of two or less sprinkler heads;
- 80% of fires were extinguished by the operation of eight or less sprinkler heads;
- 90% of fires were extinguished by the operation of eighteen or less sprinkler heads;
- Sprinkler coverage for fire protection of occupancies has full legislative as well as insurance support.

(ii) A statistical report released by NFPA for a 10 year period reveals;

- 55% of fires were controlled and extinguished by the operation of three sprinklers;
- 80% of fires were controlled and extinguished by the operation of eight sprinklers;
- 94% of fires were controlled and extinguished by the operation of twenty one to twenty five sprinklers.

A fire, which has already developed as a large fire, in an adjoining unsprinklered area, crossing over to sprinklered area is too large for sprinkler installation to cope up with, and thereby operates a large number of sprinklers rendering the sprinkler system of no consequence because it is not designed to cope with such a large fire load.

Segregation of sprinklered areas by placing fire barriers (walls, floors and fire doors with required fire resistance rating) so that fire in an unsprinklered area is prevented from spreading to sprinklered areas.

F5.1.7.

- (a) & (b) - cars contain substantial amount of petrol and enough flammable material warranting sprinkler protection.
- (c) This is to adequately cope with the extra fire load likely to be present in such large areas.
- (d) Mercantile occupancies invariably have large fire hazard potential and hence sprinkler protection is a sine qua non.
- (e) Existing Mixed Occupancy Buildings, particularly of the 'Multiplex' type, do have assorted fire hazards which pose serious life hazard when the constituent occupancies do not have independent stairways. In such existing buildings sprinkler protection is the only answer to achieve some degree of fire and life safety protection.

Besides, basements in high rise buildings, particularly in star hotels, are often used for housing various utilities like boilers, A/c plant rooms, workshops, car parks and other hazardous occupancies and hence must be sprinklered.

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- (f) Apart from the high fire load densities in these occupancies, godowns and warehouses are normally sparsely occupied. Since hardly anyone will be present most of the time, particularly during night hours, automatic detection and suppression of fires in the initial 5 to 10 min. is very vital, and hence it is important to provide sprinklers in these areas.
- (g) In tackling fires in such very tall buildings, external fire fighting is out of question, and fixed fire protection systems installed inside the building like wet risers, landing valves, hose-reels etc. invariably will be inadequate as well as time consuming for effectively dealing with a major fire situation, and that too, after the arrival of the fire service on the scene, which can entail delay. On the other hand, sprinkler system when available, can tackle the fire effectively and promptly in the incipient stages itself.
- (h) Only these high risk areas need sprinkler protection.
- (j) If these types of occupancy buildings exceed 15m in height, then they have to be sprinklered.
- (k) In so far as hotels are concerned, even one storey hotels having large areas need sprinkler protection for maintaining high levels of fire and life safety, as per International standards.
- (m) False ceilings which are greater than 800mm in height are usually used for A/c return air system and storage of materials etc. pose hidden hazards which cannot be detected by sprinklers below them.

Standards for sprinkler system stipulate extension of the system to ceiling and under-flow voids exceeding 800mm in height, whether they are utilised for any purpose or not.

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5.1.8 Automatic High Velocity water Spray or Emulsifying System

Automatic High Velocity water Spray or Emulsifying System shall be provided for protection of indoor oil cooled transformers as applicable in accordance with C-1.16 and good practice [F (22)].

5.1.9 Fixed Foam Installation:

Fixed foam generating system shall be provided for protection of oil storage area for boilers with its ancillary storage of furnace oils in the basement. Fixed foam installations can be low, medium or high expansion types, which can cover fire risks in oil storage areas generally. High expansion foams are used for cable tunnels and other confined areas.

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F5.1.8 Automatic High Velocity Water Spray System:

High Velocity Water Spray System is used for extinguishment of fires involving flammable liquids with Flash Point exceeding 65°C and heavier than water like transformer oils.

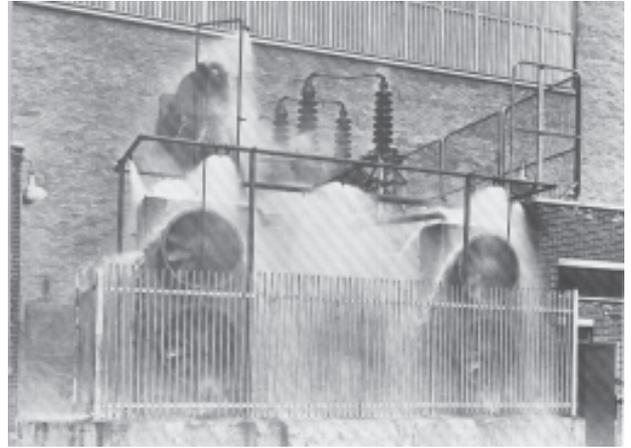


Fig-21. High Velocity Water Spray System for Transformer Fire Protection.

Fixed high velocity water spray system designed to discharge a flow of 10 lpm/m², are stipulated for fire protection for oil fired transformers with oil capacity of 2000 ltr. and above, fires in oil systems in Turbo Generators etc. Since the water is discharged in the form of broken spray droplets, there is no danger of electrical shock.

F5.1.9. Fixed Foam Installation:

Oil fires cannot be extinguished using normal water since many oils tend to float on water. Such fires may often be carried to far off places through drains also.

Foam is the most suitable extinguishing agent to be used on oil fires.

Foam extinguishes oil fires by providing a foam blanket over the surface of the burning flammable oils, thereby reducing vapour formation (starvation) and also cutting off air from the burning liquid surface (smothering or blanketing). Certain amount of cooling also takes place.

Foam is generally classified in two ways:

(a) By expansion:

The three types of foam by expansion are:

- (i) Low expansion foam--expansion upto 20
- (ii) Medium expansion foam--expansion from 50 to 250/500
- (iii) High expansion foam--expansion upto 500 to 1000

Fixed low expansion foam systems are the most commonly used for fire protection in oil installations, refineries, aircraft fire fighting etc. Medium expansion foam is more often used with portable foam making branches and are suitable for spill fires etc. due to

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5.1.10. Carbon Dioxide Fire Extinguishing System:

Fixed Carbon dioxide Fire Extinguishing installation shall be provided in accordance with good practice [F(23)] on premises where water or foam cannot be used for fire extinguishing because of special nature of the contents of the buildings/areas to be protected. For some special fire risks/essential applications, carbon dioxide may not be suitable and it may be necessary to provide BCF (Bromochlorodifluoro methane)-Halon 1211 or BTM (Bromochloro trifluoromethane) - Halon130I or some other identified substitutes.

However, the use of Halons shall be discouraged as Halons are Ozone Depleting Substances (ODS) and their use is being phased out throughout the world.

5.1.11. Fire fighting equipment shall be suitably located and clearly marked by luminous signs.

Note* This provision shall not apply to occupancies A-2 and A-4 less than 15m in height.

5.2. Fire detection /extinguishing systems:

In buildings of such size, arrangement or occupancy where a fire may not itself provide adequate warning to occupants, automatic fire detection and alarm facilities shall be provided, where necessary, to warn occupants early of the existence of fire, so that they may escape and facilitate the orderly conduct of fire exit drills.

5.2.1. Fire detection/extinguishing systems shall be in accordance with accepted standards[F(17)]. Guidelines for selection of various types of fire detectors for different occupancies shall be in accordance with good practice [F(18)]. Addressable analogue fire detection system shall be preferred.

5.2.2. The requirements of fire detection and alarm systems are also covered for each occupancy in 6.1 to 6.9; and for high rise buildings (15m or more in height) in Annex-C.

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greater coverage. High expansion foam systems are suitable for fires in confined areas like ship holds, cable tunnels, mines and also for fires in LNG and other cryogenic liquids.

(b) Foam is also known by the different types of constituents from which it is made. The main types are:

- Protein Foam(P)
- Fluoro-Protein Foam(FP)
- Aqueous Film Forming Foam(AFFF)
- Film Forming Fluoro Protein Foam(FFFP)
- Alcohol Resistant Foam(ARF, Suitable for Polar solvents/water miscible liquids).

F5.1.10. Carbondioxide gas is not a life supporting agent and hence is unsuitable for areas which are normally occupied by human beings. CO₂ extinguishing agent systems are generally used in confined spaces and are suitable for electrical hazards like Transformers, OCBs, Turbo generators, Alternators etc. Record rooms/safes, Railway locos, Flammable liquids etc. There are two types of CO₂ fire extinguishing system: (i) High pressure system(850 psi or 88.6 bars at 21°C) (ii) Low pressure system (300 psi or 20.7 bars at -18°C).The method of application of the CO₂ systems can be (i)Total flooding (ii)Local application (iii)Hand hose lines or (iv) Mobile supply.

(A separate comprehensive clause on Halon Alternatives will be included by BIS, based on the Committee proceedings of the Fire Fighting Sectional Committees, CED-22 of BIS).

F5.1.11.In case of fire, first reaction is to put off electrical supply. Marking of fire equipment locations by luminous signs help in locating them easily even in darkness.

F5.2. Fire Detection/Extinguishing Systems:

The need for Automatic Fire Alarm(AFA) Systems for protection of occupancies is well explained here as well as under 4.18.

It is actually the key element among the fire protection features of any building. If properly specified, designed, manufactured, installed, maintained, tested and used, an AFA system helps to significantly reduce losses in lives and properties in occupancies.

F5.2.1. Addressable Analog(Intelligent), Fire Detection System is a modern development which uses advanced technology as compared to conventional system. The 'addressable' extends the Data Gathering Panels(DGP) concept to each individual detector. This enables precise location of alarm to be known and the supervision of the detection system is automatic. Alarm verification reduces false alarms.

The 'Addressable Analog' (or 'Intelligent') is an extension of the Addressable system. Each device has a unique address and establishes a two way communication with the control panel.

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5.3 Fire Extinguisher / Extinguishing systems using Halon Alternatives:

Provisions for certain fire extinguishers and extinguishing systems for fire protection which may be used as halon alternatives, shall be in accordance with [F(24)] Annex-F.

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The more important advantages of the addressable Analog(Intelligent) system are:

- The precise location of alarm is known;
- Point location of sensors by type;
- Reduction in false alarm and verification of an alarm;
- Ability to interface with existing conventional fire alarm systems and also with other fire protection systems like Sprinklers, Smoke control, and also with other building facilities systems like air conditioning, heating etc.;
- Cable Economics;
- Conventional systems require more frequent maintenance.

For India, with diverse weather and environmental conditions, and where proper upkeep and maintenance of the fire alarm systems is questionable, Addressable Analog System holds out much promise.

F5.3. Halon Alternatives:

Information Note No. O/F5.3(for information only)

O.1 The National Policy on phase-out of Ozone Depleting Substances(ODS), including Halons, under the Montreal Protocol, has been notified under the Country Programme formulated and published by Govt. of India, Ministry of Environment and Forests(MOEF) in Sept. 1993.

O.2. As stipulated in the Country Programme document, Bureau of Indian Standards(BIS) had formed one Halon Alternatives Steering Committee, CED-22P for formulation of new Indian Standards on Halon Alternatives and related subjects, and for revision of the relevant IS. The Executive Committee of Montreal Protocol had approved a Project costing US \$ 88,000- for preparation and introduction of Indian Standards on Halon Alternatives. The Project is being executed through UNDP, MOEF, Govt. of India and BIS. The Steering Committee, CED 22P of BIS, has been entrusted with the actual work for formulation of new IS on Halon Alternatives and for revision / upgradation of existing IS.

O.3. The Steering Committee, CED 22P, had accordingly identified about 12 new subjects for IS on Halon Alternatives, and had also identified 19 existing IS for revision/upgradation.

The new Standards as well as the updated ones are under publication by BIS. It is understood from BIS that these have already been published.

O.4. The 12 new IS on Halon Alternatives, which are under process of publication by BIS are:

- (i) Gaseous Fire Extinguishing Systems--General Requirements for design, Installation and Commissioning;

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- (ii) Inert Gaseous Total Fire Protection(Total flooding) Systems--Inergen, Argonite, Nitrogen, Argon;
- (iii) HFC-227 ea (FM-200) Total Flooding System;
- (iv) NAF S-III(HCFC Blend A) Total Flooding System;
- (v) Water Mist Fire Protection Systems;
- (vi) Specification for Powdered Aerosol System;
- (vii) Gaseous Fire Extinguishing System--Regular Maintenance;
- (viii) Methods for Tests for determining fire extinguishing and inerting concentration for flammable liquids and gases;
- (ix) Specification for Halon 1211 and Halon 1301 for essential use(ISO 7201-1:1989)
- (x) Code of Practice for Safe Handling and Transfer Procedures of Halon 1301 and 1211;
- (xi) Carbondioxide systems, including high and low pressure and incabinet sub floor system;
- (xii) Fire Protection-Fire Extinguishing Media, Carbondioxide-Quality Assurance Test For Fire Extinguishing CO₂ Gas.

O.5. International Scenario:

O.5.1. In developed countries like USA, National Standards on Halon Alternatives have already been published. NFPA published NFPA-2001, which is the Standard on Clean Agent Fire Extinguishing Systems. The relevant Table showing the agents addressed in 2000 Edition of NFPA-2001 is reproduced below:

Table Agents Addressed in NFPA 2001		
FC-2-1-8	Perfluoropropane	C ₃ F ₈
FC-3-1-10	Perfluorobutane	C ₄ F ₁₀
HCFC Blend A	Dichlorotrifluoroethane	CHCl ₂ CF ₃
	HCFC-123 (4.75%)	
	Chlorodifluoromethane	CHClF ₂
	HCFC-22 (82%)	
HCFC-124	Chlorotetrafluoroethane	CHClF ₂ CF ₃
	HCFC-124 (9.5%)	
HCFC-124	Isopropenyl-1-methylcyclohexene	(3.75%)
	Chlorotetrafluoroethane	CHClF ₂ CF ₃
HFC-125	Pentafluoroethane	CHF ₂ CF ₃
HFC-227ea	Heptafluoropropane	CF ₃ CHFCF ₃
HFC-23	Trifluoromethane	CHF ₃
HFC-236fa	Hexafluoropropane	CF ₃ CH ₂ CF ₃
FIC-1311	Trifluoroiodide	CF ₃ I
IG-01	Argon	Ar
IG-100	Nitrogen	N ₂
IG-541	Nitrogen (52%)	N ₂
	Argon (40%)	Ar
	Carbon dioxide (8%)	CO ₂
IG-55	Nitrogen (50%)	N ₂
	Argon (50%)	Ar

Notes:
 1. Other agents could become available at later dates. They could be added via the NFPA process in future editions or amendments of the standard.
 2. Composition of inert gas agents are given in percent by volume. Composition of HCFC Blend A is given in percent by weight.

The NFPA-2001 covers all aspects of the HAs like applicability, use and limitations, safety, hazards to

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personnel, components and system design, inspection, maintenance, testing and training, marine systems, tests etc.

O.5.2. Similar new Standards have been published by British Standards Institute and Standards Australia and few other countries, besides International Standards Organisation(ISO).

The Gaseous Fire Extinguishing Systems for which ISO has published Standards are listed below:
(See next page)

O.5.3. Halons Technical Options Committee(HTOC) under the United Nations Environment Programme (UNEP) is the nodal International Body dealing with all subjects connected with Halon Phase-out and Halon Alternatives. This expert body issues exhaustive guide lines on these subjects which are meant for global application, guidance and implementation.

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**HALON ALTERNATIVES TABLE (ISO)
Listed Extinguishants**

Extingulshant	Chemical	Formula	Trade Name	Standard
CF ₃ I	Trifluoroiodomethane	CF ₃ I	Trodide	ISO 14520-2
FC-2-1-8	Perfluoropropane	CF ₃ CF ₂ CF ₃	CEA 308	ISO 14520-3
FC-3-1-10	Perfluorobutane	C ₄ F ₁₀	CEA 410	ISO 14520-4
FC-5-1-14	Perfluorohexane	CF ₃ (CF ₂) ₄ CF ₃	CEA 614	ISO 14520-5
HCFC Blend A	plus		NAF S-III	ISO 14520-6
HCFC-123	Dichlorotrifluoroethane	CHCl ₂ CF ₃		
HCFC-22	Chlorodifluoromethane	CHClF ₂		
HCFC-124	Chlorotetrafluoroethane	CHClF ₂ CF ₃		
	Isopropenyl-1-Methylcyclohexane	C ₁₀ H ₁₆		
HCFC 124	Chlorotetrafluoroethane	CHClF ₂ CF ₃	FE-241	ISO 14520-7
HFC 125	Pentafluoroethane	CHF ₂ CF ₃	FE-25	ISO 14520-8
HFC 227ea	Heptafluoropropane	CF ₃ CHF ₂ CF ₃	FM-200	ISO 14520-9
HFC 23	Trifluoromethane	CHF ₃	FE-13	ISO 14520-10
HFC 236ta	Hexafluoropropane	CF ₃ CH ₂ CF ₃	FE-36	ISO 14520-11
G-01	Argon	Ar	Argotec	ISO 14520-12
G-100	Nitrogen	N ₂		ISO 14520-13
G-55	Nitrogen (50%) Argon (50%)	N ₂ Ar	Argonite	ISO 14520-14

6. OCCUPANCYWISE REQUIREMENTS

6.1. Requirements of Residential Buildings (Group A)

6.1.1 In addition to the general requirements for the type of construction and occupancy group specified in 3.4 and the exit requirements given in 4, the requirements 6.1.2. to 6.1.4.10 shall be complied with. The capacity of any open mezzanine or balcony shall be added to the capacity of the floor below for the purpose of determining exit capacity.

6.1.2. Fire detection/extinguishing system:
The requirements for occupancy sub-divisions A-1 to A-5 as specified in Table 23 and Annex C (for High Rise Buildings) shall apply.

6.1.3. Exit Facilities:
The capacity of any open mezzanine or balcony shall be added to the capacity of the floor for the purpose of determining the exit capacity.

6.1.3.1. In addition to requirements specified for occupancy sub-division A-2, the following shall be provided for occupancy sub division A-1 :

F6. OCCUPANCYWISE REQUIREMENTS

F6.1. Requirements of Residential Buildings: (Group A)

F6.1.1. This is necessary since total exit capacity of means of escape requirement has to be sufficient for the occupant load for the floor below plus those of mezzanine and balcony.

F6.1.3. Exit Facilities:
This is generally covered under 6.1.1.

F6.1.3.1. It has to be remembered that unlike Sub division A-2, which are essentially family private dwellings, Sub division A-1 covers rented transient or permanent accommodation like clubs, guest houses etc., where more number of safe and protected exits to cater to smaller groups of individuals are necessary.

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(a) Every sleeping room above the street floor shall have access to two separate means of exits, at least one of which shall consist of an enclosed interior stairway, or a fire escape or horizontal exit all so arranged as to provide a safe path of travel to the outside of the building without traversing any corridor or space exposed to an unprotected vertical opening.

6.1.3.2. For occupancy sub-division A-2 of more than two rooms, every occupied room, excluding areas used solely for storage shall have at least two means of exits, at least one of which shall be a door or a stairway providing a means of unobstructed travel to the outside of building or street or grade level. No room or space shall be occupied which is accessible only by a ladder, folding stairs or through a trap door.

The following further provisions shall be made:

(a) All locking devices, which would impede or prohibit exit, such as chain type bolts, limited opening sliding type locks and burglar locks, which are not dis-engaged easily by quick-releasing catches, shall be prohibited. All closet door latches shall be such that even children can open the doors from inside. All bathroom door locks or fasteners shall be designed to permit the opening of the locked or closed door from the outside in an emergency with use of a special key.

6.1.3.3. For occupancy sub-division A-3, the following provisions shall apply:

(a) All dormitories shall have exits so arranged that from any sleeping room or open dormitory sleeping area, there shall be access to two separate and distinct exits in different directions with no common path of travel unless the room or space is subject to occupancy by not more than 10 persons and has a door opening directly to the outside of the building at street or grade level, or to an outside stairway in which case one means of exit may be accepted.

6.1.3.4. For occupancy sub-division A-4, the following provisions shall apply :

(a) Every individual living unit covered by occupancy sub-division A-4 shall comply with requirement for occupancy subdivision A-2 in respect of exits.

(b) Every living unit shall have access to at least two separate exits, which are remote from each other and are reached by travel in different directions, except that a common path of travel may be permitted for the first 6 m (that is a dead end corridor up to 6 m long may be permitted)

COMMENTARY

F6.1.3.2. Emphasis is laid on the need for at least two means of exit for every occupied room so as to ensure safe exit discharge to the open.

The last portion is ruling out the renting out of attics etc. which are without proper means of access/exit

These precautions are needed to ensure speedy and safe means of escape in case of fire or other emergency. They also cover the basic preventive measures to safeguard against forced, accidental or self-inflicted confinement in rooms and closets.

F6.1.3.3. Since this involves group living, and sleeping accommodation, which includes students' hostels, these minimum means of exit facilities are essential.

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provided that single exit may be permitted under any of the conditions given under (c).

- (c) Any part of building lower than the grade level shall have direct accessibility from outside
- (d) At least half of required exits shall discharge direct to the outside of the buildings; any other exit shall be same as required for hotels.

6.1.3.5. For occupancy sub-divisions A-5 and A-6, the following provisions shall apply:

- (a) Not less than two exits, as remote from each other as practicable, shall be accessible from every floor, including basements occupied for hotel purpose, except as a single exit as permitted in (b)below. Exits and ways of access thereto shall be arranged that they are accessible in at least two different directions from every point in any open area, or from any room door.
- (b) Any room or section with an outside door at street or grade level may have such outside door as single exit, provided no part of the room or area is more than 15 m from the door measured along the natural path of travel.
- (c) Provision of panic bars shall be provided in the exits.

6.1.3.5.1. Where stairways or other exits serve two or more upper floors, the same stairway or other exit required to serve any one upper floor may also serve other upper floors, except that no inside open stairway or ramp may serve as a required egress facility from more than one floor [see good practice [F(26)].

6.1.3.6. Basement Exits:

6.1.3.6.1 Basement occupied for hotel purposes shall have exits arranged in accordance with 6.1.3.5.

6.1.3.6.2 . Basement exits shall be sufficient to provide for the capacity of the basement as determined in accordance with 6.1.1. In no case shall there be less than two independent basement exits.

Basement or sub-basements not open to the public and used only for heating equipment, storage and service operations (other than kitchens, which are considered part of the hotel occupancy) shall have exits appropriate to the actual occupancy, in accordance with other applicable provisions of the code, in case of mixed occupancy where there may be doubt as to which other section is applicable, such basements shall have exits determined on the basis of lesser exit capacity.

COMMENTARY

F6.1.3.5. (a) What is important is that the minimum number of two stairways stipulated for these occupancies have to be of enclosed type.

F6.1.3.6. Basement exits:

Because of their situation, basement stairways are more likely to be filled with smoke and heat than stairs in ground and upper storeys.

The basic principle that basement should be served by two separate independent stairs should be strictly adhered to.

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6.1.4 Additional Precautions:

- 6.1.4.1.** Flammable liquids for household purposes shall be kept in tightly stoppered or sealed containers. For the limits of quantities of flammable liquids to be allowed in various occupancies, reference may be made to appropriate regulations.
- 6.1.4.2.** No stove or combustion heater shall be located directly under or immediately at the foot of stairs or otherwise so located as to block escape in case of malfunctioning of the stove or heater.
- 6.1.4.3.** All kitchen exhaust fans, where provided, shall be fixed to an outside wall or to a duct of non-combustible material, which leads directly to the outside. The ducts must not pass through areas having combustible materials.
- 6.1.4.4.** All wiring shall be done in accordance with Part 8 Building services, Section-2 Electrical installations, good practice [F(9)] and National Electric Code.
- 6.1.4.5.** Where television is installed, all outdoor antennae shall be properly grounded and protected from lightning (see part 8 Building services, section 2 Electrical installations).
- 6.1.4.6.** Doors leading to rooms in which flammable liquids are stored or used shall be as in 4.7. Such assembly shall be self closing and shall be posted with a sign on each side of the door in 25 mm high block letters stating-'FIRE DOOR - KEEP CLOSED'.
- 6.1.4.7** Where a boiler room is provided or a central heating plant is installed, which uses solid or liquid fuel, it shall be separated from rest of the building by a separation wall with all openings protected as in 3.4.7. and 3.4.8.
- 6.1.4.8.** Rooms containing high pressure boilers, refrigerating machinery, transformers or other service equipment subject to possible explosion shall not be located directly under or adjacent to exits. All such rooms shall be effectively cut off from other parts of the building and shall be provided with adequate vents to the outside air.
- 6.1.4.9.** All rooms or areas of high hazard in addition to those herein before mentioned, shall be segregated or shall be protected as may be directed by the enforcing Authority where, in the opinion of the enforcing Authority, fire, explosion or smoke therefrom is likely to interfere with safe egress from the building.
- 6.1.4.10.** For detailed information regarding fire safety requirements for hazardous petroleum products, reference may be made to the Petroleum Act, 1934 and the Rules thereof.

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F6.1.4. Additional Precautions:

- F6.1.4.1.** Accidents, some of them even fatal, had happened due to careless storage of flammable liquids in household occupancies. Particular care has to be taken to avoid storage of low flash point flammable liquid like petrol in residential accommodation.
- F6.1.4.2.** Kitchen exhaust ducts are hazardous since they convey hot and flammable gases and vapours.
- F6.1.4.6.** In addition they must have the required fire resistance also(should have a proper fire door)
- F6.1.4.7.** The separator wall must have 4 hour fire resistance with proper fire doors and ceiling/fire stops for the openings.
- F6.1.4.8.** Either such rooms should be located at least 6m away from the main building or should be segregated from the main building by fire resistant separating walls of 4 hrs. fire resistance.

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6.2. Requirements of Educational Buildings.

6.2.1 In addition to the general requirements specified in 3.4 for the type of construction and occupancy group and the exit requirements given in 6.2.2 to 6.2.6.3 shall be complied with.

6.2.2. Buildings intended for educational occupancy shall not be used for any hazardous occupancy.

6.2.3 Fire Detection/ Extinguishing System

The requirements for occupancy sub-divisions B-1 and B-2 as specified in Table 23 and Annex C (for high rise buildings) shall apply.

6.2.4 Exit Facilities.

The capacity of any open mezzanine or balcony shall be added to the capacity of the floor for the purpose of determining the exit capacity.

In addition to the provisions in 4, the following shall be provided:

6.2.4.1. Exits, in accordance with 4 shall be so arranged that at least two separate exits are available in every floor area. Exits shall be as remote from each other as practicable and so arranged that there are no pockets or dead ends of appreciable size in which occupants may be trapped.

6.2.4.2. Every room with a capacity of over 45 persons in area shall have at least two door ways.

6.2.4.3. Exterior doors shall be operated by panic bars or some other panic hardware device, except that doors leading from classrooms directly to the outside may be equipped with the same type of lock as is used on classroom doors leading to corridor, with no provision whatsoever for locking against egress from the classroom.

6.2.5. Additional precautions:

6.2.5.1. Storage of volatile flammable liquids shall be prohibited and the handling of such liquids shall be restricted to science laboratories only.

6.2.5.2 Each laboratory building shall be provided with an approved outside gas shut off valve conspicuously marked. The detailed requirements regarding safe use of gas shall conform to Part 9 NBC Plumbing Services, Section 3 Gas Supply.

6.2.5.3. All exterior openings in a boiler room or rooms containing central heating equipment if located below opening in another storey or if less than

COMMENTARY

F6.2. Requirements of Educational Buildings:

F6.2.2. Examples of hazardous occupancies are boiler rooms, transformer rooms, A/c plants, DG rooms, chemical stores etc.

In addition, it also implies that educational buildings shall not be a part of Mixed Occupancies, where other hazardous occupancy may also co-exist.

F6.2.4. Exit Facilities:

This clause emphasises the co-relation between occupant load and exit capacity.

F6.2.4.1. Being educational buildings, due care has to be taken about travel distance, number of exits, exit widths etc. Besides, this will ensure that atleast one staircase will be available for evacuation, if the others become unusable due to fire.

F6.2.4.3. Such a provision is very important for evacuation of class rooms, particularly those used by small children, or else such children can be trapped in fire/ smoke in case of a fire emergency.

F6.2.5.3. Provisions of 6.1.4.7. pertain to erection of suitable fire barriers (fire resistant walls/partitions etc. of 4 hr. fire resistanc) between A/c plant, Boiler room, Transformer room etc. and the main lobby.

F6.2.6.2. & F6.2.6.3. Wherever combustible materials like wood, plywood etc. are used, they should be rendered fire resistant by fire retardant treatment.

CODE

3m from other doors or windows of the same building, shall be protected by a fire assembly as in 3.4.8. Such assemblies shall be fixed, automatic or self closing. Provisions of 6.1.4.7 shall also apply to this group of occupancy.

6.2.6 Exception and Deviation:

6.2.6.1. Gymnasiums, indoor stadium and similar occupancies may have floors/ running tracks of wood, cinder, synthetic or unprotected steel or iron.

6.2.6.2. In gymnasiums and in multi-purpose school rooms having an area not greater than 300 m², 25 mm nominal tight tongue and grooved or 20 mm plywood wall covering may be used in the inner side in lieu of fire resistant plaster.

6.2.6.3. A building, which will have only the ground floor and is accessible to not more than 20 pupils at any time, may be used for school purposes with the following exception as required.

- (a) Exterior walls or parts of walls which are less than 900 mm from adjacent property lines shall have no openings therein.
- b) Class rooms may have only one exit not less than 900 mm wide.

6.3 Requirements of Institutional Buildings (Group C).

6.3.1. In addition to the general requirements specified in 3.4 for the type of construction and occupancy group and the exit requirements given in 4, the requirements given in 6.3.2 to 6.3.5 shall be complied with.

6.3.2. Fire Detection/Extinguishing system:

The requirements for occupancy sub-divisions as specified in Table 23 and Annex C (for high rise buildings) shall apply.

6.3.3 Exit Facilities:

In addition to provisions of 4, the following requirements shall be complied with.

6.3.3.1 In buildings or sections occupied by bed-ridden patients where the floor area is over 280 m², facilities shall be provided to move patients in hospital beds to the other side of a smoke barrier from any part of such building or section not directly served by approved horizontal exits or exits from the first floor (Floor-2) of a building to

COMMENTARY

F6.3. Requirements of Institutional Buildings (Group C):

F6.3.3. Exit Facilities:

F6.3.3.1. A smoke barrier is a continuous protected structure or partition designed for restricting the movement of smoke.

This clause emphasises the need for facilities for transfer of patients from one section of a floor to another section of the same floor that is separated by a fire barrier in such a manner that patients confined to beds can be transferred with the beds, thereby getting the patient evacuated from a fire and smoke threatening area.

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- the outside.
- 6.3.3.2** Not less than two exits of one or more of the following types shall be provided for every floor, including basements, of every building or section:
- Doors leading directly outside the building;
 - Stairways;
 - Ramps;
 - Horizontal Exits and;
 - Fire tower.
- 6.3.3.3.** All required exits that serve as egress from hospital or infirmary sections shall be not less than 2m in clear width including patient bedroom doors to permit transportation of patients on beds, litters or mattresses. The minimum width of corridors serving patients bed rooms in buildings shall be 2400 mm. For detailed information on recommendations for buildings and facilities for the physically handicapped reference may be made to good practice [F(26)].
- 6.3.3.4.** Elevators constitute a desirable supplementary facility, but are not counted as required exits. Patient lift shall also be provided with enough room for transporting a stretcher trolley.
- 6.3.3.5.** Any area exceeding 500 m² shall be divided into compartments by fire resistant walls.
- 6.3.3.6.** Doors in fire resistant walls shall be so installed that these may normally be kept in open position, but will close automatically. Corridor door openings in smoke barriers shall be not less than 2000 mm in width. Provision shall also be made for double swing single/ double leaf type doors.
- 6.3.3.7** Exits and other features for penal and mental institutions, and custodial institutions shall be the same as specified for hospitals, in so far as applicable. Reliable means shall be provided to permit the prompt release of inmates from any locked section in case of fire or other emergency.
- 6.3.3.8.** Wherever any inmates are confined in any locked rooms or spaces, adequate guards or other personnel shall be continuously on duty or immediately available to provide for release of inmates or for such other action as may be indicated in case of fire or other emergency.
- 6.3.3.9.** No building constructed in whole or in part of combustible materials shall be used to confine inmates in cells or sleeping quarters, unless automatic sprinkler protection is provided.

COMMENTARY

F6.3.3.3. The reference quoted here is IS: 4963-1987, 'Recommendations for Buildings and Facilities for the Physically Handicapped'. Besides this, detailed provisions are given in Annex-E of Part-3 NBC, 'Special Requirements for Planning of Public Buildings meant for use of Physically Handicapped' also.

F6.3.3.4. Elevators if not properly designed can prove to be a deterrant in evacuation process. They can stop in between floors if electricity fails. In any case patients on trolleys must be able to be transported using patient lift as they can only accommodate stretcher trolleys.

For information only: As per International practice, for evacuation of patients as well as disabled persons and wheel chair patients, elevators are used normally as well as during emergencies. However stringent provisions for ensuring safe operation of the elevators even during failure of the main supply by providing fool proof standby power supply arrangements, two way communication facilities in the elevator cars etc. exist.

F6.3.3.6. A fire door can be made to slide automatically over a sliding rail or to close automatically over an opening which it protects using a fusible link and a counter-weight arrangement.

F6.3.3.7. The staff employed in such institutions need to be given continuous training in evacuation drills in case of fire emergency.

F6.3.3.8. If guards are not present on duty and there is a fire, the inmates who are locked cannot escape because of locks on their cells. This could lead to loss of life which could have been easily avoided.

There had been some tragic incidents in the past causing heavy loss of lives due to non-observance of such safety precautions. To cite one case which happened on 6th August 2001 in Tamil Nadu state: Of the 43 mentally ill persons kept chained in an improvised Mental Asylum (a thatched structure), 28 died in an early morning fire which originated from a fallen K-oil chimney lamp. There were no other personnel around and within 10 min. the entire structure was gutted. The fire service on arrival recovered 28 chained charred bodies. The rest were either sent to hospital with burns or escaped.

F6.3.3.9. The incident just narrated above will bear ample testimony to the casual, callous and negative approach of the authorities concerned on such serious issues involving life safety of confined inmates in such institutional occupancies.

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6.3.310. All buildings or sections of building in penal and mental institutions used for manufacturing, storage or office purposes shall have exits in accordance with the provisions of the code for those occupancies.

6.3.4. Additional precautions:

6.3.4.1. No combustible material of any kind shall be stored or used in any building or section thereof used for institutional occupancy, except as necessary to normal occupancy and use of the building.

6.3.4.2. Bare minimum quantities of flammable materials such as chloroform, ethyl alcohol, spirit, etc shall be allowed to be handled or stored. The handling of such liquids shall not be permitted by unauthorized persons. Bulk storage of these items, shall be governed by relevant rules and safe practices.

6.3.5. Exceptions and Deviations.

It is recognized that in institutions or part of buildings housing various types of psychiatric patients, or used as penal and mental institutions, it is necessary to maintain locked doors and barred windows; and to such extent the necessary provisions in other sections of the code requiring the keeping of exits unlocked may be waived. It is also recognized that certain type of psychiatric patients are not capable of seeking safety without adequate guidance. In buildings where this situation prevails, reliable means for the rapid release of occupants shall be provided, such as remote control of locks to keys commonly used by attendants.

6.4 Requirements of Assembly Buildings (Group D)

6.4.1. In addition to the general requirements specified in 3.4 for type of construction and occupancy group and the exit requirements given in 4, the requirements given in 6.4.2 to 6.4.7.4 shall be complied with.

6.4.2. Mixed occupancy:

Places of assembly in buildings of other occupancy, such as ball rooms in hotels, restaurants in stores and assembly rooms in schools, shall be so located, separated or protected as to avoid any undue danger to the occupants of the place of assembly from a fire originating in the other occupancy or smoke there from.

6.4.3 Fire Detection Extinguishing system

The requirements for occupancy sub-division D-I to D-5 as specified in Table 23 and Annex C

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F6.3.5. These are important Code provisions which need to be brought to the notice of concerned Prison, Reformatory, Mental Asylum etc. authorities for implementation.

For information only: NFPA Life Safety Code(NFPA-101) and Means of Egress Code(NFPA-101-B) stipulate provision of approved 'delayed egress locks' and 'entrance and egress access control systems' as well as 'panic hardware' and 'fire exit hardware' for special occupancies.

F6.4.2. It goes without saying that Mixed Occupancies having Assembly Occupancy as one of the constituent, should have high standards of fire prevention, fire protection and life safety measures and such occupancies are predominantly life hazard occupancies. This concept should be given due consideration all through the planning, design, construction, inspection and maintenance stages.

F6.4.3. Fire Detection/Extinguishing System:

Canteens in auditoriums pose substantial fire and life safety hazards and are not recommended to be located in the basements. In any case they must be sprinklered to take care of any fire hazard

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(for high rise building) shall apply.

Note- Canteens shall not be provided in basements. If provided in the upper floors, it shall be sprinklered.

6.4.4 Exit facilities:

6.4.4.1. Every place of assembly, every tier of balcony, and every individual room used as a place of assembly shall have exits sufficient to provide for the total capacity thereof as determined in accordance with 4. Door width for assembly buildings shall not be less than 2000 mm.

6.4.4.1.1. Every place of assembly of subdivision D-1 shall have at least four separate exits as remote from each other as practicable.

6.4.4.1.2. Every place of assembly, of subdivision D-2, shall have at least two separate exits as remote from each other as practicable and if of capacity over 600 at least 3 exits shall be provided with each exit not less than 2000mm width.

6.4.4.2. Clear aisles not less than 1,2m in width shall be formed at right angles to the line of seating in such number and manner that no seat shall be more than seven seats away from an aisle. Rows of seats opening to an aisle at one end only shall have not more than seven seats. Under the conditions, where all these aisles do not directly meet the exit doors, cross-aisles shall be provided parallel to the line of seating so as to provide direct access to the exit, provided that not more than one cross aisle for every 10 rows shall be required. The width of cross-aisles shall be minimum of 1 m. Steps shall not be placed in aisles to overcome differences in levels, unless the gradient exceeds 1 in 10.

6.4.4.3. The fascia of boxes, balconies and galleries shall have substantial railings not less than 1000mm high above the floor. The railings at end of aisles extending to the fascia shall be not less than 1100mm high for the width of the aisle or 1200mm high at the foot of steps.

6.4.4.4. Cross aisles except where the backs of seats on the front of the aisle project 600mm or more above the floor of the aisle shall be provided with railings not less than 900mm high.

6.4.4.5. No turnstiles or other devices to restrict the movement of persons shall be installed in any place of assembly in such a manner as to interfere in any way with the required exit

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F6.4.4.3. Being Reviewed:

F6.4.4.5. Turnstiles as well as Revolving doors restrict the free movement of persons and hence should not be permitted in means of egress for any type of occupancy.

F6.4.4.6. This is in conformity with International practice also. It is necessary to ensure that the waiting spaces should not in any way obstruct the normal means of egress. In fact, an exactly similar provision exists in NFPA Codes also(NFPA-5000-2003).

For information only:

(a) The unit area of 1 person for each 0.3m² waiting space area' is actually meant for provision of exits for the persons in the waiting area. In the explanatory notes given in the NFPA Codes, it has been clarified that where standing room is permitted(in case of over crowd) the capacity of the standing area should have the undermentioned criteria:

- (i) It should be determined on the basis of 5 ft.²(0.46m²) per person;
- (ii) It should have its capacity added to the seating capacity in determining egress requirements;
- (iii) It should be located to the rear of the seating area;
- (iv) It should be assigned "standing-room-only tickets" according to the area designated for the purpose.

(b) A few major cinema/theatre fires which had happened in the world are listed below:

Date	Incident Brief	Casualties
30 Dec. 1903	Iroquois Theatre fire Chicago, US	602
19 Aug. 1978	Abadan Cinema fire, Iran(sabotage)	430
Feb.1983	Tuticorin, T.Nadu Cinema fire	64
8 Feb. 1989	Premier Film Studio fire Mysore	49+100 injured
8 Dec. 1994	Kalamreji Cinema hall North China fire	525 School Children
13 June 1997	Uphar Cinema fire N. Delhi	59+ 200 injured
24 Sept. 1999	Cinema Complex Indonesia	75+ Several injured

Note: The worst fire in a single building occurred in a theatre in Canton, China in 1845, when 1670 people got killed.

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facilities.

6.4.4.6. In theatres and similar places of public assembly where persons are admitted to the building at a time when seats are not available for them are allowed to wait in a lobby or similar place until seats are available, such use of lobby or similar space shall not encroach upon the required clear width of exits. Such waiting shall be restricted to areas separated from the exit ways by substantial permanent partitions or fixed rigid railing not less than 105cm high. Exits shall be provided for such waiting spaces on the basis of 1 person for each 0.3 m² of waiting space area. Such exits shall be in addition to exits specified for the main auditorium area and shall conform in construction and arrangement to the general rules of exit given above.

6.4.4.7. No display or exhibit shall be so installed or operated as to interfere in any way with access to any required exit, or with any required exit sign.

All displays or exhibits of combustible material or construction and all booths and temporary construction in connection therewith shall be so limited in combustibility or protected as to avoid any undue hazard of fire which might endanger occupants before they have opportunity to use the available exits, as determined by the authority.

6.4.4.8. Places of assembly in buildings of other occupancy may use exits common to the place of assembly and the other occupancy, provided the assembly area and the other occupancy are considered separately, and each has exits sufficient to meet the requirements of the code.

6.4.4.9. Exits shall be sufficient for simultaneous occupancy of both the places of assembly and other parts of the building, unless authority determines that the simultaneous occupancy will not occur.

6.4.4.10. For any place of assembly under subdivision D-1, at least half the required means of exit shall lead directly outdoors or through exit ways completely separated from exits serving other parts of the building.

6.4.4.11. For detailed information regarding cinema buildings, reference may be made to good practice [F(27)].

F6.4.4.7. Modern day tendency in multiplexes is to display big hoardings in the entrance lobbies to attract attention of audiences visiting them. It is however equally important that they should be installed clear of all exits and exit signs to facilitate proper evacuation of people in case of a fire emergency.

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6.4.5 Lighting:

No open flame lighting devices shall be used in any place of assembly, except in the following cases:

- (a) Where necessary for ceremonial purposes, the enforcing authority may permit open flame lighting under such restrictions as are necessary to avoid danger or ignition of combustible materials or injury to occupants.
- (b) Candles may be used on restaurant tables if securely supported on non combustible bases and so located as to avoid danger of ignition of combustible materials.
- (c) Open flame devices may be used on stages where they are a necessary part of theatrical performance, provided adequate precautions, satisfactory to the authority are taken to prevent ignition of combustible materials.

6.4.6 Additional Precautions:

6.4.6.1. The decoration of places of assembly shall be of non-flammable materials. Fabrics and papers used for such purpose shall be treated with an effective flame retardant material. Stage settings made of combustible materials shall likewise be treated with fire retardant materials of class 1 flame spread.

6.4.6.2. Seats in places of assembly, accommodating more than 300 persons, shall be securely fastened to the floor, except as permitted in 6.4.6.3. All seats in balconies and galleries shall be securely fastened to the floor, except that in nailed-in enclosures like boxes with level floors and having not more than 14 seats the seats need not be fastened.

F6.4.4.9. The commentary given earlier under F6.4.2. holds good here also.

F6.4.5. Lighting:

(a) & (b) India, being a country where open flaming lamps are not only commonly used for all types of social and religious functions, but are objects of daily worship also (besides the observance of festival of lights etc.), these fire safety and fire precautionary requirements are to be scrupulously implemented by all concerned. This assumes extra importance in the context of certain major fire outbreaks which had happened due to flouting of these basic fire safety measures.

(c) This being a liberal clause, extreme care is essential on the part of all concerned to ensure that no mishap occurs due to any oversight on the observance on safety precautions.

F6.4.6. Additional Precautions:

F6.4.6.1. Decoration materials and stage settings of combustible nature have been the cause of several theatre fires which have resulted in total losses. In this context this requirement assumes greater importance.

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6.4.6.3. Chairs not secured to the floor may be permitted in restaurants, night clubs and other occupancies where fastening to the floor may not be practicable, provided that in the area used for seating, excluding dance floor, stage, etc, there shall be not more than one seat for each 1.4m² of floor area and adequate aisles to reach exits shall be maintained at all times.

6.4.6.3.1. Rows of seats between aisles have not more than 14 seats.

6.4.6.3.2. Rows of seats opening on to an aisle at one end only shall have not more than 7 seats.

6.4.6.3.3. Seats without dividing arms shall have their capacity determined by allowing 450 mm per person.

6.4.6.4. The spacing of rows of seats from back to back shall be neither be less than 850mm nor less than 700mm plus the sum of the thickness of the back and the inclination of the back. There shall be a space of not less than 350mm between the back of one seat and the front of the seat immediately behind it as measured between plumb lines.

6.4.6.5. Rooms containing high pressure boilers, refrigerating machinery other than domestic refrigerator type, large transformers or other service equipments subject to possible explosion shall not be located directly under or adjacent to required exits. All such rooms shall be effectively cut off from other parts of the building and provided with adequate vents to the outer air.

6.4.6.6. All rooms or areas used for storage of any combustible material or equipment, or for painting, refinishing, repair or similar purposes shall be effectively cut off from assembly areas or protected with a standard system of automatic sprinklers. They shall be located away from staircases.

6.4.6.7. Every stage equipped with fly galleries, grid irons and rigging for movable theatre type scenery, shall have a system of automatic sprinklers over and under such stage areas or spaces and auxiliary spaces, such as dressing rooms, store rooms and workshops. The proscenium opening shall be provided with a fire- resisting curtain, capable of withstanding a lateral pressure of 4 KN/m² over the entire area. The curtain shall have an emergency closing device capable of causing the curtain to close without the use of power and when so closed, it shall be reasonably tight against the passage of

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F6.4.6.3. Among the occupancies cited here, 'night clubs', where large number of people gather for amusement purposes, with the premises functioning almost overnight, had been the scene of several fire tragedies in the past. Some of the worst cases are mentioned below showing the heavy number of casualties suffered.

Date	Incident Brief	Casualties
28 Nov. 1942	Coconut Grove, Boston, USA, worst Night Club fire ever happened	492
28 May 1977	Beverly Hills Night Club Kentucky, USA	165
1 Feb. 1981	Stardust Disco, Dublin	48(young revellers)
17 Dec. 1983	Madrid Disco fire(Spain)	78 -do-
27 Nov. 1994	China Night Club fire (quickly overcome by smoke and toxic gases within 2 to 3 min. - 230 burnt bodies recovered close to door).	234(College Students)
18 Mar. 1996	Manila Ozone Disco fire (due to smoke from plastics-only one exit)	162

F6.4.6.5. This clause contains some important fire safety rules for compliance. A typical instance of non-compliance of such rules leading to a major catastrophe is the Uphar Cinema Theatre fire in Delhi.

F6.4.6.6. Besides installation of sprinklers, it will be necessary for provision of fire barriers(fire resistant seperating walls) also to segregate the fire hazardous areas from Assembly areas.

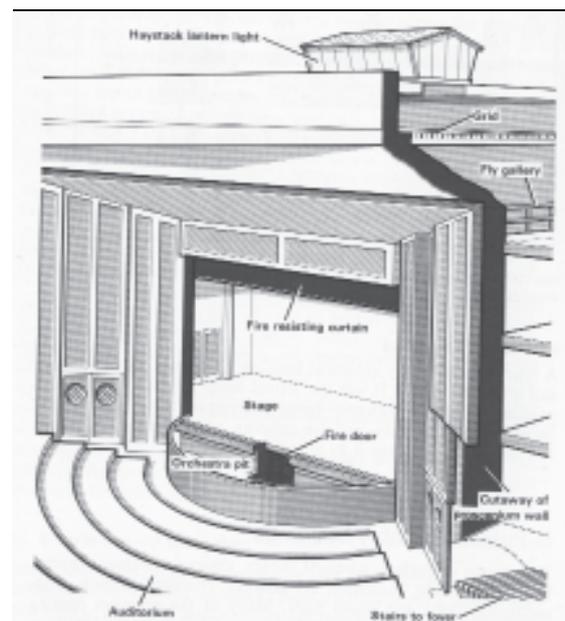


Fig-22. Theatre stage showing fire resistant curtain and proscenium wall

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smoke.

6.4.6.8. The stage roof of every theatre using movable scenery or having a motion picture screen of highly combustible construction shall have a ventilator or ventilators in or above it, operable from the stage floor by hand and also opening by fusible links or some other approved automatic heat/smoke actuated device, to give a free opening equal to at least one-eighth the area of the floor of the stage.

6.4.6.9. The proscenium wall of every theatre using movable scenery or decorations shall have exclusive of the proscenium opening, not more than two openings entering the stage, each not to exceed 2 m² and fitted with self-closing fire resistant doors.

6.4.6.10 Every place of assembly in which projection of motion pictures by light is made shall have the projection apparatus enclosed in a fire-resisting fixed booth in accordance with good practice [F(27)], except that such booth shall not be required where no nitrocellulose motion picture film is used.

6.4.6.11 Automatic smoke vents actuated by smoke detectors shall be installed above the auditorium or theatres, including motion picture houses, with vent area equal to not less than 3.1/3% of the floor area of the auditorium, including the floor areas of all balconies, galleries, boxes and tiers. It may be desirable to provide a large number of small vents rather than a small number of large vents.

6.4.7. Exception and Deviation:

6.4.7.1. Where boilers or central heating plants using liquid or solid fuels are located at grade level, these shall be separated from the remainder of the building by a separating wall with openings protected as in 3.4.7 & 3.4.8.

6.4.7.2 Gymnasiums, indoor stadiums and similar occupancies may have floors/ running tracks of wood, cinder, synthetic or un-protected steel or iron.

6.4.7.3. The underside of continuous steel deck grandstands when erected outdoors need not be fire protected when occupied for public toilets.

6.4.8. Fire Protection and Fire Fighting System for Metro Stations

6.4.8.1. Wet riser system

Main and diesel fire pump of 1 800 LPM capacity

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F6.4.6.8. This relates to the provision of automatic roof vents over the stage roofs in theatres for smoke venting.

F6.4.6.11. For details on smoke and fire venting please refer to clause D-2.

F6.4.7. Exception and Deviation: This clause is under revision.

F6.4.8. This is a new section included in the Code. It is felt that in the first instance a separate Indian Standard on Code of Practice on this subject should have been published before incorporation of the detailed fire protection recommendations in the Code. Detailed comments on this have been forwarded separately. (Please see Comments on NBC Part 4, Part B)

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to be provided to support 3 to 4 hydrants at a time. Jockey pump capacity shall be 180 LPM. Where it is possible to extend reliable DG supply to the fire pump room without routing through the station building, the provision of diesel pump can be dispensed with and instead, two electric pumps may be provided out of which at least one should have DG backup. The jockey pump should also have DG back up.

6.4.8.2. Internal hydrant

The internal hydrant is proposed to be provided with 2 number RRL hose pipes of 38 mm dia with 63 mm standard instantaneous coupling along with associated branch pipes and cabinet and a first aid hose reel of 25 mm dia, length 45 m and fitted with 6.5 mm nozzle.

Two internal hydrants are proposed to be provided on each platform in such a way so that most of the platform is covered by hose. However, in case of necessity, the hose pipes from other hose cabinets can be utilized for extending the length of fire hose pipe for fire fighting, if need be. At the concourse level minimum two hydrants will be provided. In station where the concourse is split into two halves at least one hydrant is to be provided in each half of the concourse. Further, in case the area is more than 2000 sqm, an additional first aid hose-reel point shall be provided for every additional 1000sqm.

In addition, hydrants shall be provided in commercial areas also.

One hydrant shall be provided at entry of each station at ground floor for providing the coverage to the parking area.

6.4.8.3. Sprinklers

Sprinklers are required to be provided only in the commercial areas, if any, in the station. The commercial areas will be segregated from the station area through 2h fire rated walls & doors. Additional sprinklers pumps are not required, as two pumps already provided for hydrant system will take care of the sprinkler flow requirements. However, if such commercial areas in the premises of stations are in isolated building separate from the station building then the provision of sprinkler pump and water tank capacities shall be as per NBC. The water storage and pumps may however be common.

6.4.8.4. Detectors

Detectors are required to be provided only in areas there are false ceiling, the detectors should be provided both above and below fals

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ceiling giving due consideration to depth of false ceiling/flooring. However, in concourse the detectors below false ceiling may not be effective due to heights/cross ventilation and therefore may not be provided in other areas, because of high heights and cross-ventilations, detectors will not be effective and hence therefore can be dispensed A conventional detection system will suffice at a normal station.

6.4.8.5. Manual call box

Manual call box should be provided at a central place on each platform (near emergency plunger) and at least two on the concourse, on each sidewall. When the concourse in two halves there should be one manual call box on each side.

6.4.8.6. Manual panel gas flooding

Electric panels should have provision of manual gas flooding. Alternatively panels can be provided with linear heat sensing tubes with CO₂ cylinder. This required to be provided only in main power panels i.e. HT panel, main LT panel, main LT distribution board and essential power panels and other such major panels.

6.4.8.7. External area of the station

A two way/four way Fire Brigade inlet to be provided at ground level on each rising main for hydrants/sprinklers.

The 'Draw Off Connection' shall be provided on the underground tank for fire brigade.

6.4.8.8. Water tank capacity

Capacity of fire tanks at stations without any commercial development (Beverage stall/ATM/Florist/Book stalls up to total 250 sqm excluded) shall be 50,000 litres.

However, at stations having commercial development, the fire tank capacity shall be 100,000 litres.

6.4.8.9. Portable fire extinguishers

For the purpose of standardization, the following portable extinguishers are recommended.

- i) Water CO₂ type 9 litres
- ii) CO₂ fire extinguishers 4.5 kg

They shall be provided in various areas as detailed hereunder

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SI No. (1)	Item (2)	Numbers & Location (3)	
PLATFORM			
1.	Internal Hydrants	Two at each platform The hydrants at two platform may be staggered for maximum coverage	
2.	Manual call box	One on each platform preferably near emergency plunger	
3.	Portable Extinguishers	One set of Water CO ₂ and CO ₂ type on each platform at a central area	
CONCOURSE			
1.	Internal Hydrants	Two at each Concourse. When Concourse is in two parts then each part should have at least one hydrant.	
2.	Additional first aid reel point	Additional first aid reel point for every additional 1000 sqm, if the area is more than 2000 sqm. Similarly, if the Concourse is in two parts then additional first aid reel point for every additional 1000 sqm, if the area of the part is more than 1000 sqm.	
3.	Manual call box	Two at each Concourse. When Concourse is in two parts then each part should have at least one.	
4.	Portable Extinguishers	Two sets at each Concourse. When Concourse is in two parts then each part should have at least one set.	
5.	Detectors	Above false ceiling where depth of false ceiling is greater than 800 mm. Required in Commercial areas	

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also.		
EQUIPMENT ROOM AREAS		
1.	Inernal Hydrants/ first aid reel point	The requirement shall get covered with platform/concourse. Additional first aid reel point may be provided, if required.
2.	Manual call box	One at a central place. When the equipment rooms are in two / more parts then each part should have one.
(1)	(2)	(3)
3.	Portable Extinguishers	One set for each room
4.	Detectors	Above & below false ceiling and below floor giving due consideration to depth of false ceiling/ floor
5.	Response indicator	To be provided
6.	Panel gas flooding	To be provided for HT panel, main LT panel, main LT distribution board and Essential power panels and other such major panels.
EXTERNAL AREAS		
1.	Hydrants	One at ground floor at each entry to station near staircase/DG room.
2.	Two/four way fire brigade inlet	To be provided for each riser / sprinkler riser.
3.	Fire brigade Draw off connection	To be provided on water tank
6.5. Requirements of Business Buildings (Group-E):		
6.5.1. In addition to the general requirements specified in 3.4 for type of construction and occupancy group and exit requirements given in 4, the requirements given in 6.5.2 to 6.5.5 shall be complied with.		
6.5.2 Fire detection / Extinguishing system: The requirements for occupancy sub-divisions as specified in Table-23 and Annex-C (For High rise Buildings) shall apply.		
6.5.2.1. Occupancy subdivision E-1(Except Office		

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Buildings)		
Details of Occupancy	Fire Detection / Extinguishing System	
E-1	Automatic fire alarm system {good practice [F(17)] and [F(18)], and Table 23}	
6.5.2.2 Occupancy Subdivision E-2		
Details of Occupancy	Fire Detection/Extinguishing System	
a) Laboratory with delicate instruments	Fixed Automatic CO ₂ fire extinguishing system or automatic fire alarm system {good practice [F(18)] and [F(23)] and Table 23}	
b) Solvent storage and / or flammable liquid	Automatic foam installation or Automatic CO ₂ fire extinguishing system	
6.5.2.3. Occupancy Subdivision E-3		
Details of Occupancy	Fire Detection/Extinguishing System	
a) Area of computer installations	Automatic fire alarm system {good practice [F(17)] and [F(18)] and Table 23} any suitable halon alternative fire extinguishing system (see 5.3) or any other suitable fire extinguishing installation {see also [F(28)]}	
b) Space under false ceiling (floor)	Automatic fire alarm system {good practice [F(17)] and [F(18)], and Table 23}	
c) Space above false ceiling and below false floor	Automatic fire alarm system {good practice [F(17)] and [F(18)], and Table 23}	
d) Electrical switch board	Automatic fire alarm system {good practice [F(17)] and [F(18)] and Table 23} and CO ₂ fire extinguishing installation	
6.5.2.4 Occupancy Subdivision E-4		
Details of Occupancy	Fire Detection/ Extinguishing System	
Telephone exchanges	Any suitable halon alternative fire extinguishing system (see	

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5.3) and/or automatic sprinkler system as per requirement (see also Table 23)	
6.5.2.5. Occupancy Subdivision E-5	
Details of Occupancy System	Fire Detection/Extinguishing System
Broadcasting stations	Automatic fire alarm system based on smoke detectors and sprinkler system (see also Table 23)
6.5.3. Exit Facilities	
Following requirements shall be complied with in addition.	
6.5.3.1. In case of mezzanines or balconies open to the floor below, or other unprotected vertical openings between floors, the population of the mezzanine or other subsidiary floor for level shall be added to that of the main floor the purpose of determining the required exits, provided, however, that in no case shall the total number of exit units be less than that required if all vertical openings were enclosed.	
6.5.3.2. Not less than two exits shall be provided for every floor, including basements occupied for office purposes or uses incidental thereto.	
6.5.4. Additional Requirements:	
6.5.4.1 The handling and use of gasoline, fuel oil and other flammable liquids shall not be permitted, unless such use and handling complies with appropriate regulation.	
6.5.4.2. Every boiler room or room containing a central heating plant using solid or liquid fuel shall be separated from the rest of the building by a separating wall. Every boiler room or room containing a central heating plant, which burns gas as a fuel shall be adequately separated from the rest of the building.	
6.5.5. Exception and deviation.	
6.5.5.1. Basements used only for storage, heating or any other service equipment shall conform to exit requirements for Group H occupancies in all respects.	

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6.6 Requirements of Mercantile Buildings (Group F).

6.6.1 In addition to the general requirements specified in 3.4 for type of construction and occupancy and the exit requirements given in 4, the requirements given in 6.6.1.1 to 6.6.5 shall be complied with.

6.6.1.1. Mixed Occupancy

No dwelling unit shall have its sole means of exit through any mercantile occupancy in the same building except in the case of a single family unit where the family operates the store.

6.6.2. Fire Detection/Extinguishing System

The requirements for occupancy sub-divisions F-1 to F-3 as specified in Table 23 and Annex C (for high rise buildings) shall apply

6.6.3. Exit Facilities

In addition to the provisions of 4, the following requirements shall be complied with.

6.6.3.1. In the case of mezzanines or balconies open to the floor below, or other unprotected vertical openings between floors, the population or areas of the mezzanine or other subsidiary floor level shall be added to that of the main floor for the purpose of determining the required exits, provided, however, that in no case shall the total number of exit units be less than that required if all vertical openings were enclosed.

6.6.3.2. At least two separate exits shall be accessible from every part of every floor, including basements; such exits shall be as remote from each other as practicable and so arranged as to be reached by different paths of travel in different directions, except that a common path of travel may be permitted for the first 15m from any point.

6.6.4. Additional Precautions

6.6.4.1. Requirements specified in 6.5.4.1. shall be applicable to all Group F occupancies also.

6.6.4.2. Hazardous areas of mercantile occupancies shall be segregated or protected suitably.

6.6.4.3. In self-service stores, no check out stand or associated railings or barriers shall obstruct exits or required aisles or approaches thereto.

6.6.4.4. Open-air mercantile operations, such as open-air markets, gasoline filling stations, roadside stands for the sale of a farm produce and other outdoor mercantile operations shall be

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F6.6. Requirements of Mercantile Buildings (Group F):

F6.6.1.1. Mixed Occupancies of this nature are quite hazardous and quite a few fire incidents had occurred in different cities/towns in India and abroad in such premises causing fatalities, especially in big Departmental Stores.

F6.6.3. Occupancies coming under Sub divisions F-2 (Departmental Stores/Supermarkets etc.) and F-3 (Underground Shopping Complexes) are extra fire prone, as borne out of practical experience. To illustrate this point, some of the major tragedies which had occurred in such premises are listed below:

Date	Incident Brief	Casualties
22 May. 1967	Department Store fire, Brussels (unenclosed stairways and plenty of highly flammable plastic materials)	311 died and 400 injured
24 Feb. 1972	Andraus Dept. Store Sao Paulo, Brazil	20
23 Nov. 1973	Taiyo Dept. Store, Japan	100
20 March 1994	Bogor Dept. Store (Indonesia)	77 died + 25 injured
27 June 1995	5 storey Dept. Store S. Korea (Bldg. crowded with shoppers collapsed following gas explosion)	100 dead and 900 injured.

F6.6.4. Additional Precautions:

F6.6.4.2. This calls for an in-depth survey/assessment of the risks involved and subsequent selection of the appropriate fire protection measures.

F6.6.4.3. This clause implies non-use of barriers like turnstiles which constitute a hindrance to free exit discharge.

F6.6.4.4. In our cities and towns, the practice of holding 'weekly markets' in the open is quite popular. The safety precautions enumerated under this clause are quite essential and compliance of these should be monitored by the licencing authorities.

F6.6.4.5. Apart from 'over-roof' mercantile operations, mercantile units do function in basements and sub basements levels also in our cities. These below grade shop complexes are quite fire hazardous and warrants due fire protection measures, like mandatory sprinkler protection.

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so arranged and conducted as to maintain free and unobstructed ways of travel at all times to permit prompt escape from any point of danger in case of fire or other emergency, but no dead-ends in which persons might be trapped due to display stands, adjoining buildings, fences, vehicles or other obstructions.

6.6.4.5. If mercantile operations are conducted in roofed over areas, these shall be treated as mercantile buildings, provided canopies over individual small stands to protect merchandise from the weather shall not be construed to constitute buildings for the purpose of code.

6.6.5. Exception and deviation

Any mercantile occupancy, where goods of a highly hazardous nature are pre-dominant, shall be considered under Group-J occupancy for the purpose of the Code.

6.7. Requirements Of Industrial buildings (Group G):

6.7.1. In addition to the general requirements specified in 3.4 for the type of construction and occupancy group and the exit requirements given in 4, the requirements given in 6.7.2 to 6.7.5 shall be complied with.

6.7.2. Fire Detection/ Extinguishing system:

The requirements for occupancy sub-divisions G-1 to G-3 as specified in Table 23 and AnnexC (for high rise building) shall apply.

6.7.3 Exit Facilities:

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F6.7. Requirements of Industrial Buildings (Group G)

General:

- (a) Industrial occupancies cover a broad spectrum of industries of general purpose, utility, and manufacturing types. They include factories, power plants, refineries, Defence industries etc. For hazard assesment of industrial occupancies, the primary factors to be considered are building design, construction, nature, fire load potential and quantity of raw materials, fire and explosion hazards potential of processes involved and the fire hazard potential of products(storage, handling and transportation risk of different chemicals). As compared to other occupancies, this Group of occupancies calls for deeper knowledge and understanding of various branches of engeneering technology for the design, construction, operation and maintenance of the broad range of industrial occupancies which vary very widely in size and fire risks. There are small scale industries located in small sheds employing only a few persons, and there are big industries which are spread over hundreds of acres employing thousands of persons.
- (b) Fire hazard affects the potential for life loss and property damage. It is important that building design, process lay out and fire protection systems allow for safe occupant egress in the event of fire or explosion.
- (c) Since explosions are probably the cause for most destructive industrial accidents in terms of life and property loss, they require special attention. Flammable dust, vapours, mist or gas presents an explosion hazard. A carefully designed system is needed to ensure life safety from explosive forces. Specialised equipments designed to detect, suppress and control damage from explosions are available and must be utilized judiciously.
- (d) The overall approach to the fire and life safety problems in industrial premises should be to address employees' safety and their safe and speedy evacuation first, and then property protection.

F6.7.1. Apart from the three distinct Sub divisions of G-1(low hazard industries), G-2 (moderate hazard industries), and G-3 (high hazard industries) whose varying degrees of fire, explosion and toxic hazard risk have been very well explained in clause-3.1.8, there are what are called as 'small scale industries'. Most of these function in mixed occupancy premises, which also need to be brought under more strict regulatory control of (Central/State/Local Authority) Building Codes/Development Control Regulations, especially in view of the fact that several serious fire incidents had been reported in such premises.

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In addition to the provisions of 4, the following requirements shall be complied with.

6.7.3.1. Not less than two exits shall be provided for every floor or section, including basements used for industrial purposes or uses incidental thereto.

6.7.3.2. In buildings used for aircraft assembly or other occupancy requiring undivided floor areas so large that the distances from points within the areas to the nearest outside walls where exit doors could be provided are in excess of 45 m, requirements for distance to exits may be satisfied by providing stairs leading to exit tunnels or to overhead passageways. In cases where such arrangements are not practicable, the authority may, by special ruling, permit other exit requirements for one storey building with distances in excess of the maximum distances specified in 4, if completely automatic sprinkler protection is provided and if the heights of the ceiling curtain boards and roof ventilation are such as to minimize the possibility that employees will be overtaken by the spread of fire or smoke within 1800 mm of the floor level before they have time to reach exits, provided, however, that in no case may the distance of travel to reach the nearest exit exceed 45 m where smoke venting is required as a condition for permitting distances of travel to exits in excess of the maximum otherwise allowed.

6.7.3.3 Additional Precautions:

6.7.3.3.1. In any room in which volatile flammable substances are used or stored, no device generating a glow or flame capable of igniting flammable vapour shall be installed or used. Such a room shall be provided with a suitably designed exhaust ventilation system(See Annex-D). To ensure safety from fire due to short circuit, faulty electrical connection or some similar cause, proper care shall be taken in designing electrical installations in such room (See Part-8 Building Services Section-ii Electrical Installations)

6.7.3.3.2. The storage, use and handling of gasoline, fuel oil and other flammable liquids shall not be permitted in any industrial occupancy unless it complies with regulations pertaining to Petroleum Act, 1934 and rules there-under.

6.7.3.3.3. Every boiler room or room below the 1st floor containing a heating plant shall be adequately separated from the rest of the buildings.

6.7.3.3.4. For requirements regarding electrical generating and distribution stations, reference

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F6.7.2. Fire Detection/Extinguishing System:

- (a) According to this Clause, it has to be borne in mind that the requirements for fire detection/extinguishing systems for occupancy sub divisions G-1 to G-3 will mainly be as specified in Table-23 on account of maximum building height restrictions for industrial occupancy buildings in general. Only Low(G-1) and Moderate(G-2), Hazard occupancies are permitted upto 18m height. The maximum height limit for High Hazard (G-3) industrial occupancy is 15m., which means only low hazard and moderate hazard industrial buildings will come, to some extent, under the high-rise building class.
- (b) The minimum requirements of fire protection installations as given in Table-23 for industrial occupancies are presumably for general purpose industries located in urban areas. In so far as water supplies for fire fighting are concerned, this appears to be the perception adopted.
- (c) (i) BIS themselves had formulated several IS (Codes of Practices on Fire Safety) for several industries, including one on Petroleum Refineries and Fertilizer Plants, (IS:15394-2003), wherein detailed fire protection requirements including water supplies for fire fighting have been laid down. There is one other IS, viz., IS 9668-1990 on Code of Practice on Provision and Maintenance of Water Supplies for Fire Fighting, which also contains some guidelines on water supplies for fire fighting to be provided in industries.
 - (ii) Besides, Oil Industry Safety Directorate(OISD), Ministry of Petroleum and Chemicals, Govt. of India, has also issued their own Standards, among others, on (i) Fire Protection Facilities for Petroleum Refineries/Process Plants(OISD-STD-116), (ii) Fire Protection Facilities for Petroleum Depots and Terminals (OISD-STD-117) and (iii) LPG Bottling Plant Operations (OISD-STD-144), wherein detailed requirements of water supplies for fire fighting have been specified.

C. For information only:

A study of all the above mentioned Standards, particularly on the issue of water supplies for fire fighting/fire protection for Petroleum Refineries(as a typical example) reveals the following:

- (i) IS:9668-1990 (CP on Provision and Maintenance of Water Supplies for Fire Fighting), vide Clause '4.2. For Industries' contains the undermentioned provisions:
 - The guiding factor shall be to determine the number of fire fighting jets(at an output of 600lpm) likely to be employed in case of **one major fire outbreak in the industry.**
 - All light hazard industries with floor area not exceeding 1000m² shall have water storage for fire fighting upto 1hr. pumping capacity minimum when using two strong water jets (each of 600lpm output).

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may be made to good practice [F(22)]

6.7.3.4 Exception and Deviation:

6.7.3.4.1 Basements used only for storage, heating or other service equipment, and not subject to industrial occupancy, shall have exits in accordance with the requirements of Group H occupancies.

6.7.3.4.2. The following exceptions shall apply to special purpose industrial occupancies:

- (a) Exits need be provided only for the persons actually employed; spaces not subject to human occupancy because of the presence of machinery or equipment may be excluded from consideration.
- (b) Where unprotected vertical openings are necessary to manufacturing operations, these may be permitted beyond the limits specified for industrial occupancy, provided every floor level has direct access to one or more enclosed stairways or other exits protected against obstruction by any fire in the open areas connected by the unprotected vertical openings or smoke there from.
- (c) Industrial buildings of low and moderate hazard are permitted only up to 18 m height.

6.7.3.4.3. The following exceptions shall apply to High Hazard Industrial Occupancies.

- (a) Exits shall be so located that it will not be necessary to travel more than 22.5m from any point to reach the nearest exit.
- (b) From every point in every floor area, there shall be at least 2 exits accessible in two different directions; where floor areas are divided into rooms, there shall be at least two ways of escape from every room, however small, except toilet rooms, so located that the points of access thereto are out of or are suitably shielded from areas of high hazard.
- (c) In addition to types of exits for upper floors specified for Group-G occupancies, slide escapes may be used as required exits for both new an existing building.
- (d) All high hazard industrial occupancies shall have automatic sprinkler protection or such other protection as appropriate to the particular hazard, including explosion venting for any area

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When area exceeds 1000m², additional quantity at the rate of 50% of the above shall be provided subject to a minimum of 2hrs. pumping capacity;

- For moderate hazard industries with floor area upto 1000m² water storage for fire fighting equivalent to minimum 2hrs. while using 4 water jets simultaneously. When area exceeds 1000m², additional quantity@ 50% of above, subject to a minimum for 2 hrs. pumping capacity.
- For high hazard industries, with floor area upto 1000m² water storage for minimum 3hrs. fire fighting while using 8 water jets. When area exceeds 1000 m², additional quantity @ 50% of above subject to minimum 4 hrs. pumping capacity.

(ii) OISD-STD-116 for Petroleum Refineries-- requirements for fire water system stipulates the following:

- System to be designed to meet fire water flow requirement for fighting **two major fires simultaneously.**
- Fire water flow calculated for purposes of cooling, foam application, supplementary hose streams(for oil storage tanks, LPG spheres, LPG loading gantries, process unit etc.)

The total design fire water rate requirements work out to 3700 m³/hr. (37 lakh ltr.) and for minimum 4 hrs. storage requirement, it works out to (3700 m³/hr. x 4), 14800³/hr, or 148 lakh ltrs.

(iii) IS: 15394-2003, IS on Petroleum Refineries and Fertilizer Plants:

- Capacity of storage of fire water shall be for 4 hrs. fire fighting at full installed pumping capacity.
- In case of large size Refineries, pumping capacity to be worked out on the basis of two major fires to be fought simultaneously. The minimum capacity for fire water pump output shall be 410m³/hr/8.8Cm² pr.(6840 lpm.)
- The minimum requirement for fire fighting installations as given in Appendix-B to the IS are generally in conformity with the requirements as given in Table-23 Part-4 NBC.

F6.7.3.3. Additional Precautions:

F6.7.3.3.1

- (a) Ventilators should be provided near cieling level for lighter than air vapours, and near the floor for heavier than air vapours like LPG.

For information only:

- (b) Infact such areas where flammable vapours/gases are present are deemed as 'hazardous areas' under Petroleum Rules 1976(Chapter-IV Electric Installations), and detailed instructions on electrical safety are given therein which have to be scrupulously followed in such areas. In appropriate cases, clearance from the Chief Controllor of Explosives (Explosives Dept.) will also be necessary.

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subject to explosion hazard, designed to minimise danger to occupants in case of fire or other emergency before they have time to utilize exits to escape.

- (e) Industrial buildings of high hazard are permitted only up to 15m in height.

6.7.4. For detailed information on fire safety of certain

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- (c) Whenever flammable vapours/gases are present within their flammable limits, the slightest spark created by the operation of electrical equipment like switches or spark producing tools(friction sparks) can give rise to fire or explosion. While safety from electrical sparks can be achieved by safe electrical equipment/apparatus as already mentioned, spark from tools can be avoided by use of non-sparking tools.

- (d) If Petroleum liquids are stored or handled at temperatures at or above their flash point, they should be treated with extreme caution(as for class-1 flammable liquids). Hazardous area normally covers an area extending upto 15m from equipment handling flammable/combustible liquids, or 30m from equipment handling flammable gases.

- (e) The ignition energies required for ignition of a flammable gas/vapour air mixture is as low as 0.2 to 10 milli-joules, which is below the ignition energy created by a spark.

- (f) There had been several devastating industrial fires and explosions originated by the ignition of flammable vapour clouds(which are known by the term, 'Unconfined Vapour Cloud Explosions or UVCEs)

F6.7.3.3.2. The explanatory comments given above are equally relevant here also.

F6.7.3.3.4.

- (a) The importance of fire safety for electricity generating and distribution stations cannot be over emphasised since any fire outbreak in such occupancies may not only completely disrupt the life of the community as a whole, but several other industries and enterprises depending upon them for power will also have to be shut down.
- (b) Electricity generation can be done from conventional sources using coal, oil, gas turbines, or diesel generating sets. Apart from above, hydro-power and Nuclear power generation also are employed. Each one of the types have their own fire hazards which call for appropriate fire protection measures, for which relevant standards exist.

F6.7.3.4.2.

- (a) (i) This is with reference to calculation of exit capacities and number of exits to be provided for the industrial occupancy concerned (ii) Exit requirements for floors not actually inhabited need not be same as those for floors where persons are normally present. (iii) Many modern hazardous processes are centrally controlled from a control room for safety and other reasons.
- (c) These height restrictions are necessary to ensure adequate safety of the premises.

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individual (specific) industrial occupancies reference may be made to good practice [F(29)].

6.7.5. Fire protection considerations for venting industrial occupancies shall be as in Annex D.

6.8. Requirements of storage buildings (Group H)

F6.7.3.4.3.

- (b) (i) In case of high hazard risks the development of fire and danger of subsequent explosions is so rapid that every room however small need to be protected with 2 exits for safe evacuation. (ii) These escape routes should be of fully protected types.
- (c) This is as per international practice also. However care has to be taken to comply with the following requirements;
 - (i) Each slide escape shall be of an approved type;
 - (ii) If used as means of egress they should be rated at a capacity of 60 persons;
 - (iii) Slide escapes should not constitute more than 25% of the required egress capacity;
 - (iv) They shall be counted as means of egress component only when regularly used in emergency escape drills so that occupants are familiar with their use;
 - (v) Since the option of their use has been extended to existing buildings also, necessary instructions may have to be issued to all concerned for compliance by authorities having jurisdiction;
- (d) This sub clause covers certain important and essential requirements of fire protection for high hazard industrial occupancies. While sprinkler protection has been made a general mandatory requirement, such systems may not be suitable for certain fire risk areas. The choice of the fire protection system shall depend on the nature of the risk to be covered. This again calls for an in-depth risk evaluation even at the planning and design stages. Every detail with regard to maintenance of adequate safeguards against likely fire and explosion hazards in the entire premises, covering all processes and activities, will have to be verified for effective implementation.

F6.7.4. Codes of Practices on Fire Safety of about 16 industrial occupancy types are given under the reference. One more may be added, viz., IS 15394-2003, 'Code of Practice on Fire Safety of Petroleum Refineries and Fertiliser Plants' which has been recently published by BIS.

F6.7.5. Detailed guidelines on the subject are contained in Annex-D.

F6.8. Requirements of Storage Buildings (Group-H):

No other occupancy present such a wide range of hazards, particularly as the facilities are increasing in size and complexity of materials stored. Examples of storage occupancies are warehouses, freight terminals, parking garages, aircraft hangars, grain

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6.8.1. In addition to the general requirements specified in 3.4 for type of construction and occupancy group and exit requirements given in 4, the requirements given in 6.8.2 to 6.8.5 shall be complied with.

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elevators etc.

Large number of fires occur in storage occupancy group mainly because of the following reasons:

- (i) Storage and Hazardous groups of occupancies(H&J) have the highest values of fire load density as compared to other occupancies(upto 500kg/m²), second highest being Mercantile occupancies(upto 250kg/m²);
 - (ii) The premises remain unoccupied most of the time, and if a fire breaks out, it remains undetected for some time, and by then it assumes serious proportions;
 - (iii) Due to the same reason as stated above, by the time fire brigade is sommoned and arrives at the scene, the fire would have become a major one making fire fighting operations prolonged and difficult;
 - (iv) Because the godowns are invariably packed upto cieling/roof level, with few and inadequate aisles between stacks, fire fighting operations are rendered difficult;
 - (v) Although fire potential is quite high in such premises, generally the level of even essential fire protection arrangements remain far below the stipulated minimum standards, or the existing fire protection systems fail to operate due to bad maintenance. Hence in the event of fire, prompt detection, control and extinguishment, as it should be, hardly happens;
- (c) From a study of several case histories of dangerous fires in Storage Occupancies (including some cases which had happened abroad), it has been seen that the principal causes of outbreak of fire are:
- Careless smoking
 - Electrical faults(bad maintenance being the main cause)
 - Bad house keeping;
 - Spontaneous ignition(of oil/paint smeared cotton waste thrown underneath the stacks after cleaning/ maintenance work;
 - External sparks(from moving locos etc.);
 - Welding/cutting, spray painting etc. within the building;
 - Use of naked lights/heaters/sigris inside the building;
 - Use of highly combustible materials like cork, expanded foam insulations(of polyurethane, polystyrene etc.) In cold storages(although they operate in very low temperatures ranging from -5°C to 20°C), have led to major fires;
 - Large amounts of packing materials (including plastic expanded foam), paper, straw etc. which are invariably present in warehouses;
 - Stacking of stores, especially of combustible types, close to the ceiling lights;
 - Storage of hazardous cargo also along with other

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6.8.2. Fire Detection/ Extinguishing system:

The requirements for occupancy group H, as specified in Table 23 and Annex C (for high rise building) shall apply.

Note-Automatic sprinklers are prohibited where water reactive materials are kept. Instead automatic fire alarm system coupled with suitable fire extinguishing systems shall be installed.

6.8.3. Exit Facilities:

In addition to the provisions of 4, the following requirements shall also be complied with.

6.8.3.1. Every building or structure used for storage and every section thereof considered separately, shall have access to at least one exit so arranged and located as to provide a suitable means of escape for any person employed therein and in any room or space exceeding 1400 m² gross area, or where more than 10 persons may be normally present, at least two separate means of exit shall be available, as remote from each other as practicable.

6.8.3.2. Every storage area shall have access to at least two means of exit, which can be readily opened. This shall not be subject to locking so long as any persons are inside and shall not depend on power operation.

6.8.3.3 The following special provisions shall apply to parking garages of closed or open type, above or below ground, but not to mechanical parking facilities where automobiles are moved into and out of storage mechanically which are not normally occupied by persons and thus require no exit facilities. Where repair operations are conducted, the exits shall comply with the requirements of Group G occupancies in addition to compliance with the following:

- (a) Where both parking and repair operations are conducted in the same building, the entire building shall comply with the requirements for Group G occupancies, unless the parking and repair sections are effectively separated by separation walls.

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stores without proper segregation, especially in marine and air cargo terminals;

- Storage of flammable stores in 'bonded goods' area of the warehouses;
- Badly maintained or over-taxed sprinkler systems;
- Careless handling of mechanical handling equipment like EOT cranes, Forklift trucks etc.;
- Failure to carry out regular closing hour checks;
- Arson.

F6.8.2. Fire Detection/Extinguishing System:

The design of the sprinkler system which is commonly recommended for storage occupancy should be compatible with the materials stored and with the storage heights.

Apart from automatic sprinkler system, the following types of automatic extinguishing systems are also available for installation. Any suitable type among them can be selected depending on the type of risk to be protected:

- (i) Automatic gaseous extinguishing system using CO₂/ approved Halon alternatives;
- (ii) Dry Chemical System;
- (iii) Automatic Foam Extinguishing System;
- (iv) Automatic Inert Gas System;
- (v) Automatic Water Spray System;
- (vi) Automatic Water Mist System;

These systems can either be of the total flooding type or local application type.

6.8.3. Exit Facilities:

The point to be borne in mind while planning and designing the exit facilities for a Storage Occupancy is the fact that in this type of occupancy the occupant load will be much less, and clear escape routes from all locations of the occupancy will be difficult to plan

F6.8.3.2. Exits which are kept locked should be openable by means of double-latch locking arrangement which is operable both from inside as well as outside to avoid people getting trapped inside a closed godown.

F6.8.3.3. (a) This is because repair operations which involve specialised equipment and tools and other facilities virtually constitute a separate industrial premises and hence being a mixed occupancy, should be deemed as an industrial occupancy of G-1 or G-2 type.

- (d) Modern trend is to provide multi storeyed parking with a spiral ramp leading to upper floors;

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- (b) Every floor of every closed parking garage shall have access to at least two separate means of exit, so arranged that from any point in the garage the paths of travel to the two means of exit shall be in different directions, except that a common path of travel may be permitted for the first 15 m, from any point.
- (c) On the street floor, at least two separate exit doors shall be provided, except that any opening for the passage of automobiles may serve as a means of exit, provided no door or shutter is installed thereon. Street floor exits in closed garages shall be so arranged that no point in the area is more than 30 m from the nearest exit. The distance may be increased to 45m in the case of garages protected by automatic sprinklers, distance being measured along the natural path of travel.
- (d) On floors above the street, at least two means of exit shall be provided, one of which shall be an enclosed stairway. The other means of egress may be a second exit of any of the types. In a ramp type garage with open ramps not subject to closure, the ramp may serve as the second means of exit.
- (e) Upper floor exits in closed garages shall be so arranged that no point in the area shall be more than 30m from the nearest exit other than a ramp on the same floor level. The distance may be increased to 45m in the case of garages protected by automatic sprinklers.
- (f) On floors below the street (either basement or outside underground garages) at least two exits shall be provided, not counting any automobile ramps, except that for garages extending to only one floor level below the street, a ramp leading direct to the outside may constitute one required means of exit. In garages below street level, exits shall be so arranged that no part of the area shall be more than 30 m from the nearest stair exit.
- (g) If any gasoline pumps are located within any closed parking garage, exits shall be so located that travel away from gasoline pump in any direction shall lead to an exit; with no dead-end in which occupants might be trapped by fire or explosion at any gasoline pump. Such exit shall lead to the outside of the building on the same level, or downstairs. No upward travel shall be permitted unless direct outside exits are available from that floor and any floor below (as in the case of a basement garage where the grade is one storey or more lower at the rear than at the street).

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- (f) The exit facilities prescribed here are similar to those in underground car parks, commonly found in starred hotels, cinema complexes and Assembly buildings;
- (g) This situation is certainly hazardous, and hence the need for ensuring safe means of escape for the occupants, which aspect has been adequately taken care of in this clause;

However, special attention is needed for taking extra care of the additional fire safety precautions including adequate normal ventilation as well as smoke extraction arrangements necessary because of the location of the Petrol pump facility within the closed car park area.

F6.8.3.4. Aircraft Hangars:

- (i) The aircraft fuel tanks cannot be completely emptied before the aircraft is moved into the aircraft hangar. Hence, large quantities of flammable liquids and their vapours pose an ever present danger of fire and explosion in a hangar. Besides, many maintenance servicing procedures involve use of highly flammable liquids;
- (ii) Large areas required for parking of large size commercial aircraft inside a hangar also compel extended travel distances to reach exits. Hence, careful planning is necessary by designing means of exits for aircraft hangar;
- (iii) Since aircraft hangars cover large areas with wide ranging hazards, it will be necessary for proper segregation of the hazardous activities.
- (iv) The presence of such multiple hazards call for design and installation of the best types of fire protection systems and equipment also.

F6.8.3.6. Grain Elevators:

General:

- (i) Grain Elevators are usually constructed of concrete or steel, and rarely of wood also. Handling grains generates some dust, and dust explosions are the primary hazard in these occupancies. They pose serious life hazards also, because of the inherent fire and explosion hazards;
- (ii) In many dust explosions, the primary and only means of escape from the upper parts of the elevator may get destroyed or damaged, trapping workers on top of the structures.

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6.8.3.4. Exits from aircraft hangars (storage or servicing areas) shall be provided at intervals of not more than 45 m on all exterior walls of aircraft hangars. There shall be a minimum of two exits serving each aircraft storage or servicing areas. Horizontal exits through interior fire walls shall be provided at intervals of not more than 30 m. 'Dwarf or Smash' doors accommodating aircraft may be used to comply with these requirements. All doors designated as exits shall be kept unlocked in the direction of exit travel while the area is occupied.

6.8.3.5. Exits from mezzanine floors in aircraft storage or servicing areas shall be so arranged that the maximum travel to reach the nearest exits from any point on the mezzanine shall not exceed 22.5 m. Such exits shall lead directly to a properly enclosed stairwell discharging directly to the exterior or to a suitably cut-off area or to outside fire escape stairs.

6.8.3.6. The following special provisions shall apply to grain elevators:

- (a) There shall be at least one stair tower from basement to first floor and from the first floor to the top floor of workhouse which is enclosed in a dust-tight non-combustible shaft.
- (b) Non-combustible doors of self-closing type shall be provided at each floor landing,
- (c) An exterior fire escape of the stair or basket ladder type shall be provided from the roof of the workshop to ground level or the roof of an adjoining annexe with access from all floors above the first.
- (d) An exterior fire escape of either the stair or basket ladder type shall be provided from the roof of each storage annexe to ground level

6.8.4 Additional Precautions:

Requirements specified in 6.7.3.3 shall apply to Group H occupancies also.

6.8.5. Exceptions and Deviations:

Every area used for the storage of hazardous commodities shall have an exit within 22.5 m of any point in the area where persons may be present, or 35m where automatic sprinkler protection is provided.

6.9. Requirements of Buildings For Hazardous Uses (Group J)

6.9.1 In addition to the general requirements specified in 3.4 for type of construction and occupancy group and the exit requirements given in 4, the require-

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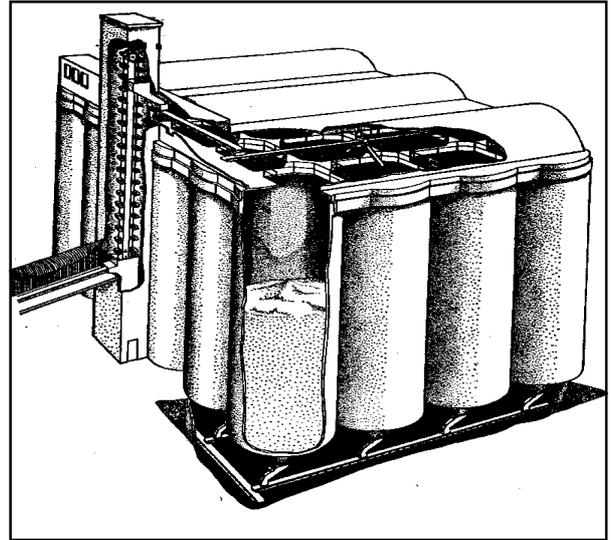


Fig-23. Modern Multiple Grain Silo, with elevator conveyor serving all storage silos.

- (a) The stair tower, which is the only one means of egress available should be of a totally enclosed type of minimum 2hrs. fire resistance;
- (b) The doors should be proper fire doors of minimum 2hrs. fire resistance;
- (c) The exterior fire escape, which serves as an alternate means of escape, should be provided with all the appropriate fire protection arrangements as had been mentioned under clause-4;
- (d) All working areas should have access to atleast one stairway leading to an exit discharge point at ground level;
- (e) Those grain elevators which are provided with underground passages beneath the silos for conveyors should have at least two means of egress/exit.

F6.9. Requirements of Buildings for Hazardous Uses (Group J):

The purposes for which this group of buildings are utilised have been clearly brought out in clause 3.1.10. of this document. What needs particular mention is that it includes storage, handling, manufacturing and processing of a wide range of hazardous materials.

Hazardous material is defined as 'a material which may be explosive, flammable, poisonous/toxic, corrosive, or otherwise harmful and likely to cause death or injury'. This means that this important Group covers a wide range of hazardous substances, which can result in a serious life hazard, a serious fire, and (or) explosion hazard, or a serious environmental hazard either individually or collectively.

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ments given in 6.9.2 to 6.9.4 shall be complied with.

6.9.2 Fire Detection/Extinguishing system:

The requirements for occupancy Group J, as specified in Table 23 and Annex C (For High Rise building) shall apply.

Note- Hazardous buildings shall have vapour detectors /explosion suppression system/automatic sprinklers, besides hydrant system, wet risers and automatic fire alarm system depending on the type of fire hazard involved.

6.9.3. Exit facilities:

Requirements specified in 4 and 6.7.3.4.3 shall apply to Group J occupancies also.

6.9.4. Additional Precautions.

The following requirements shall apply to all Group J occupancies, as applicable.

- (a) Each building where gas is employed for any purpose shall be provided with an approved outside gas shut-off valve conspicuously marked. The detailed requirements regarding safe use of gas shall conform to Part 9 NBC Plumbing Services, Section 3 Gas supply.
- (b) Each boiler room or room containing a heating plant shall be separated for the rest of the building by a separating wall.
- (c) In any room in which volatile flammable substances are used or stored, no device generating a spark, glow or flame capable of igniting flammable vapour shall be installed or permitted unless it is enclosed in a flameproof enclosure.
- (d) The use, handling, storage and sale of gasoline, fuel oil and other flammable liquids shall not be permitted in Group J occupancies unless such use, handling, storage and sale is in accordance with appropriate legislation in force.
- (e) All openings in exterior walls except wall vents shall be protected by a fire stop assembly as in 4 and they shall be fixed, automatic or self closing. Wall vents having an area of not less than 100 cm² each shall be placed in the exterior walls near the floor line, not more than 1800mm horizontally apart. Each building shall be provided with a power driven fan exhaust system of ventilation which shall be arranged and operated so as to produce a complete change of air in each room every 3 minutes.
- (f) Each machine in dry-cleaning establishments

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6.9.4. Additional Precautions:

Breakage of gas line due to heat of fire can be disastrous. Approaching gas control valves in a room on fire becomes dangerous. It is therefore necessary to shut off gas supply from a valve located outside the building.

Such valve location should also be conspicuously marked on external walls for locating them readily in case of emergency.

- (f) Use of explosion suppression system helps in saving costly machinery from being destroyed and tackling explosion at early stage.
- (g) Certain dusts, besides being environmental hazard, can cause dangerous explosions if they are allowed to mix with air so as to reach their explosive limit, and hence this requirement.

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which uses flammable liquid shall have an adequate suitable extinguishing agent directly connected to it, so arranged as to have the agent

Table 1 Fire Resistance Ratings of Structural and Non-structural Elements
(Clause 3.3.1)

SI No.	Structural Element		Type of Construction			
			Type 1	Type 2	Type 3	Type 4
(1)	(2)		(3)	(4)	(5)	(6)
1)	Exterior walls: a) Fire separation less than 3.7 m	i) Bearing	4	2	2	1
		ii) Non-bearing	2	1½	1	1
		b) Fire separation of 3.7 m or more but less than 9 m	i) Bearing	4	2	2
		ii) Non-bearing	1½	1	1	1
	c) Fire separation of 9 m or more	i) Bearing	4	2	2	1
		ii) Non-bearing	1	1	1	1
2)	Fire resisting walls		4	2	2	2
3)	Fire separation assemblies (like fire check doors)		4	2	2	2
4)	Fire enclosures of exitways, hallways and stairways		2	2	2	2
5)	Shaft other than exitways, elevator and hoistways		2	2	2	2
6)	Exitway access corridors		1	1	1	1
7)	Vertical separation of tenant spaces		1	1	1	1
8)	Dwelling unit separation Non-load bearing partitions		1	1	1	1
			-- At least half an hour --			
9)	Interior bearing walls, bearing partitions, columns, girders, trusses (other than roof trusses) and framing	i) Supporting more than one floor	4	2	2	2
		ii) Supporting one floor only	3	1½	1	1
		iii) Supporting a roof only	3	1½	1	1
10)	Structural members support walls		3	1½	1	1
11)	Floor construction including walls		3	1½	1	1
12)	Roof construction	i) 5 m or less in height to lowest member	2	1½	1	1
		ii) More than 5 m but less than 6.7 m in height to lowest member	1	1	1	1
		iii) 6.7 m or more in height to lowest member	0	0	0	0

Table 2 Masonry Walls : Solid (Required to Resist Fire from One Side at a Time)
(Clause 3.3.2)

Nature of Construction and Materials		Minimum Thickness (mm), Excluding any Finish for a Fire Resistance (Hours) of									
		Load Bearing					Non-load Bearing				
		1	1½	2	3	4	1	1½	2	3	4
1)	Reinforced ¹⁾ cement concrete	120 (25) ²⁾	140 (25) ²⁾	160 (25) ²⁾	200 (25) ²⁾	240 (25) ²⁾					
2)	Unreinforced cement concrete	150	175	-	-	-					
3)	No-fines concrete with :										
	a) 13 mm cement/sand or gypsum/sand						150	150	150	150	150
	b) 13 mm light weight aggregate gypsum plaster						150	150	150	150	150
4)	Bricks of clay:										
	a) Without finish	90	100	100	170	170	75	90	100	170	170
	b) With 13 mm lightweight aggregate gypsum plaster	90	90	90	100	100	75	90	90	90	100
5)	Bricks of sand lime:										
	a) Without finish	90	100	100	190	190	75	90	100	170	170
	b) With 13 mm lightweight aggregate gypsum plaster	90	90	90	100	100	75	90	90	90	100
6)	Blocks of concrete:										
	a) Without finish	90	100	100	-	-	75	90	100	140	150
	b) With 13 mm lightweight aggregate gypsum plaster	90	90	90	100	100	75	75	75	90	100
	c) With 13 mm cement/sand or gypsum/sand						75	90	90	100	140
7)	Blocks of lightweight concrete:										
	a) Without finish	90	100	100	140	150	75	75	75	125	140
	b) With 13 mm lightweight aggregate gypsum plaster	90	90	90	100	100	50	63	75	75	75
	c) With 13 mm cement/sand or gypsum/sand						75	75	75	90	100

Nature of Construction and Materials		Minimum Thickness (mm), Excluding any Finish for a Fire Resistance (Hours) of									
		Load Bearing					Non-load Bearing				
		1	1½	2	3	4	1	1½	2	3	4
8	Blocks of aerated concrete: a) Without finish b) With 13 mm lightweight aggregate gypsum plaster	90	100	100	140	180	50	63	63	75	100

1) Walls containing at least 1 percent of vertical reinforcement.
2) Minimum thickness of actual cover to reinforcement.

Table 3 Masonry Walls : Hollow (Required to Resist Fire From One Side at a Time)
(Clause 3.3.2)

Nature of Construction and Materials		Minimum Thickness (mm), Excluding any Finish for a Fire Resistance (Hours) of										
		Load Bearing						Non-load Bearing				
		1	1½	2	3	4	½	1	1½	2	3	4
1)	Bricks of clay: a) Without finish b) With 13 mm lightweight aggregate gypsum plaster	170	170	170	200	200	75	75	90	100	170	170
		100	100	170	170	170	75	75	90	90	90	100
2)	Block's of concrete: a) Without finish b) With 13 mm cement/sand or gypsum/sand c) With 13 mm lightweight aggregate gypsum plaster						90	125	125	140	140	150
							90	125	125	140	140	140
		190	200	200	-	-	75	90	90	100	125	125
3)	Blocks of lightweight concrete: a) Without finish b) With 13 mm cement/sand or gypsum/sand c) With 13 mm lightweight aggregate gypsum plaster						75	90	90	100	140	150
							75	75	75	100	140	140
		100	100	100	-	-	63	63	63	75	90	100

Table 4 Framed Construction, Load Bearing (Required to Resist Fire From One Side at a Time)
(Clause 3.3.2)

	Nature of Construction And Materials/Timber Studs at Centres not Exceeding 600 mm, Faced on Each Side with	Minimum Thickness (mm) of Protection for a Fire Resistance of 1h
1	Plasterboard layers with joints staggered, joints in outer layer taped and filled – Total thickness for each face	25
2	One layer of 12.7 mm plasterboard with a finish of lightweight aggregate gypsum plaster	13
3	Metal lath and plaster, thickness of plaster : a) Sanded gypsum plaster (metal lathing grade) b) Lightweight aggregate gypsum plaster	22 13

Table 5 Framed Construction, Non-Load Bearing (Required to Resist Fire From One Side at a Time)
(Clause 3.3.2)

Nature of Construction and Materials/Steel or Timber Frame at Centres not Exceeding 600 mm, Facings on Both Sides of	Stud Construction	Minimum Thickness (mm) of Protection for a Fire Resistance of 1h			
		½ h	1h	1½ h	2h
A) Dry lining with materials fixed direct to studs (without plaster finish)					
1 One layer of plasterboard with taped and filled joints	Timber or steel	12.7			
2 Two layers of plasterboard with joints staggered, joints in outer layer taped and filled – Total thickness for each face	Timber or steel	19	25		
3 One layer of asbestos insulating board with transverse joints backed by fillers of asbestos insulating board not less than 9 mm thick, or by timber	Timber or steel	9 12			
4 One layer of wood wool slabs	Timber	25			
5 One layer of chipboard or of plywood	Timber or steel	18			
B) Lining with materials fixed direct to studs, with plaster finish :					
1 Plasterboard of thickness : a) With not less than 5 mm gypsum plaster finish b) With not less than 13 mm gypsum plaster finish	Timber or steel	9.5	12.7		

Nature of Construction and Materials/Steel or Timber Frame at Centres not Exceeding 600 mm, Facings on Both Sides of	Stud Construction	Minimum Thickness (mm) of Protection for a Fire Resistance of 1h			
		½ h	1h	1½ h	2h
C) Wet finish :					
1 Metal lath and plaster, thickness of plaster:					
a) Sanded gypsum plaster	Timber or steel	13			
b) Lightweight aggregate gypsum plaster	Timber or steel		13	19	25

Table 6 Framed External Walls Load Bearing (Required to Resist Fire From One Side at a Time)
(Clause 3.3.2)

	Nature of Construction And Materials	Minimum Thickness (mm) of Protection for a Fire Resistance of 1h
1	Timber studs at centers not exceeding 600 mm with internal linings of : Plasterboard layers with joints in outer layer taped and filled, total thickness of plasterboard	25

**Table 7 Framed External Walls Non-Load Bearing Required to Resist Fire only
From Inside the Building (A)
(Clause 3.3.2)**

Nature of Construction and Materials	Minimum Thickness (mm) of Protection for a Fire Resistance of 1h					
	½ h	1h	1½ h	2h	3 h	4h
A) Steel frame with an external cladding of non-combustible sheets (excluding sheet steel), with a steel supporting framework and internal lining of :						
1 Metal lath and plaster, thickness of plaster :						
a) Sanded gypsum plaster (metal lathing grade)	13	13				
b) Lightweight aggregate gypsum plaster	10	13	15	15	15	19
2 Two layer of plasterboard with joints staggered joints in outer layer taped and filled – Total thickness	21	32				
3 Plasterboard of thickness :						
a) With not less than 5 mm gypsum plaster finish	12.7					
b) With not less than 13 mm gypsum plaster finish	9.5					
c) With not less than 10 mm lightweight aggregate gypsum plaster	9.5					
4 One layer of asbestos insulating board with transverse joints backed by fillers of asbestos insulating board not less than 9 mm thick, or by timber	9	9	12	12	12	12
5 One layer of wood/wool slabs without finish		50				
6 One layer of compressed straw building slabs :						
a) Without finish	50					
b) With not less than 5 mm gypsum plaster finish		50				
7 Aerated concrete blocks	50	50	63	63	75	100
8 Bricks of clay :						
a) Without finish	75	75	90	90	100	100
b) With not less than 13 mm lightweight aggregate gypsum plaster			75	75	90	90

**Table 9 Framed Walls Non-Load Bearing Required to Resist Fire only
From Inside the Building (C)
(Clause 3.3.2)**

Nature of Construction and Materials	Minimum Thickness (mm) of Protection for a Fire Resistance of 1½ h
C) Timber frame with external cladding of weather boarding or external plywood, 9.5 mm with an internal lining of : 1 Plasterboard not less than 9.5 mm thick, finished with: a) Gypsum plaster b) Lightweight aggregate gypsum plaster	 13 10
2 Plasterboard not less than 12.7 mm thick, finished with: a) Gypsum plaster b) Lightweight aggregate gypsum plaster	 10 10
3 One layer of asbestos insulating board with transverse joints backed by fillers of asbestos insulating board not less than 9 mm thick, or by timber	 9 12

**Table 10 Reinforced Concrete Columns
(Clause 3.3.2)**

Nature of Construction and Materials			Minimum Dimensions (mm) Excluding any Finish, for a Fire Resistance of					
			½ h	1h	1½ h	2h	3 h	4h
1	Fully exposed	Width	150	200	250	300	400	450
		Cover	40	40	40	40	40	40
2	50 percent exposed	Width	125	160	200	200	300	350
		Cover	40	40	40	40	40	40
3	One face exposed	Thickness	100	120	140	160	200	240
		Cover	40	40	40	40	40	40

**Table 11 Concrete Beams
(Clause 3.3.2)**

Nature of Construction and Materials			Minimum Dimensions (mm) Excluding any Finish, for a Fire Resistance of					
			½ h	1h	1½ h	2h	3 h	4h
1	Reinforced concrete (simply supported)	Width	200	200	200	200	240	280
		Cover	20	20	20	40	60*	70*
2	Reinforced concrete (continuous)	Width	200	200	200	200	240	280
		Cover	20	20	20	30	40	50*
3	Prestressed concrete (simply supported)	Width	100	120	150	200	240	280
		Cover	25	40	55	70	80	90
4	Prestressed concrete (continuous)	Width	80	100	120	150	200	240
		Cover	20	30	40	55	70	80

* Require attention to the additional measures necessary to reduce the risk of spalling.

Table 12 Concrete Floors
(Clause 3.3.2)

Nature of Construction and Materials			Minimum Dimensions (mm) Excluding any Finish, for a Fire Resistance of					
			½ h	1h	1½ h	2h	3 h	4h
1	Reinforced concrete (simply supported)	Thickness	75	95	110	125	150	170
		Cover	20	20	25	35	45*	55*
2	Reinforced concrete (continuous)	Thickness	75	95	110	125	150	170
		Cover	20	20	20	25	35	45*

* Require attention to the additional measures necessary to reduce the risk of spalling.

Table 13 Concrete Floors : Ribbed Open Soffit
(Clause 3.3.2)

Nature of Construction and Materials			Minimum Dimensions (mm) Excluding any Finish, for a Fire Resistance of					
			½ h	1h	1½ h	2h	3 h	4h
1	Reinforced concrete (simply supported)	Thickness of floor	75	95	110	125	150	170
		Rib width	125	125	125	125	150	175
		Cover	20	20	35	45	55	65
2	Reinforced concrete (continuous)	Thickness	75	95	110	125	150	170
		Width	125	125	125	125	150	175
		Cover	20	20	20	35	45	55

* Require attention to the additional measures necessary to reduce the risk of spalling.

Table 14 Encased Steel Columns, 203 mm x 203 mm (Protection Applied on Four Sides)
(Clause 3.3.2)

Nature of Construction and Materials	Minimum Dimensions (mm) Excluding any Finish, for a Fire Resistance of				
	1h	1½ h	2h	3 h	4h
A) Hollow protection (without an air cavity over the flanges): 1 ¹⁾ Metal lathing with trowelled lightweight aggregate gypsum plaster	13	15	20	32	
2 Plasterboard with 1.6 mm wire binding at 100 mm pitch, finished with lightweight aggregate gypsum plaster not less than the thickness specified : a) 9.5 mm plaster board b) 19 mm plaster board	10 10	15 13	20		
3 Asbestos insulating boards, thickness of board : a) Single thickness of board, with 6 mm cover fillets at transverse joints b) Two layers, of total thickness		19	25	38	50
4 Solid bricks of clay, composition or sand lime, reinforced in every horizontal joint, unplastered	50	50	50	75	100
5 Aerated concrete blocks	60	60	60		
6 Solid blocks of lightweight concrete Hollow protection (with an air cavity over the flanges)	50	50	50	60	75
B) Asbestos insulating board screwed to 25 mm asbestos battens	12	19			
C) Solid protections 1 Concrete, not leaner than 1:2:4 mix (unplastered) : a) Concrete not assumed to be load bearing, reinforced ²⁾ b) Concrete assumed to be load bearing	25 50	25 50	25 50	50 75	75 75
2 Lightweight concrete, not leaner than 1:2:4 mix (unplastered) : concrete not assumed to be load bearing, reinforced ²⁾	25	25	25	40	60
¹⁾ So fixed or designed, as to allow full penetration for mechanical bond. ²⁾ Reinforcement shall consist of steel binding wire not less than 2.3 mm in thickness, or a steel mesh weighing not less than 0.5 kg/m ² . In concrete protection, the spacing of that reinforcement shall not exceed 200 mm in any direction.					

Table 15 Encased Steel Beams, 406 mm x 176 mm (Protection Applied on Three Sides)
(Clause 3.3.2)

Nature of Construction and Materials	Minimum Thickness (mm) of Protection for a Fire Resistance of					
	½ h	1h	1½ h	2h	3 h	4h
A) Hollow protection (without an air cavity beneath the lower flange):						
1 ¹⁾ Metal lathing with trowelled lightweight aggregate gypsum plaster	13	13	15	20	25	
2 Plasterboard with 1.6 mm wire binding ²⁾ at 100 mm pitch, finished with lightweight aggregate gypsum plaster not less than the thickness specified :						
a) 9.5 mm plaster board	10	10	15			
b) 19 mm plaster board	10	10	13	20		
3 Asbestos insulating boards, thickness of board :						
a) Single thickness of board, with 6 mm cover fillets at transverse joints			19	25		
b) Two layers, of total thickness					38	50
B) Hollow protection (with an air cavity below the lower flange):						
1 Asbestos insulating board screwed to 25 mm asbestos battens	9	12				
C) Solid protection :						
1 Concrete, not leaner than 1:2:4 mix (unplastered):						
a) Concrete not assumed to be load bearing, reinforced ³⁾	25	25	25	25	50	75
b) Concrete assumed to be load bearing	50	50	50	50	75	75
2 Lightweight concrete ⁴⁾ , not leaner than 1:2:4 (mix) unplastered	25	25	25	25	40	60
¹⁾ So fixed or designed, as to allow full penetration for mechanical bond. ²⁾ Where wire binding cannot be used, expert advice should be sought regarding alternative methods of support to enable the lower edges of the plasterboard to be fixed together and to the lower flange, and for the top edge of the plasterboard to be held in position. ³⁾ Reinforcement shall consist of steel binding wire not less than 2.3 mm in thickness or a steel mesh weighing not less than 0.5 kg/m ² . In concrete protection, the spacing of that reinforcement shall not exceed 200 mm in any direction. ⁴⁾ Concrete not assumed to be load bearing, reinforced.						

**Table 16 Timber Floors – Tongued and Grooved Boarding, or Sheets of Tongued and Grooved Plywood or Wood Chipboard, of not less than 21 mm Finished Thickness
(Clause 3.3.2)**

Nature of Construction and Materials	Minimum Thickness (mm) of Protection for a Fire Resistance of		
	½ h	1 h	2 h
37 mm (minimum) timber joists with a ceiling of :			
1 Timber lathing and plaster, plaster of thickness	15		
2 Metal lathing and plaster, thickness of plaster : a) Sanded gypsum plaster (metal lathing grade) b) Lightweight aggregate gypsum plaster	15 13	13	25
3 One layer of plasterboard with taped and filled joints	12.7		
4 Two layers of plasterboard with joints staggered, joints in outer layer taped and filled total thickness	19	31	
5 One layer of plasterboard not less than 9.5 mm thick, finished with : a) Gypsum plaster b) Sanded gypsum plaster c) Lightweight aggregate gypsum plaster	5 13 13		
6 One layer of plasterboard not less than 12.7 mm thick, finished with : a) Gypsum plaster b) Lightweight aggregate gypsum plaster	5 10		
7 One layer of asbestos insulating board with any transverse joints backed by fillets of asbestos insulating board not less than 9 mm thick, or by timber	9	12	

Table 17 Timber Floors – Tongued and Grooved Boarding, or Sheets of Tongued and Grooved Plywood or Wood Chipboard, of not less than 15 mm Finished Thickness
(Clause 3.3.2)

Nature of Construction and Materials	Minimum Thickness (mm) of Protection for a Fire Resistance of		
	1½ h	1 h	2 h
37 mm (minimum) timber joists with a ceiling of :			
1 Timber lathing and plaster, plaster of thickness	15		
2 Metal lathing and plaster, thickness of plaster for : a) Sanded gypsum plaster (metal lathing grade) b) Lightweight aggregate gypsum plaster	15 13	13	25
3 One layer of plasterboard with taped and filled joints	12.7		
4 Two layers of plasterboard with joints staggered, joints in outer layer taped and filled total thickness	22	31	
5 One layer of plasterboard not less than 9.5 mm thick, finish with : a) Gypsum plaster b) Sanded gypsum plaster c) Lightweight aggregate gypsum plaster	5 15 13		
6 One layer of plasterboard not less than 12.7 mm thick, finished with : a) Gypsum plaster b) Lightweight aggregate gypsum plaster	5 10		
7 One layer of asbestos insulating board, with any transverse joints backed by fillets of asbestos insulating board not less than 9 mm thick, or by timber	9	12 ¹⁾	
¹⁾ Finished on top with 25 mm minimum thick glass fibre or mineral wool laid between joints.			

Table 18 Timber Floors – Any Structurally Suitable Flooring of Timber or Lignocellulosic Boards
(Clause 3.3.2)

Nature of Construction and Materials	Minimum Thickness (mm) of Protection for a Fire Resistance of	
	½ h	1 h
37 mm (minimum) timber joists with a ceiling of :	½ h	1 h
1 Timber lathing and plaster, plaster of thickness	15	
2 Metal lathing and plaster, thickness of plaster for : a) Sanded gypsum plaster (metal lathing grade) b) Lightweight aggregate gypsum plaster	15 13	19
3 One layer of plasterboard with joints taped and filled and backed by timber	12.7	
4 Two layers of plasterboard with joints staggered, joints in outer layer taped and filled total thickness	25	
5 Two layers of plasterboard, each not less than 9.5 mm thick, joints between boards staggered and outer layer finished with gypsum plaster	5	
6 One layer of plasterboard not less than 9.5 mm thick, finish with : a) Sanded gypsum plaster b) Lightweight aggregate gypsum plaster	13 15	
7 One layer of plasterboard not less than 12.7 mm thick, finished with : a) Sanded gypsum plaster b) Lightweight aggregate gypsum plaster	15 13	
8 One layer of asbestos insulating board with any transverse joints backed by fillets of asbestos insulating board not less than 9 mm thick, or by timber	12	

Table 19 Comparative Floor Area Ratios for Occupancies Facing One Public Street at Least 9 m Wide
(Clause 2.6 and 3.4.5)

Occupancy Classification (1)	Type of Construction			
	Type 1 (2)	Type 2 (3)	Type 3 (4)	Type 4 (5)
Residential	UL	2.0	1.4	1.0
Educational	UL	2.0	1.4	1.0
Institutional	UL	1.5	1.0	0.8
Assembly	UL	1.0	0.7	0.5
Business	UL	2.9	2.3	1.6
Mercantile	8.0	1.8	1.4	1.0
Industrial	7.5	1.9	1.6	1.3
Storage (see Note 5)	6.0	1.5	1.3	1.0
Hazardous (see Note 5)	2.8	1.1	0.9	NP

UL – Unlimited
NP – Not permitted

NOTES

- The FAR values given in this table are subject to overall restrictions on the heights of buildings in the case of educational, institutional, assembly, storage and hazardous occupancies as specified in col 2 of Table 23.
- This table has been prepared, taking into account the combustible content in the different occupancies as well as the fire resistance offered by the type of construction.
- This table should be modified by the Authority, taking into account the other aspects as given below :
 - Density in terms of dwelling units per hectare;
 - Traffic considerations;
 - Parking spaces;
 - Local fire fighting facilities; and
 - Water supply, drainage and sanitation requirements.
- The FAR values specified in this table may be increased by 20 percent for the following services :
 - A basement or cellar space under a building constructed on stilts and used as a parking space and air-conditioning plant room used as accessory to the principal use;
 - Watchman's booth, pumphouse, garbage shaft, electric cabin or substation and other utility structures meant for the services of the building under considerations;
 - Projections and accessory buildings as specifically exempted under the Code; and
 - Staircase room and lift rooms above the topmost storey; architectural feature; and chimneys and elevated tanks of dimensions as permissible under the Code; the area of the lift shaft shall be taken only on one floor.
- In so far as single storey storage and hazardous occupancies are concerned, they would be further governed by volume to plot area ratio (VPR) to be decided by the Authority.

Table 20 Occupant Load
(Clause 4.3)

SI No.	Group of Occupancy	Occupant Load, Floor Area in m ² /Person
(1)	(2)	(3)
i)	Residential (A)	12.5
ii)	Educational (B)	4
iii)	Institutional (C)	15 (see Note 1)
iv)	Assembly (D)	
	a) With fixed or loose seats and dance floors	0.6 (see Note 2)
	b) Without seating facilities including dining rooms	1.5 (see Note 2)
v)	Mercantile (F)	
	a) Street floor and sales Basement	3
	b) Upper sale floors	6
vi)	Business and industrial (E&G)	10
vii)	Storage (H)	30
viii)	Hazardous (J)	10

NOTES

- 1 Occupant load in dormitory portions of homes for the aged, orphanages, insane asylums, etc, where sleeping accommodation is provided, shall be calculated at not less than 7.5m² gross floor area/person.
- 2 The gross floor area shall include, in addition to the main assembly room or space, any occupied connecting room or space in the same storey or in the storeys above or below, where entrance is common to such rooms and spaces and they are available for use by the occupants of the assembly place. No deductions shall be made in the gross area for corridors, closets or other subdivisions; the area shall include all space serving the particular assembly occupancy.

Table 21 Occupants Per Unit Exit Width
(Clause 4.4.2, 4.4.3 and C-1.6.2)

SI No.	Group Of Occupancy	Number Of Occupants		
		Stairways	Ramps	Doors
(1)	(2)	(3)	(4)	(5)
i)	Residential (A)	25	50	75
ii)	Educational (B)	25	50	75
iii)	Institutional (C)	25	50	75
iv)	Assembly (D)	40	50	60
v)	Business (E)	50	60	75
vi)	Mercantile (F)	50	60	75
vii)	Industrial (G)	50	60	75
viii)	Storage (H)	50	60	75
ix)	Hazardous (J)	25	30	40

Table 22 Travel Distance for Occupancy and Type of Construction
(Clause 4.4.1, 4.5.1 and 4.5.2)

SI No.	Group Of Occupancy	Maximum Travel Distance Construction	
		Types 1 & 2	Types 3 & 4
(1)	(2)	(3) m	(4) m
i)	Residential (A)	30.0	22.5
ii)	Educational (B)	30.0	22.5
iii)	Institutional (C)	30.0	22.5
iv)	Assembly (D)	30.0	30.0
v)	Business (E)	30.0	30.0
vi)	Mercantile (F)	30.0	30.0
vii)	Industrial (G)	45.0	
viii)	Storage (H)	30.0	
ix)	Hazardous (J)	22.5	

NOTES

- 1 For fully sprinklered building, the travel distance may be increased by 50 percent of the values specified.
- 2 Ramps shall be protected with automatic sprinkler system and shall be counted as one of the means of escape.
- 3 Construction of type 3 or 4 is not permitted.

Table 23 Minimum Requirements for Fire Fighting Installations
(Clause 4.18.2, 6.1.2, 6.2.3, 6.3.2, 6.4.3, 6.5.2, 6.5.2.1, 6.5.2.2, 6.5.2.3, 6.5.2.4, 6.5.2.5, 6.6.2, 6.7.2, 6.8.2 and 6.9.2)

Sl No.	Type of Building Occupancy	Type of Installation							Water Supply (in l)		Pump Capacity (in l/min)			
		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
RESIDENTIAL BUILDINGS (A)														
a)	Lodging or Rooming Houses (A-1) (see Note 1)													
1)	Less than 15 m in height	R	NR	NR	NR	NR	NR	R (see Note 2)	NR	NR	NR	5 000 (see Note 3)	NR	NR
	i) Up to 15 rooms	R	NR	NR	NR	NR	NR	R (see Note 2)	NR	NR	NR	5 000 (5 000) (see Note 4)	NR	450 (450) (see Note 4)
	ii) More than 15 and up to 30 rooms	R	R	NR	NR	NR	NR	R (see Note 2)	NR	NR	NR	10 000 (5 000) (see Note 4)	NR	450 (450) (see Note 4)
	iii) More than 30 rooms	R	R	NR	NR	NR	NR	R (see Note 2)	R (see Note 5)	NR	NR	10 000 (5 000) (see Note 4)	NR	450 (450) (see Note 4)
b)	One or two Family Private Dwellings (A-2) (see Note 1)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
c)	Dormitories (A-3) Apartment Houses (A-4)													
1)	Less than 15 m in height	R	R	NR	NR	NR	NR	R (see Note 2)	NR	NR	NR	5 000 (5 000) (see Note 4)	NR	450 (450) (see Note 4)

	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)	15 m and above but not exceeding 35 m in height	R	R	R	R	R	R	R (see Note 2)	R (see Note 7)	R	R	25 000	NR	900
j	Above 35 m but not exceeding 45 m in height	R	R	R	R	R	R	R (see Note 2 and Note 6)	R	R	75 000	5 000 (5 000) (see Note 4)	(see Note 19)	NR
j	Above 45 m in height but not exceeding 60M in height	R	R	R	R	R	R	R	R	R	75 000	10 000	(see Note 20)	NR
j)	Above 60 M in height	R	R	R	R	R	R	R	R	R	100 000	25 000	(see Note 21)	NR
d)	Hotels (A-6)													
1)	Less than 15 m in height													
i)	Covered area not exceeding 300 m ² on each floor	R	R	R	R	R	R	R (see Note 2)	R	R	NR	5 000 (see Note 2)	NR	450 (see Note 3)
ii)	Covered area exceeding 300 m ² but not more than 1 000 m ² on each floor	R	R	R	R	R	R	R (see Note 2)	R	R	10 000 for every 500 m ² covered area subject to minimum of 50 000 (see Note 5)	10 000 (see Note 2)	(see Note 5 and Note 19)	NR
ii)	Covered area exceeding 1 000 m ² on each floor	R	R	R	R	R	R	R (see Note 10)	R	R	100 000 (see Note 5)	10 000 (see Note 2)	(see Note 9 and Note 19)	NR
2)	15 m and above but not exceeding 30 m	R	R	R	R	R	R	R (see Note 10)	R	R	150 000	20 000	(see Note 20)	NR
3)	Above 30 m in height	R	R	R	R	R	R	R (see Note 10)	R	R	200 000	20 000	(see Note 21)	NR

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
e)	Hotels (A-6)	R	R	NR	R	NR	R	R (see Note 10)	R	R	200 000	20 000	(see Note 22)	NR
EDUCATIONAL BUILDINGS (B) (see Note 12)														
1)	Less than 15 m in height	R	NR	NR	NR	NR	NR	R (see Note 2)	NR	NR	NR	5 000 (see Note 3)	NR	450 (see Note 3)
	i) Ground plus one storey													
	ii) Ground plus two or more storeys	R	R	NR	NR	NR	NR	R (see Note 2)	NR	NR	NR	10 000 (5 000) (see Note 4)	NR	450 (450) (see Note 4)
2)	15 m and above but not exceeding 30 m in height	R	R	NR	NR	R	NR	R (see Note 2)	R	NR	NR	25 000	NR	900
INSTITUTIONAL BUILDINGS (C) (see Note 12)														
a)	Hospitals, Sanatoria and Nursing Homes (C-1)	R	R	NR	NR	NR	NR	R (see Note 2)	R	NR	NR	2 500 (2 500) (see Note 4)	NR	NR
1)	Less than 15 m in height with plot area upto 1 000 m ²	R	R	NR	NR	R	NR	R (see Note 2)	R	NR	NR	5 000 (5 000) (see Note 4)	NR	450 (450) (see Note 4)
	i) Up to ground plus one storey, with no beds													
	ii) Up to ground plus one storey with beds													
	iii) Ground plus two or more storeys, with no beds	R	R	NR	NR	R	NR	R (see Note 2)	R	R	NR	5 000 (5 000) (see Note 4)	NR	450 (450) (see Note 4)
	iv) Ground plus two or more storeys, with beds	R	R	NR	R	NR	NR	R (see Note 2)	R	R	50 000	5 000 (5 000) (see Note 4)	(see Note 19)	NR

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
2)	Less than 15 m in height with plot area more than 1 000 m ²	R	R	NR	R	NR	R	R (see Note 2)	R	R	1 00 000	10 000	(see Note 19)	NR
3)	15 m and above but not exceeding 24 m in height	R	R	NR	R	NR	R	R (see Note 11)	R	R	100 000	20 000	(see Note 20)	NR
4)	Above 24 m and not exceeding 30 m in height	R	R	NR	R	NR	R	R (see Note 11)	R	R	150 000	20 000	(see Note 21)	NR
b)	Custodial (C-2), and Penal and Pentail (C-3)													
1)	Less than 10 m in height													
	i) Up to 300 persons	R	R	NR	NR	NR	NR	R (see Note 2)	R	NR	NR	10 000 (5 000) (see Note 4)	NR	450 (900) (see Note 4)
	ii) More than 300 persons	R	R	NR	NR	R	NR	R (see Note 2)	R	NR	NR	15 000 (5 000) (see Note 4)	NR	450 (900) (see Note 4)
2)	10 m and above but not exceeding 15 m in height	R	R	NR	R	NR	R	R (see Note 2)	R	R	50 000	5 000 (5 000) (see Note 4)	(see Note 20)	NR
3)	15 m and above but not exceeding 24 m in height	R	R	NR	R	NR	R	R (see Note 11)	R	R	75 000	10 000	(see Note 20)	NR
4)	24 m and above but not exceeding 30 m in height	R	R	NR	R	NR	R	R (see Note 11)	R	R	100 000	20 000	(see Note 21)	NR
ASSEMBLY BUILDINGS (D) (see Note 12)														
a)	Buildings (D-1 TO D-6)													

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
5)	Above 30 m in height	R	R	R	R	NR	R	R (see Note 10)	R	R	200 000	20 000	(see Note 22)	NR
MERCANTILE BUILDINGS (F)														
a)	F-1 & F-2 (see Note 12)													
1)	Less than 15 m in height													
	i) Ground plus one storey, with total covered area not exceeding 500 m ²	R	R	NR	NR	R	NR	R (see Note 2)	NR	NR	NR	5 000 (5 000) (see Note 4)	NR	450 (450) (see Note 4)
	ii) Ground plus one storey and covered area exceeding 500 m ²	R	R	NR	NR	R	NR	R (see Note 2)	R	NR	NR	25 000	NR	900
	iii) More than ground plus one storey	R	R	R	NR	R	NR	R (see Note 2)	R	NR	NR	5 000 (5 000) (see Note 4)	NR	900
2)	Above 15 m but not exceeding 24 m in height	R	R	NR	R	NR	NR	R (see Note 11)	R	R	100 000	10 000	(see Note 20)	NR
3)	Above 24 m but not exceeding 30 m in height	R	R	NR	R	NR	R	R (see Note 10)	R	R	150 000	10 000	(see Note 21)	NR
b)	Underground shopping complex (F-3) (see Note 13)	R	R	NR	R	NR	R	R (see Note 10)	R	R	150 000	10 000	(see Note 21)	NR
INDUSTRIAL BUILDINGS (G) (see Note 14)														
a)	Low Hazard (G-1) (see Note 15)													
	i) Built up area up to 100 m ²	R	NR	NR	NR	NR	NR	R (see Note 2)	NR	NR	NR	5 000 (see Note 3)	NR	450 (see Note 3)
	ii) Built up area more than 100 m ² and up to 500 m ²	R	R	NR	NR	R	NR	R (see Note 2)	NR	NR	NR	5 000 (5 000) (see Note 4)	NR	450

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	iii) Built up area more than 500 m ²	R	R	NR	R	R	R	R	NR	R	100 000	10 000	(see Note 20)	450
b)	Moderate Hazard (G-2) (See Note 14)					(see Note 7)								
	i) Built up area up to 100 m ²	R	R	NR	NR	NR	NR	R	NR	NR	NR	10 000	NR	450
	ii) Built up area more than 100 m ² and up to 500 m ²	R	R	NR	NR	NR	NR	R	NR	NR	NR	10 000	NR	900
	iii) Built up area more than 500 m ² and upto 1000 m ²	R	R	NR	R	R	R	R	R	R	75 000	20 000	(see Note 20)	900
	iv) Built up area more than 1000 m ²	R	R	NR	R	R	R	R	R	R	100 000	20 000	(see Note 20)	900
c)	High Hazard (G-3) (see Note 16)					(see Note 7)								
	i) Built up area up to 50 m ²	R	R	NR	NR	NR	NR	R	NR	NR	NR	5 000	NR	450
	ii) Built up area more than 50 m ² and up to 150 m ²	R	R	NR	NR	NR	NR	R	NR	R	NR	5 000	NR	450
	iii) Built up area more than 150 m ² and upto 300 m ²	R	R	NR	R	NR	NR	R	NR	R	25 000	10 000	(see Note 19)	450
	iv) Built up area more than 300 m ² and upto 500 m ²	R	R	NR	R	NR	R	R	R	R	50 000	20 000	(see Note 19)	900
	v) Built up area more than 500 m ²	R	R	NR	R	R	R	R	R	R	100 000	20 000	(see Note 20)	900
	STORAGE BUILDINGS (H) (see Note 17)					(see Note 7)								
1)	Below 15 meter in height and covered area less than 250 m ²	R	R	NR	NR	NR	NR	R	NR	NR	25 000	5 000	(see Note 19)	450

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
2)	Below 15 meter in height and covered area more than 250 m ²													
	i) Ground floor only	R	R	NR	R	NR	R	R	NR	R	50 000	10 000	(see Note 20)	450
	ii) Ground plus one floor	R	R	NR	R	NR	R	R	NR	R	75 000	10 000	(see Note 20)	450
	iii) More than ground plus one floor	R	R	NR	R	NR	R	R	NR	R	100 000	10 000	(see Note 20)	450
HAZARDOUS BUILDINGS (J) (see Note 17)														
1)	Up to 15 m in height													
	i) Single Storey Building	R	R	NR	NR	NR	R	R	R	R	Minimum 4 h fire fighting requirements	NR	(see Note 18)	NR
	ii) More than one floor building but not exceeding 15 m	R	R	NR	R	R	R	R	R	R	Minimum 4 h fire fighting requirements	50 000	(see Note 18)	900

R – Required
NR – Not Required

NOTES

- 1 Buildings above 15 m in height not to be permitted for occupancies A-1 and A-2.
- 2 Required to be installed in basement if area of basement exceeds 200 m².
- 3 Required to be provided if basement area exceeds 200 m².
- 4 Additional value given in parenthesis shall be added if basement area exceeds 200 m².
- 5 Required to be provided for buildings with more than two storeys (Ground + One).
- 6 As per the requirement of local authority Dry Riser may be used in hilly areas, industrial areas or as required.
- 7 Required to be provided for buildings with height above 15 m.
- 8 To be installed in basement. If basement provided is used for car parking and area thereof exceeds 750 m² then the sprinklers shall be fed water from both underground static water storage tank and terrace tank.
- 9 Required to be provided for buildings with more than one storey.
- 10 To be installed in entire building.
- 11 To be installed in all floors at appropriate places and in consultation with local fire authorities.
- 12 Buildings above 30 m in height not to be permitted for Group B, Group C, Group D and Group F occupancies.
- 13 All underground shopping areas should be fully air conditioned.

- 14 The requirements given in this table for Group G Industrial Buildings are for small scale industry units. For other industries the requirements will have to be worked out on the basis of relevant Indian Standards and also in consultation with the local fire authorities.
- 15 Buildings above 18 m in height not to be permitted for G-1 and G-2 occupancies.
- 16 Buildings above 15 m in height not to be permitted for G-3 occupancies.
- 17 Buildings above 15 m in height not to be permitted for Group H and Group J occupancies.
- 18 Pump capacity shall be based on the covered area of the building.
- 19 One electric and one diesel pump of capacity 1620 LPM and one electric pump of capacity 180 LPM[See Fig 4].
- 20 One electric and one diesel pump of capacity 2280 LPM and one electric pump of capacity 180 LPM[See Fig. 4]
- 21 Two electric and one diesel pump of capacity 2280 LPM and one electric pump of capacity 180 LPM[See Fig 5].
- 22 Two electric and one diesel pump of capacity 2850 LPM and one electric pump of capacity 180 LPM[See Fig 5].
- 23 For buildings 45 m and above, the entire quantity of water for fire fighting purpose (as required in respective occupancy), if provided at the terrace level, the main pump, sprinkler pump, jockey pump and common pump need not be provided, however one electric fire pump of 900 LPM capacity with automatic operation is required to be provided.

Table 24 Size of Rising Mains/Risers
(Clause 5.1.2)

Size of the Mains	Type of Building	Height of Building
(1)	(2)	(3)
100 mm as single outlet landing valves	1) Residential buildings (A) i) ¹⁾ Lodging or rooming houses ii) Dormitories iii) One or two family private dwellings iv) Apartment houses (flats) v) With shopping area not exceeding 500 m ² vi) Hotels	15 m or above and not exceeding 45 m Less than 15 m 15 m or above in height but not exceeding 30 m and area not exceeding 600 m ² per floor
-do -	2) Educational buildings (B)	15 m or above but not exceeding 30 m
-do -	3) Institutional buildings (C) i) For hospitals and sanitorium ii) For custodial institutions and mental institutions	15 m or above but not exceeding 30 m 15 m or above but not exceeding 30 m
-do -	4) Assembly buildings (D)	15 m or above but not exceeding 30 m and total floor area not exceeding 500 m ² /floor (above 30 m, not to be permitted)
-do -	5) Business buildings (E)	15 m or above but not exceeding 30
-do-	6) Mercantile buildings (F) (Above 35 m, not to be permitted)	15 m or above but not exceeding 30 m (above 30 m, not to be permitted)
-do-	7) Industrial buildings (G)	15 m or above but not exceeding 18 m

150 mm as single outlet landing valves	8) All buildings classified under (i) to (iv)	Above 45 m
-do-	9) All buildings classified under (v) above with shopping area exceeding 500 m ²	Above 15 m
-do-	10) All buildings classified under 1(v) above	Above 30 m and area exceeding 500 m ²
150 mm with twin outlet landing valves	11) Hotels	Above 30 m
-do-	12) All buildings classified under 2 and 3 above	Above 30 m
-do-	13) All buildings classified under 5 above	Above 30 m
-do-	14) All storage buildings (H)	Above 10 m but not exceeding 15 m
-do-	15) All Hazardous buildings (J)	Above 10 m but not exceeding 15 m
¹⁾ Buildings above 15 m in height not permitted in case of high hazard industrial buildings.		

ANNEX A
(Clause 3.1.8)

**CALORIFIC VALUES OF COMMON MATERIALS AND TYPICAL
VALUES OF FIRE LOAD DENSITY**

A-1 The calorific values of some common materials are given in Table 25 for guidance.

Table 25 Calorific Values of Common Materials

Material	Calorific Value (10³ kJ/kg⁻¹)¹⁾	Wood Equivalent (kg/kg)
Solid Fuels		
Anthracite	28.6	1.66
Bituminous Coal	30.8	1.75
Charcoal	28.4	1.61
Coke (average)	27.5	1.56
Peats	20.9	1.19
Sub-bituminous Coal	22.0	1.25
Woods (hard or softwood)	17.6	1.00
Hydrocarbons		
Benzene	39.6	2.25
Butane	47.1	2.68
Ethane	49.1	2.79
Ethylene	47.7	2.71
Fuel Oil	41.6	2.36
Gas Oil	42.9	2.44
Hexane	44.9	2.55
Methane (natural gas)	52.8	3.00
Octane	45.3	2.58
Paraffin	39.6 – 44.0	2.3 – 2.5
Pentane	46.0	2.61
Propane	47.3	2.69
Propylene	46.2	2.63
Alcohols		
Ethyl Alcohol	28.4	1.61
Methyl Alcohol	21.1	1.20
Propyl Alcohol	31.9	1.81

Polymers		
Casein	23.1	1.31
Cellulose	16.5	0.94
Cellulose Acetate	17.8	1.01
Polyethylene	48.4	2.75
Polypropylene	48.4	2.75
Polystyrene	41.8	2.38
Polyvinylchloride	20.9	1.19
Polymethylmethacrylate	24.6	1.40
Polyurethane	35.2	2.00
Polyamide (nylon)	22.0	1.25
Polyester	22.0	1.25
Common Solids		
Asphalt	38.3	2.13
Bitumen	33.4	1.90
Carbon	32.1	1.83
Cotton (Dry)	15.8	0.90
Flax	14.3	0.81
Furs & skins	18.7	1.06
Hair (animal)	20.9	1.19
Leather	17.6	1.00
Ozokerite (wax)	43.3	2.46
Paper (average)	15.4	0.88
Paraffin wax	40.9	2.33
Pitch	33.0	1.88
Rubber	37.4	2.13
Straw	13.2	0.75
Tallows	37.6	2.14
Tan bark	20.9	1.19
Tar (bituminous)	35.2	2.00
Wool (raw)	21.6	1.23
Wool (scoured)	19.6	1.11
Foodstuffs		
Barely	14.1	0.80
Bran	11.0	0.63
Bread	9.9	0.56
Butter	29.5	1.68
Cheese (Cheddar)	18.1	1.03
Corn meal	14.1	0.80
Flour	14.1	0.80
Margarine	29.5	1.68

Oatmeal	15.8	0.90
Rice	13.9	0.79
Soya been flour	16.1	0.91
Sugar	15.4	0.88
Whole Wheat	14.3	0.81
Miscellaneous		
Acetone	29.7	1.69
Acetaldehyde	25.1	1.43
Formaldehyde	17.6	1.00
Hydrogen	134.2	7.63
Magnesium	24.0	1.36
¹⁾ 1 kJ is approximately equal to 1 Btu so the figures in the tables are also equivalent to Btu/kg.		

A-2 The typical values fire load density for arriving at the classification of occupancy hazard is given in Table 26 for guidance.

Table 26 Typical Values of Fire Load Density

Building Type		Fire Load Density (expressed as Wood Equivalent Kilograms Per Square Meter)
1.	Residential (A-1 & A-2)	25
2.	Residential (A-3 to A-5)	25
3.	Institutional and Educational (B & C)	25
4.	Assembly (D)	25-50
5.	Business (E)	25-50
6.	Mercantile (F)	up to 250
7.	Industrial (G)	up to 150
8.	Storage and Hazardous (H & J)	up to 500

ANNEX B
(Clause 3.1.8 and 3.1.11)

**BROAD CLASSIFICATION OF INDUSTRIAL AND NON-INDUSTRIAL
OCCUPANCIES INTO DIFFERENT DEGREE OF HAZARD**

B-1 LOW HAZARD OCCUPANCIES

Abrasive manufacturing premises
Aerated water factories
Agarbatti manufacturing premises
Analytical and/or Q.C. Laboratories
Arecanut slicing and/or Betelnut factories
Asbestos steam packing and lagging manufacturers
Assembly buildings small (D-4 & D-5)
Battery charging and service stations
Battery manufacturing
Breweries
Brickworks
Canning factories
Cardamom factories
Cement factories and/or asbestos or concrete products manufacturing premises
Ceramic factories, crockery, stoneware pipe manufacturing
Clay works
Clock and watch manufacturing
Clubs
Coffee curing, roasting and grinding factories
Condensed milk factories, milk pasturising plants and dairies
Confectionary manufacturing
Dwellings, lodges, dormitories, etc
Educational and research institutions
Electric lamps (incandescent and fluorescent) and T.V. tube manufacturing
Electroplating works
Engineering workshops
Fruits and vegetables dehydrating and drying factories
Fruits products and condiment factories
Glass and glass fibre manufacturing
Godowns and warehouses (non-combustible goods)
Gold thread/gilding factories
Gum and/or glue and gelatine manufacturing
Ice candy and ice-cream and ice factories
Ink (excluding printing ink) factories
Mica products manufacturing
Office premises
Places of worship
Pottery works
Poultry farms
Residential buildings (A-1 to A-4) (except hotels A-5)

Salt crushing factories/refineries stables
Sugar candy manufacturing
Sugar factories and refineries
Tanneries
Umbrella assembling factories
Vermicelli factories
Water treatment/filtration plants and water pump houses
Zinc/copper factories

B-2 MODERATE HAZARD OCCUPANCIES

Airport and other transportation terminal buildings
✓ Aluminium factories
✓ Assembly buildings (D-1, D-2 and D-3)
Atta and cereal grinding
Bakeries and biscuit factories
Beedi factories
Bobbin factories
Book-binders, envelopes and paper bag manufacturing
Camphor boiling
Candle works
Carbon paper/typewriter ribbon makers
Card board box manufacturing
Carpenters, wood wool and furniture makers
Carpet and durries factories
Cashewnut factories
Chemical manufactures (using raw materials having F.P > 23°C)
Cigar and cigarette factories
Coir factories
Cold storage premises
Computer installations
Cork products manufacturing (coir, carpets, rugs and tobacco) (hides and skin presses)
Dry cleaning, dyeing and laundries, cable manufacturing
Electric substations/distribution stations
Electrical generating stations except u/g powerhouses
Enamelware factories
Filler and wax paper manufacturing
Flour mills
Garment makers
Ghee factories (other than vegetable)
Godowns and warehouses (other than non-combustible goods)
Grains and seed disintegrating or crushing
Grease manufacturing
Hosiery, lace, embroidery and thread
Hospitals including `X' ray and other diagnostic clinics (institutional buildings)
Incandescent Gas Mantle manufacturers
Industrial gas manufacturing (only halogenated hydrocarbons/inert gases)
Man made yarn/fibre (except acrylic fibre/yarn)

Manure and fertilizer works (blending, mixing and granulating only)
Mercantile occupancies (departmental stores, shopping complex, etc)
Mineral oil blending and processing
Museums, archives, record rooms
Oil and leather cloth factories
Open storage of flammable liquids (in drums, cans, etc)
Oxygen plants
Paper and cardboard mills (except raw material yard)
Piers, wharves, dockyards
Plastic goods manufacturing
Plywood/wood veneering factories
Printing press premises
Pulverizing and crushing mills
Residential apartments, hotels, cafes, restaurants
Rice mills
Rope works
Rubber goods manufacturing
Rubber tyres and tubes manufacturing
Shellac factories
Silk filatures
Soaps and glycerine factories
Spray painting
Starch factories
Tea factories (including blending packing of tea)
Telephone exchanges, garages
Textile mills
Tobacco chewing and pan masala making
Tobacco redrying factories
Woolen mills

B-3 HIGH HAZARD OCCUPANCIES

A)

Aircraft hangers
Aluminium/magnesium powder plants
Bituminised paper/hessian cloth/tar felt manufacturing
Bulk storage of flammable liquids (tank farm, etc)
Celluloid goods making
Chemical manufacturers (where raw materials have a F.P. <23°C)
Cigarette filter manufacturing
Cinema films and T.V. production studios
Coal, coke and charcoal ball and briquettes making
Collieries, steel plants
Cotton seeds cleaning and delinting factories
Cotton waste factories
Distilleries
Duplicating/stencil paper making
Fire works manufacture

Foamed plastic and/or converting plants
Godowns of warehouses (combustible/hazardous goods) (H)
Grass, hay, fodder and bhoosa (chaff)
Hazardous occupancy buildings (J)
Industrial gas manufacturing (except halogenated hydrocarbon gases/inert gases)
Industrial units (G₃ occupancies)
Jute mills and jute presses
Linoleum factories
Man made fibres (only acrylic fibre/yarn making)
Match factories
Mattress and pillow makings (foam plastics)
Metal or tin printers (if more than 50% is engineering, shift to ordinary hazard)
Oil mills
Oil extraction plants
Oil terminals/depots
Paints/varnish factories
Paper and cardboard mills (only raw material yard)
Pressing factories
Printing ink making
Resin, lamp black and turpentine manufacture
Saw mills
Surgical cotton manufacturing
Tarpaulin and canvas proofing factories
Turpentine and resin distilleries
Type retreading and resoling factories
Underground shopping complexes (F-3)

B)

Ammonia and urea synthesis plants
Explosive factories
LPG bottling plants
Petrochemical plants
Petroleum refineries

NOTE – In case of complexes having segregated plants with varying degrees of hazards, the competent authority having jurisdictions shall be consulted to decide the level of protections to be provided.

CODE

automatically released to the inside of each machine should an explosion occur in the machine..

- (g) Equipment or machinery which generates or emits combustible or explosive dust or fibers shall be provided with an adequate dust collecting and exhaust system.

Annex-C:

(clause 3.4.11.1,5.1.8,5.2.2,6.1.2,6.2.3,6.3.2,6.4.3, 6.5.2, 6.6.2,6.7.2,6.8.2,6.9.2 and E-5.1)

FIRE PROTECTION REQUIREMENTS FOR

COMMENTARY

Annex-C:

(clause 3.4.11.1,5.1.8,5.2.2,6.1.2,6.2.3,6.3.2,6.4.3, 6.5.2, 6.6.2,6.7.2,6.8.2,6.9.2 and E-5.1)

FIRE PROTECTION REQUIREMENTS FOR HIGH RISE BUILDINGS- 15 M IN HEIGHT OR ABOVE.

C.0. General:

- (a) From fire protection stand point, high rise buildings present certain unusual characteristics and special problems. Individually any one of these can constitute a challenge to the fire service. But, when combined, these unique problems can pose unprecedented challenges to the fire fighters.
- (b) Some of the outstanding problems which had been experienced by the fire services during fire fighting operations in high rise buildings are:
- External fire fighting and rescue difficult;
 - Evacuation prolonged/difficult/rescue and fire fighting mainly from within the building;
 - Being fully airconditioned, traps heat and smoke during fires, danger of flash overs;
 - Smoke venting problems;
 - Large number of occupants--incase of fire, human behaviour unpredictable, special care for physically handicapped;
 - Special care to keep escape routes clear;
 - Hazards from increasing use of plastic materials, interior finish/decoration;
 - Multi occupancy hazards, high fire loads;
 - Inadequate water supplies;
 - Inadequate/unserviceable fire protection systems and equipment.
- (c) For the last four decades, there had been an ever increasing number of high rise fires, of major proportions and with tragic loss of lives. Some of these major fires have indicated that fires can occur that can quickly exceed the operational capability of even a larger, well equipped fire service. Further, even with fire resistive construction, fire, smoke and toxic gases pose a major threat to the life safety of both occupants and fire fighters.
- (d) Evacuation problem:
- (i) Experience has shown that it is not practicable to attempt total evacuation of a high rise building which is involved in a major fire. Moreover, diverting fire service personnel to provide necessary assistance in this regard will also seriously hamper the manpower resources which are required for effecting speedy control and extinguishment of fire;
- (ii) Under these circumstances, phased evacuation of occupants involved in high rise building fire is preferable to total or simultaneous evacuation;
- (iii) The main principles involved in phased evacuation are as given below:

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HIGH RISE BUILDINGS- 15 M IN HEIGHT OR ABOVE.

C-0 General

In addition to the general provisions given in this part, the Authority may insist on suitable protection measures (see C-I to C-II) in a building 15m in height or above

C-1 Construction

C-1.1. All materials of construction in load bearing elements, stairways, corridors and facades shall be non-combustible.

C-1.2. The interior finish materials shall not have a flame spreadability rating exceeding class 1 (see 3.4.15.2).

C-1.3. The internal wall of staircase shall be of brick or reinforced concrete with a minimum of 2hr. fire rating.

C-1.4. The staircase shall be ventilated to the atmosphere at each landing with a vent at the top; the vent opening shall be of 0.5 m² in the external wall and the top. If the staircase cannot

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- The first people to be evacuated should be those who are immediately affected by the fire (those on the fire floor and the floor just above the floor on fire);

Subsequently, depending on the need, occupants of two floors at a time (above the floor on fire) can be evacuated;

- Care should also be taken to evacuate the handicapped persons or those with reduced mobility to safe areas like refuge areas and subsequently to final exitways;
 - Supporting facilities such as specially designed fire alarm systems should be provided and maintained;
 - If the building exceeds 30m. in height, the entire building should be sprinklered.
- (e) The definition of high rise building, viz., 15m in height or above, should be read in conjunction with the definition for 'Building Height' under 2.4.

For information only:

A Compendium on Major High Rise Building Fires in the World has been compiled by Shri. G. B. Menon Fire Adviser, Govt. of India(Retd.), which document was released during the International seminar held in Goa from 12 to 14 Feb, 2003. Copies are available for a nominal price, with Gen. Secretary, National Association of Fire Officers, Qrs. No. 305-B, P.O. Fertiliser Nagar, VADODARA(Gujarat)-391750.

C-1 Construction:

C-1.1. Design of structural steel framework is important for high rise buildings because bare steel members if provided would collapse under fire conditions much earlier than other structural elements like walls, slabs etc. All supporting structural beams and columns of steel should therefore be enclosed in 2in. thick concrete or equivalent fire proofing material.

The hazards of unprotected steel involved in fire have already been explained in detail under clause-3.3.3.

C-1.2. Interior finish materials like wall panelings, wooden floorings, or false ceilings play equally destructive role in aggravating loss of human lives and property in case of fire, and hence these must conform to class-1 flame spread characteristics.

The interior finish materials play a vital role in the fire growth and severity of fire, besides generation of large volumes of smoke and toxic gases seriously affecting the life safety of the occupants.

C-1.4. Venting or pressurisation of staircases provide smoke-free passage to people being evacuated who face danger of suffocation by smoke inhalation.

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be ventilated, because of location or other reasons, a positive pressure 50Pa shall be maintained inside. The mechanism for pressurising the staircase shall operate automatically with the fire alarm. The roof of the shaft shall be 1m above the surrounding roof.
Glazing or glass bricks if used in staircase shall have fire resistance rating of minimum 2 hours.

C-1 .5. Lifts

General requirements of lift shall be as follows:

- (a) Walls of lift shaft enclosures shall have a fire rating of 2 h ;lift shafts shall have a vent at the top, of area not less than 0.2 m²;
- (b) Lift motor room shall be located preferably at the top of the shaft and separated from the shaft by the floor of the room;
- (c) Landing doors in lift enclosures shall have fire resistance of not less than 1h;
- (d) **The number of lifts in one row for a lift bank shall not exceed 4 and the total number of lifts in the bank shall not exceed 8.**
A wall of 2 h. rating shall separate individual shafts in a bank.
- (e) Lift car door shall have a fire resistance rating of half an hour;
- (f) Collapsible gates shall not be permitted for lifts. They shall have solid doors with fire resistance of at least 1h.;
- (g) If the lift shaft and lobby is in the core of the building, a positive pressure between 25 and 30 Pa shall be maintained in the lobby, and a positive pressure of 50 Pa shall be maintained in the shaft. The mechanism for pressurisation shall act automatically with the fire alarm; it shall be possible to operate this mechanically also;
- (h) Exit from the lift lobby, if located in the core of the building , shall be through a self-closing smoke stop door of half an hour fire resistance;
- (j) Lifts shall not normally communicate with the basement; if, however, lifts are in communication, the lift lobby of the basements shall be pressurised as in (g), with self closing door as in (h);
- (k) Grounding switch(es), at ground floor level, shall be provided on all the lifts to enable the fire service to ground the lifts;

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C-1.5. Lifts.

For information only:

- (a) As per international practice, the area of vents for the lifts should be not less than 3^{1/2}% of the area of each lift car, or not less than 0.28m² (3 ft.²), whichever is greater;
- (b) Lift motor is the heart of the lift mechanism. Therefore, it must be protected from any fire in the lift shaft;
- (d) Not more than 4 lift cars shall be located in any single lift bank (hoistway) enclosure. The lift shaft and lift lobbies shall be smoke proof;
- (f) Collapsible gates permit spread of smoke and hot gases into the lift car and lift shaft, and hence shall not be permitted;
- (g) Higher pressure in lift shaft in case of fire, helps keeping lift shafts smoke-free thereby facilitating evacuation as well as fire fighting by the fire service;
The interconnection of the pressurisation system with the automatic/manual fire alarm system is a basic fire safety requirement. (Please see 4.10.6);
- (j) These are basic and essential requirements even for low rise buildings;
- (k) This will facilitate fire service in their fire fighting operations;
- (m) People trapped in lifts, in case of any fire outbreak or other emergency in the lift, should be able to communicate with the fire control room. This will also facilitate fire service in their fire fighting operations, if needed;
- (p) Positioning of such signs near lifts has a special importance because normal response of an occupant in the high rise building is to use lifts for going down;
In case of fire, use of lifts may prove dangerous unless they are properly segregated. Their use in such conditions is normally not advocated;
- (q) (iv) By opening the hatch, fire brigade may be able to rescue people trapped in lifts which have suddenly stopped in case of a fire;
- (q) (v) Automatic changeover from normal supply to generator supply is very important because the generator room may not easily be accessible in case of a severe fire. Sometimes, the delay in manual changeover may prove costly due to delayed response;
- (q) (viii) This helps fire brigade to locate fire lifts even in darkness. It is quite likely that electricity may have been switched off at the time of arrival of fire brigade.

Notes:

- (i) It will be a worth while safety precaution to insist upon a test certificate for lifts as a pre condition before issue of NOC for a building;

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- (m) Telephone or other communication facilities shall be provided in lift cars for buildings of 30m in height and above. Communication system for lifts shall be connected to fire control room for the building;
- (n) Suitable arrangements such as providing slope in the floor of lift lobby, shall be made to prevent water used during fire fighting etc, from entering the lift shafts;
- (p) A sign shall be posted and maintained on every floor at or near the lift indicating that in case of fire, occupants shall use the stairs unless instructed otherwise. The sign shall also contain a plan for each floor showing the locations of the stairways. Alternate source of power supply shall be provided for all the lifts through a manually operated changeover switch.
- (q) **Fire Lifts**
Following details shall apply for a fire lift:
 - (i) To enable fire services personnel to reach the upper floors with the minimum delay , one fire lift per 1200 m² of floor area shall be provided, and shall be available for the exclusive use of the firemen in an emergency;
 - (ii) The lift shall have a floor area of not less than 1.4 m². It shall have loading capacity of not less than 545 kg (8 persons lift) with automatic closing doors of minimum 0.8 m width;
 - (iii) The electric supply shall be on a separate service from electric supply mains in a building and the cables run in a route safe from fire, that is, within the lift shaft. Lights and fans in the elevators having wooden paneling or sheet steel construction shall be operated on 24 volt supply;
 - (iv) Fire lift should be provided with a ceiling hatch for use in case of emergency, so that when the car gets stuck up, it shall be easily openable;
 - (v) In case of failure of normal electric supply, it shall automatically changeover to alternate supply. For apartment houses, this changeover of supply could be done through manually operated changeover switch. Alternatively, the lift shall be so wired that in case of power failure, it comes down at the ground level and comes to stand-still with door open.
 - (vi) The operation of fire lift should be by a simple toggle or two -button switch situated in glass-fronted box adjacent to the lift at the entrance level. When the switch is on, landing call points will become inoperative and the lift

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- (ii) It has to be ensured that the lifts are properly maintained so that they remain available for fail safe operation at all times.

CODE**COMMENTARY**

will be on car control only or on a priority control device. When the switch is off, the lift will return to normal working, when this lift can be used by the occupants in normal times.

- (viii) The words 'Fire Lift' shall be conspicuously displayed in fluorescent paint on the lift landing doors at each floor level.
- (ix) The speed of the fire lift shall be such that it can reach the top floor from ground level within one minute.

C-1.6 Basements

C-1.6.1. Each basement shall be separately ventilated.

Vents with cross sectional area (aggregate) not less than 2.5 % of the floor area spread evenly around the perimeter of the basement shall be provided in the form of grills, breakable stallboard lights, pavement lights or by way of shafts. Alternatively, a system of air inlets shall be provided at basement floor level and smoke outlets at basement ceiling level. Inlets and extracts shall be terminated at ground level with stallboard or pavement lights as before, but ducts to convey fresh air to the basement floor level will have to be laid. Stallboard and pavement lights should be in positions easily accessible to the fire brigade and clearly marked '**SMOKE OUTLET**' OR '**AIR INLET**' with an indication of areas served at or near the opening.

C-1.6.2. The staircase of basements shall be of enclosed type having fire resistance of not less than 2 hours and shall be situated at the periphery of the basement to be entered at ground level only from the open air and in such positions that smoke from any fire in the basement shall not obstruct any exit serving the ground and upper storeys of the building. It shall communicate with basement through a lobby provided with fire resisting self closing doors of one hour resistance. For travel distance refer 4.5. If the travel distance exceeds as given in Table 21, additional staircases shall be provided at proper places .

C-1.6.3. In multistorey basements, intake ducts may serve all basement levels, but each basement level and basement compartment shall have separate smoke outlet duct or ducts. **Ducts so provided shall have the same fire resistance rating as the compartment itself. Fire rating may be taken as the required smoke extraction time for smoke extraction ducts.**

C-1.6.4. Mechanical extractors for smoke venting system from lower basement levels shall also be provided, The system shall be of such design as

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to operate on actuation of heat/smoke sensitive detectors or sprinklers, if installed, and shall have a considerably superior performance compared to the standard units. It shall also have an arrangement to start it manually.

C-1.6.4.1. Mechanical extractors shall have an internal locking arrangement, so that extractors shall continue to operate and supply fans shall stop automatically with the actuation of fire detectors.

C-1.6.4.2. Mechanical extractors shall be designed to permit 30 air changes per hour in case of fire or distress call. However, for normal operation, air changes schedule shall be as given in 3.4.11.5.

C-1.6.4.3. Mechanical extractors shall have an alternative source of supply;

C-1.6.4.4 Ventilating ducts shall be integrated with the structure and made out of brick masonry or reinforced cement concrete as far as possible, and when this duct crosses the transformer area or electrical switchboard, fire dampers shall be provided.

C-1.6.5. Use of basements for kitchen working on gas fuel shall not be permitted unless air- conditioned.

The basement shall not be permitted below the ward block of a hospital/nursing home unless it is fully sprinklered.

Building services such as electrical substations, boiler rooms in basements shall comply with the provisions of I.E. Act/ Rules.

C-1.6.6 If cut-outs are provided from basements to the upper floors or to the atmospheres, all sides of cut out openings in the basements shall be protected by sprinkler heads at close spacing so as to form a water curtain in the event of a fire.

C-1.7. Operable windows on external walls shall be fitted with such locks that can be opened by a fireman's axe.

C-1.8. All floors shall be compartmented with area not exceeding 750 m² by a separation wall with 2 h fire rating. For floors with sprinklers the area may be increased by 50 percent. In long building, the fire separation walls shall be at distances not exceeding 40 m. For departmental stores, shopping centers and basements, the area may be reduced to 500 m² for compartmentation.

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C-1.6.4.4. Ventilating ducts, if made of steel or other metal may fail in case of a fire and defeat the very purpose for which they are made.

C-1.6.5. Occupancies which are prohibited from being located in basements are either of high risk category, or an Assembly occupancy, making their evacuation in case of fire difficult due to smoke logging and also possible impediments to fire fighting operations.

C-1.8. Compartmentation is seldom attempted in modern buildings due to several operational as well as aesthetic considerations on the part of builders, users etc. However, this is a very important requirement from fire safety point of view, for effective confinement and control of fire and preventing the fire spreading to adjacent areas.

C-1.8.1 Many a time, damage caused by water used in fire fighting has proved costlier than the fire damage itself, possibly because of the nature of the materials involved. It is therefore important that they have proper drainage arrangements in all the areas of the building. Similarly, it is equally important to have non combustible drain pipes for obvious reasons.

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Where this is not possible, the spacing of the sprinklers shall be suitably reduced. When reducing the spacing of sprinklers, care should be taken to prevent spray from one sprinkler impeding the performance of an adjacent sprinkler head

C-1.8.1. It is essential to make provisions for drainage of any such water from all floors to prevent or minimise water damage of the contents. The drain pipes should be provided on the external wall for drainage of water from all floors. On large area floors several such pipes may be necessary which should be spaced 30 m apart. Care shall be taken to ensure that the construction of the drain pipe does not allow spread of fire/smoke from floor to floor.

C1.9. Service Ducts/Shafts.

- (a) Service ducts and shafts shall be enclosed by walls of 2 h, and doors of 1 h, fire rating. All such ducts/shafts shall be properly sealed and fire stopped at all floor levels.
- (b) A vent opening at the top of the service shaft shall be provided having between one-fourth and one-half of the area of the shaft.

C-1.10 Refuse chutes shall have opening at least 1 m above roof level for venting purpose and they shall have an enclosure wall of non-combustible material with fire resistance of not less than 2 hours. They shall not be located within the staircase enclosure or service shafts, or air-conditioning shafts. Inspection panel and doors shall be tight fitting with 1hr fire resistance; the chutes should be as far away as possible from exits.

C-1.11 Refuge Area

Provisions contained in 4.12.3 shall apply for all high- rise buildings except multi-family dwellings where refuge area of not less than 15 m² shall be provided on external walls

C-1.12. Electrical services shall conform to the following:

- (a) The electric distribution cable/wiring shall be laid in a separate duct. The duct shall be sealed at every floor with non-combustible materials having the same fire resistance as that of the duct. Low and medium voltage wiring running in shaft and in false ceiling shall run in separate conduits.
- (b) Water mains, telephone lines, intercom lines, gas pipes or any other service line shall not be laid in the duct for electrical cables; use of bus ducts/ solid rising mains instead of cables is preferred.

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C-1.9. Natural venting of service shafts helps in smoke disposal thus making fire fighting and rescue operations easier.

C-1.10. Refuse chutes which are used for collection and disposal of the waste from the various floors constitute a potential source of fire due to accumulation of combustible waste. Their location in staircase and a/c shafts can pose grave hazards due to chimney effect of fire. Provision of fire resistant doors at every floor level helps prevention of fire spread from floor to floor. Fires are thereby contained to floor of origin.

C-1.12.

- (a) Sealing of electrical ducts at every floor by proper sealing materials having adequate fire resistance, helps preventing spread of fires through electrical cables. Their insulation is flammable and capable of producing intense smoke which hampers fire fighting/rescue efforts.
- (b) Electrical ducts, if used for other services, can pose great hazard to those services in case of a short circuit and fire. Conversely, running gas lines in these ducts can pose danger to electrical services in case of gas fires.s.
- (c) It is imperative to have properly labelled master switches for each of the emergency services in the emergency panel (which is to be energised both by the normal supply as well as the generated supply) for easy identification and ease of operations.
- (e) Electrical fires caused by short circuits can spread very fast through false ceilings if they are of combustible nature. They would only add fuel to the fire.s.
- (g) Due to continuous use, meter rooms tend to heat up, and there are chances of short circuits in the mains if they are not well maintained. In any case they should not be located in staircases where fires can spread very fast vertically to all floors due to stack effect.

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- (c) Separate circuits for fire fighting pumps, lifts, staircases, corridor lighting and blowers for pressurising system shall be provided directly from the main switch gear panel and these circuits shall be laid in separate conduit pipes, so that fire in one circuit will not affect the others. Such circuits shall be protecting at origin in an automatic circuit breaker with its no-volt coil removed. Master switches controlling essential service circuits shall be clearly labelled.
- (d) The inspection panel doors and any other opening in the shaft shall be provided with air tight fire doors having fire resistance of not less than 1h.
- (e) Medium and low voltage wiring running in shafts, and within false ceiling shall run in metal conduit. Any 230 V wiring for lighting or other services, above false ceiling, shall have 660 V grade insulation. The false ceiling, including all fixtures used for its suspension, shall be of non-combustible material and shall provide adequate fire resistant to the ceiling in order to prevent spread of fire across ceiling, reference may be made to good practice [F(29)];
- (f) An independent and well ventilated electrical service room shall be provided on the ground level or first basement with direct access from outside or from the corridor for the purpose of termination of electric supply from the licensees* service and alternative supply cables. The doors provided for the service room shall have fire resistance of not less than 2 hours.

Note: If service room is located at the first basement, it should have automatic fire extinguishing system.

- (g) If the licensees agree to provide meters on upper floors, the licensees' cables shall be segregated from consumers' cables by providing a partition in the duct. Meter rooms on upper floors shall not open into staircase enclosures and shall be ventilated directly to open air outside; and
- (h) Suitable circuit breakers shall be provided at the appropriate points.

C-1.13 Gas supply shall conform to the following:

- (a) Town gas/ L.P.Gas supply pipes - Where gas pipes are run in buildings, the same shall be run in separate shafts exclusively for this purpose and these shall be on external walls, away from the staircases. There shall no interconnection of this shaft with the rest of the floors, LPG distribution pipes shall always be below the false ceiling. The length of these pipes shall be as short as possible. In the case of kitchen cooking range area, apart from providing hood, covering the entire cooking range the

COMMENTARY

C-1.13.

- (a) Running of town gas/LPG pipes in separate shafts help in containing gas fires. If town gas/LPG pipes are run above false ceiling, disastrous consequences may result from possible fire outbreaks above false ceiling, which can spread very fast through these ducts and ceiling void. If oil vapours escape from fume hoods which are already at high temperatures, chances of fires flashing across hoods cannot be ruled out.
- (b) Fires in kitchen fume hoods can prove very costly because of use of LPG and their exhaust system which helps in rapid spread of fire. This hazard is of prime importance in starred hotels where kitchen fires are common. Providing fixed fire fighting systems for kitchen hoods are therefore essential.

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exhaust system should be designed to take care of 30 m³ per minute per m² of hood protected area. It should have grease filters using metallic grill to trap oil vapours escaping into the fume hood.

Note - For detailed information on gas pipe installations, reference may be made to Part 9 Plumbing Services, Section 3 Gas supply.

- (b) All wiring in fume hoods shall be of fiber glass insulation. Thermal detectors shall be installed into fume hoods of large kitchens for hotel, hospitals, and similar areas located in high-rise buildings. Arrangements shall be made for automatic tripping of the exhaust fan in case of fire. If LPG is used, it shall be shut off. The voltage shall be 24 v or 100 v dc operated with external rectifier. The valve shall be of the hand re-set type and shall be easily accessible. The hood shall have manual facility for steam or carbon dioxide gas injection, depending on duty condition;
- (C) Gas meters shall be housed in a suitably constructed metal cupboard located in a well ventilated space, keeping in view the fact that LPG is heavier than air and town gas is lighter than air.

C-1.14 Illumination of Means of Exit

Staircase and corridor lights shall conform to the following (see 4.16 and 4.17 for additional details):

- (a) The staircase and corridor lighting shall be on separate circuits and shall be independently connected so that it could be operated by one switch installation on the ground floor easily accessible to fire fighting staff at any time irrespective of the position of the individual control of the light points, if any . It should be of miniature circuit breaker type of switch so as to avoid replacement of fuse in case of crisis;
- (b) Staircase and corridor lighting shall also be connected to alternative supply. The alternative source of supply may be provided by battery continuously trickle charged from the electric mains:
- (c) Suitable arrangements shall be made by installing double throw switches to ensure that the lighting installed in the staircase and the corridor does not get connected to two sources of supply continuously. Double throw switch shall be installed in the service room for terminating the stand-by supply.
- (d) Emergency lights shall be provided in the staircase

COMMENTARY

C-1.14.

- (a) One control switch at the ground level will help in putting on emergency lights for prompt illumination of escape routes. Miniature circuit breakers avoid frequent fuse replacement.

Location of MCBs at ground level facilitate their accessibility to fire brigade personnel immediately on their arrival.

- (d) Staircases and corridors constitute the commonly used components of means of escape in fire emergencies. It is therefore necessary to keep them well illuminated at all times, whether main supply is on or not, to avoid chaos and ensure smooth evacuation of trapped persons.

C-1.15. On detection of fire, the first normal reaction is to switch off the main electric supply, to prevent fire spread by possible short circuit etc. It is however important to keep all emergency services going which are essential for evacuation and fire fighting operation. Therefore, to have a standby generator supply which comes on automatically is a prime requirement so as to maintain all essential emergency services.

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and corridor.

- (e) All wires and other accessories used for emergency light shall have fire retardant property

C-1.15 A stand-by electric generator shall be installed to supply power to staircase and corridor lighting circuits, fire lifts, the stand-by fire pump, pressurisation fans and blowers, smoke extraction and damper systems in case of failure of normal electric supply. The generator shall be capable of taking starting current of all the machines and circuits stated above simultaneously. If the stand-by pump is driven by diesel engine, the generator supply need not be connected to the main electrical pump. Where parallel HV/LV supply from a separate sub-station is provided with appropriate transformer for emergency, the provision of generator may be waived in consultation with the Authority.

C-1.16 Transformers shall conform to the following:

- (a) A sub-station or a switch-station with oil filled equipment shall not be located in the building. The substation structure shall have separate fire resisting walls/surroundings and shall necessarily be located at the periphery of the flow having separate access from fire escape staircase. The outside walls, ceiling, floor, openings including doors and windows to the substation area shall be provided with a fire resisting door of 2hr. fire rating. Direct access to the transformer room shall be provided, preferably from outside the fire escape staircase.
- (b) The substation area needs to be maintained at negative air pressure and area in substation shall not be used as storage / dump areas.
- (c) When housed inside the building, the transformer shall be of dry type and shall be cut off from the other portion of premises by walls / doors / cut out having fire resistance rating of 4 hrs.

C-1.17 Air-conditioning shall conform to the following:

- (a) Escape routes like staircases, common corridors, lift lobbies, etc, shall not be used as return air passage;
- (b) The ducting shall be constructed of substantial gauge metal in accordance with good practice [F(30)];
- (c) Wherever the ducts pass through fire walls or floors, opening around the ducts shall be sealed with materials having fire resistance rating

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C-1.16.

- (a) Being reviewed in line with the Indian Electricity Act/ Rules, NEC and IS: 1646-1997.
- (e) In case of fire and subsequent rupture of transformers, it becomes difficult to tackle transformer fires. If transformers are located above ground level, there is a danger from over flowing of the burning fuel to the floors below and even to the drains.
- (f) In case of transformer fires a soakpit is required for collection of the oil draining out at a safe distance, thereby removing the fuel from the fire scene.

C-1.17.

- (a) Fires circulating through return air ducts can hamper escapes/evacuation of occupants through staircases, and hence this requirement.
- (c) Small gaps between a/c ducts and walls/floors through which they pass can provide an easy path for fire to pass from one area to another, and hence this requirement.
- (d) Use of metallic ducts is the accepted and safer method for conveying return air instead of using the ceiling void as plenum. In fact there is an IS on this subject.
- (f) Any combustible insulating material will aggravate the fire hazard in case of any fire passing through the ducts.
- (k) Shutting down of the Air Handling Units(AHUs) on operation of automatic fire alarm system ensures that fire does not get circulated via a/c ducts and also restricts fire spread to other areas.
- (p) This is a basic fire safety requirement which has to be scrupulously enforced.

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of the compartment;

- (d) Where duct crosses a compartment which is fire rated, the ducts shall be fire rated for same fire rating. Further depending upon services passing around the duct work, which may get affected in case of fire temperature rising the ducts shall be insulated;
- (e) As far as possible metallic ducts shall be used even for the return air instead of space above the false ceiling;
- (f) Where plenum is used for return air passage, ceiling and its fixtures shall be of non-combustible material;
- (g) The materials used for insulating the duct system (inside or outside) shall be of non-combustible materials. Glass wool shall not be wrapped or secured by any material of combustible nature;
- (h) Areas more than 750 m² on individual floor shall be segregated by a fire wall and automatic fire dampers for isolation shall be provided [see (s)];
- (i) Air ducts serving main floor areas, corridors, etc, shall not pass through the staircase enclosure;
- (j) The air-handling units shall be separate for each floor and air ducts for every floor shall be separated and in no way inter-connected with the ducting of any other floor;
- (k) If the air-handling unit serves more than one floor, the recommendations given above shall be complied with in addition to the conditions given below;
- (1) Proper arrangements by way of automatic fire dampers working on smoke detector/or fusible link for isolating all ducting at every floor from the main riser shall be made;
- (2) When the automatic fire alarm operates, the respective air-handling units of the air-conditioning system shall automatically be switched off.

NOTE-Fusible link operates on heat detection system.

- (m) The vertical shaft for treated fresh air shall be of masonry construction;
- (n) The air filters of the air-handling units shall be of non-combustible materials;
- (p) The air handling unit rooms shall not be used for storage of any combustible materials;
- (q) Inspection panels shall be provided in the main trunking to facilitate the cleaning of ducts of accumulated dust and to obtain access for maintenance of fire dampers;
- (r) No combustible material shall be fixed nearer than

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150 mm of any duct unless such duct is properly enclosed and protected with non-combustible material (glass wool or spun glass with neoprene facing enclosed and wrapped with aluminum sheeting) at least 3.2 mm thick which would not readily conduct heat;

(s) Fire Dampers:

- 1) These shall be located in conditioned air ducts and return air ducts/passages at the following points:
 - (i) At the fire separation wall;
 - (ii) Where ducts/passages enter the central vertical shaft;
 - (iii) Where the ducts pass through floors, and;
 - (iv) At the inlet of supply air duct and the return air duct of each compartment on every floor;
- (2) The dampers shall operate automatically and shall simultaneously switch off the air-handling fans. Manual operation facilities shall also be provided.

Note-For blowers, where extraction system and duct accumulators are used, dampers shall be provided.

- (3) Fire/smoke dampers (for smoke extraction shafts) for buildings more than 24 m in height:

For apartment houses -In non-ventilated lobbies / corridors operated by fusible link / smoke detectors with manual control.

For other buildings-On operation of smoke detection system and with manual control.

- 4) Automatic fire dampers shall be so arranged as to close by gravity in the direction of air movement and to remain tightly closed on operation of a fusible link / smoke detector.

C-1.18. Provisions of boiler and boiler rooms shall conform to Indian Boiler Act. Further, the following additional aspects may be taken into account for the location of boiler room;

- (a) The boilers shall not be allowed in sub basement, but may be allowed in the basements away from escape routes;
- (b) The boilers shall be installed in a fire resisting room of 4h fire resistance rating, and this room shall be situated on the periphery of the basement. Catch- pits shall be provided at the low level;
- (c) Entry to this room shall be provided with a composite door of 2h fire resistance;

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C-1.18.

- (a) Boilers and such other utility services machines should not be housed in sub basements as per the usual accepted safety standards. They should also be located away from escape routes so as to prevent any obstruction to safe evacuation process.
- (b) Boilers when located in a 4 hr. fire resistant enclosure will ensure that any possible boiler explosion or fire effects are confined to the boiler enclosure and are not conveyed to outside. Provision of catchpit ensures that escaping burning fuel flowing out of a transformer on fire does not spread to other areas. Its location on the periphery ensures its easy isolation from other areas.
- (d) Smoke extraction and ventilation become very important in case of fires in boiler rooms which use fuels that can generate dense smoke.
- (f) This requirement attains great importance where boilers use liquid fuels. Fires in liquid fuels which are lighter than water can only be extinguished by using foam extinguishing methods.

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- (d) The boiler room shall be provided with fresh air inlets and smoke exhausts directly to the atmosphere;
- (e) The furnace oil tank for the boiler, if located in the adjoining room, shall be separated by fire resistant wall of 4h rating. The entrance to this room shall be provided with double composite doors. A curb of suitable height shall be provided at the entrance in order to prevent the flow of oil into the boiler room in case of tank rupture.
- (f) Foam inlets shall be provided on the external walls of the building near the ground level to enable the fire services to use foam in case of fire.

C-2. Provision of first aid fire fighting appliances:

The first aid fire fighting equipment shall be provided on all floors, including basements, Lift rooms etc, in accordance with good practice[F(20)] in consultation with the authority

C-3. Fire Alarm System:

- C-3.1.** All buildings with height of 15m or above shall be equipped with manually operated electrical fire alarm (MOEFA) system and automatic fire alarm system in accordance with good practice [F(17)] and [F (18)]. However, apartment building between 15m and 30 m height may be exempted from the installation of the automatic fire alarm system provided the local fire brigade is suitably equipped for dealing with fire in a building of 15 m in height or above, and in the opinion of the authority, such building does not constitute a hazard to the safety of the adjacent property or occupants of the building itself.

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C-2. Provision of First Aid Fire Fighting Appliances:

The details of the scales and procedure for deployment, selection, installation, maintenance etc. for portable fire extinguishers are given in IS: 2190-1992.

C-3. Fire Alarm System:

- C-3.1.** For provision of AFA system for apartment buildings of height between 15m and 30m, the opinion of the authority (Chief Fire Officer) will be implemented.

C-3.1.1. The Manual Fire Alarm(MFA) System installed in high rise buildings will be an integrated one with the Automatic Fire Alarm(AFA) System and the Manual Call Point(MCP) will function as the activating device for the manual operation of the AFA system. Manual operation is done when any person on the floor notices a fire before the operation of the fire detectors. The MCPs are normally sited on the exit routes, and in particular on the floor landings of stairways or near the exit doors. Generally, they should be the wall mounted type fixed at a height of 1.4m above the floor level and preferably with a travel distance not exceeding 30m for operation by any person on the floor.

C-3.1.2. For information only:

It will be of interest to know that as per international practice and trends, manual call boxes are installed in such premises. Life safety of the occupants and fire protection of the premises are of primary concern to the authorities, and possibilities of random misuse, which are of secondary concern, are overlooked. If installation and operation of such fire protection and life safety devices in these occupancies could result in the saving of at least some lives of the occupants, and minimise property damage, the main objective of the installation of the manual call points in the premises would be fully achieved.

What will be necessary under these circumstances will be to educate the young users about the need for such safety measures in the interests of general safety and welfare, including themselves.

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C-3.1.1 Manually operated electrical fire alarm system shall be installed in the building with one or more call boxes located at each floor. The call boxes shall conform to good practice [F(18)] and [F (19)]

C-3.1.2 The installation of call boxes in hostels and such other places where these are likely to be misused shall be avoided. Location of all boxes in dwelling units shall preferably be inside the building.

C-4 Lightning protection of buildings.

The lightning protection of buildings shall be provided as given in Part 8 Building services, section 2 Electrical Installations.

C-5 Fire Control Room.

For all buildings 15m in height and above and apartment buildings with a height of 30m and above, there shall be a Control Room on the entrance floor of the building with communication system (suitable public address system) to all floors and facilities for receiving the message from different floors. Details of all floor plans along with the details of fire fighting equipment and installations shall be displayed in the fire control room. The fire control room shall also have facilities to detect the fire on any floor through indicator boards connection; fire detection and alarm systems on all floors. The fire staff in charge of the fire control room shall be responsible for maintenance of the various services and the fire fighting equipment and installations in co-ordination with security, electrical and civil staff of the building.

C-6 Fire Officer for Hotels, Business and Mercantile Buildings with height more than 30m.

C-6.1 A qualified fire officer with experience of not less than 3 years shall be appointed who will be available on the premises.

C-6.2. The fire officer shall,

- (a) Maintain the fire fighting equipment in good working condition at all times
- (b) Prepare fire orders and fire operational plans and get them promulgated,
- (c) Impart regular training to occupants of the buildings

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C-5. Fire Control Room:

- (a) Detailed instructions about the facilities to be provided in this Fire Control Room(also known as Control Centre /Control Centre Room) are given under clause-10 of IS:2189-1999, 'Selection, Installation and Maintenance of Automatic Fire Detection and Alarm System-Code of Practice'
- (b) The main features of this room, as given in the IS, are:
 - (i) It should have an area of 16m² to 20m², preferably on ground floor;
 - (ii) The Control and Indicating Equipment(Control Panel of the AFA system), power supply units and the fire protection ancillary panels(for automatic sprinkler system or other fixed fire protection system etc.) should be installed in the room;
 - (iii) It should have intercom and direct telephone facilities. Where possible, a direct hot line to local fire brigade should be provided;
 - (iv) It should have a mimic panel of the premises protected and details of all the fire protection systems installed;
 - (v) The room should be air-conditioned and should have emergency lighting system.

C-6. Fire Officer for Hotels, Business and Mercantile Buildings with height more than 30m.

Any advice in this regard can be sought from the local fire chief.

The need for professionalism in fire fighting field can hardly be over emphasised.

C-6.2. Fire fighting equipment being seldom used except for fighting actual fires, their maintenance is often neglected. Besides having best equipment in their perfect working order, it is equally important to have trained man power to use them. More over, it is essential that the occupants are made fully conversant with the actions to be taken in case of fire as well as for speedy and orderly evacuation.

Proper liaison with local fire brigade would ensure that they are familiar with the risks in the building and, further, it would be for mutual benefit. This is very important because fires which are not tackled in the initial 5 min. attain dangerous proportions soon after.

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in the use of fire fighting equipments provided on the premises, and keep them informed about the fire emergency evacuation plan,

- (d) Keep proper liaison with city fire brigade, and
- (e) Ensure that all fire precautionary measures are observed at all times.

Note: Competent authority having jurisdiction may insist on compliance of the above rules in case of buildings having very large areas even if the height is less than 30m.

C-7. Housekeeping

To eliminate fire hazards, good house keeping, both inside and outside the building, shall be strictly maintained by the occupants and the owner of the building.

C-8. Fire drills and fire orders:

Fire notices/ orders shall be prepared to fulfill the requirements of fire fighting and evacuation from the buildings in the event of emergency. The occupants shall be made thoroughly conversant with their actions in the event of emergency by

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C-7: House keeping:

Good house keeping boils down to regular upkeep of the premises, keeping things in their places and regular waste disposal. Good house keeping reflects good management style and a strong desire to follow fire prevention practices.

C-8. Fire drills and fire orders:

- (a) **Fire orders:** is a document containing instructions/guide lines on fire safety/fire prevention rules for the premises. It also contains details of the actions to be taken in case of fire by the occupants, their duties and responsibilities, important telephone numbers etc. Copies of these fire orders are distributed to all concerned for their information and compliance
- (b) **Fire drills:** While promulgation and dissemination of fire orders is important, it is equally important to ensure that all occupants are made fully conversant with actions to be taken in case of fire by periodically making them practice the action procedure through mock drills. More details about the fire drills are given in Annex-E.

C-9. Compartmentation:

- (i) Compartmentation, or installation of fire barriers at appropriate places, in the building is one of the well established principles which is widely followed for a fire safe design of a building for structure.
- (ii) Fires on one or two floors, or when spread over a large floor area, are extremely difficult to control and extinguish by manual fire fighting methods. Building designs with unprotected vertical openings, like open stairwells, large floor areas without separation walls, a/c duct work without dampers etc. provide avenues for fire spread vertically as well as side ways. Fire fighting operations become difficult and prolonged as the fire propagation continues upwards as well as horizontally.
- (iii) Judicious compartmentation of a building, which is considered as a primary method among passive fire protection measures, helps to achieve the following:
 - Confine a fire to its place of origin;
 - Prevent a growing fire from spreading to other areas;
 - Segregate a space that has a higher fire or life hazard than the surrounding area;
 - Limit the size of the fire, thereby limiting the smoke generation and also facilitate fire suppression;
 - To protect high value or critical areas or operations from a fire in the surrounding area (Eg: Computer rooms, control rooms, safe vaults, records room etc.)

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displaying fire notices at vantage points and also through regular training. Such notices should be displayed prominently in broad lettering.

For guidelines for fire drills and evacuation procedures for high rise building, see Annex E.

C-9. Compartmentation:

The building shall be suitably compartment alised so that fire/ smoke remains confined to the area where fire incident has occurred and does not spread to the remaining part of the building.

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C-10. Helipad:

- (a) Requirement of helipad is important for very tall buildings because conventional evacuation of occupants through staircases becomes impractical and at times results in fatigue to the aged and children.

International experience:

There had been several cases of major high rise building fires when many persons had collected on the roofs of the burning buildings because of non availability of staircases for escape due to smoke accumulation in the escape route. In many such cases they were rescued from the roof tops using helicopter sorties. Some of the outstanding cases are mentioned below:

Date	Place	Remarks
24 Feb. 1972	Andraus Bldg. Sao Paulo, Brazil (24 storeys)	Roof used as heliport. A shuttle service of 11 helicopters used to rescue over 350 persons from the roof.
01 Feb. 1974	Joelma Bldg. Sao Paulo, Brazil (21 storeys)	72 persons rescued by helicopters
25 Dec. 1971	Hotel, Seoul, S. Korea	6 rescued by helicopters
21 Mar. 1981	Office Bldg., Santiago, Chile (35 storeys)	Helicopters rescued several
6 June, 1983	Office Bldg., Gopala Towers Delhi(14 storeys)	6 rescued by helicopters
31 Dec, 1986	Dupont Plaza Hotel Puerto Rico (20 storeys)	Helicopter rescued several
4 May, 1988	Office Bldg., California, US (62 storeys)	8 rescued by helicopters
20 Nov. 1996	Office Bldg., Hong Kong (16 storeys)	Several were rescued by helicopters

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C-10 Helipad:

For high rise buildings above 60 m in height, provision for helipad should be made.

C-11. Materials for Interior Decoration/ Furnishing:

The use of materials which are combustible in nature and may spread toxic fume/gases should not be used for interior decoration/furnishing etc.

ANNEX-D: (Clauses 6.7.3.3. and 6.75)

FIRE PROTECTION CONSIDERATIONS FOR VENTING IN INDUSTRIAL BUILDINGS.

D-1 APPLICATION AND SCOPE

D-1.1. The provisions given below are applicable only to single storey industrial buildings (factories and storage buildings) covering large floor areas without subdividing/ separating walls which are usually designed to meet modern production methods.

D-1.2. The requirements of fire and explosion venting of industrial buildings, as dealt with in this section, fall under two categories :

- (a) Smoke and fire venting, and
- (b) Explosion relief vents

D-2. SMOKE AND FIRE VENTING

D-2.1. The basic considerations for formulating the design and other requirements for smoke and fire vents are as given in D-2.1.1 to D-2.1.20.

D-2.1.1. The smoke and hot combustion products from a fire, being lighter than the surrounding air, tend to rise and on reaching the roof or ceiling spread out (mushroom) on all sides and form a layer which floats on top of the cold air beneath. In the absence of vents, this layer becomes progressively deeper until the whole building is filled with hot smoky gases. The time consumed for this to happen may be only a few minutes, depending on variables like, type of materials on fire, process/ storage conditions involved, etc.

D-2.1.2. The hot gases at the roof level moved by convection currents contribute to rapid lateral spread of fire.

D-2.1.3 The provision of properly designed and suitably located vents in adequate number helps the

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Annex-D:

FIRE PROTECTION CONSIDERATIONS FOR VENTING IN INDUSTRIAL BUILDINGS:

D-1.1. This is a very important point to be kept in mind. The regulations hereunder do not apply to multi storey buildings

D-2.1.4. This clause emphasises the need for the vents to be designed for automatic operation which is necessary for prompt and speedy venting of the smoke and hot gases.

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speedy removal of smoke and hot gases, thereby preventing spread of fire, besides reducing risks of explosion of unburnt gases and reducing damage to the contents and structure of the building by heat and smoke. In addition, they facilitate fire fighting operations, and minimise personal hazards to the firemen.

D-2.1.4 The time taken for accumulation of smoke and hot gases within a building on fire being very short, the venting devices installed shall be designed to operate in the early stage of the fire, and must be automatic so as to ensure speed and efficiency in their operation.

D-2.1.5 The smoke and fire venting system shall be designed in such a manner as to keep the temperature of the combustion products from the fire as low as possible, preferably below approx. 150 °C;

D-2.1.6. Automatic venting systems are complementary to the fire extinguishing systems, and automatic sprinklers, where provided, should operate before the operation of the vents; otherwise, venting may delay sprinkler operation.

D-2.1.7. It is easier to vent a building of smoke than clear it of smoke once it has been filled.

D-2.1.8. Venting is particularly desirable in large area industrial buildings or warehouses, windowless buildings, underground structures or in areas housing hazardous operations. Automatic fire vents shall be provided for all industrial occupancies (including storage building) classified as medium hazard or above having floor areas exceeding 750 m², irrespective of whether they are compartmentalised or not.

D-2.1.9. These provisions do not cover other aspects of ventilation (or lighting) designed for regulation of temperature within a building for personal comfort or meeting process needs.

D-2.1.10. Similarly, fire and smoke venting requirements as given hereunder are also not applicable to multi-storey buildings, as their requirements are different and more complex.

D-2.1.11. It is difficult to determine precise venting requirements on account of the many variables involved. For instance, the rate of combustion varies appreciably according to the nature, shape, size and packaging of the combustible materials as well as the size, height and disposition of the stacks of materials.

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D-2.1.5. In other words, the operating temperature of the vents should be below 150°C (say, between 120°C to 130°C)

D-2.1.6. This is a very important point to be kept in mind while selecting sprinkler heads. The actuation temperature of the sprinklers must be lower than those of fusible links operating the vents.

The issue whether in such premises the sprinklers should operate before the vents, or the vents should operate before sprinkler operation, had been a prolonged controversial issue among the fire experts. However, practical experience of the fire services supports the directive contained in this clause.

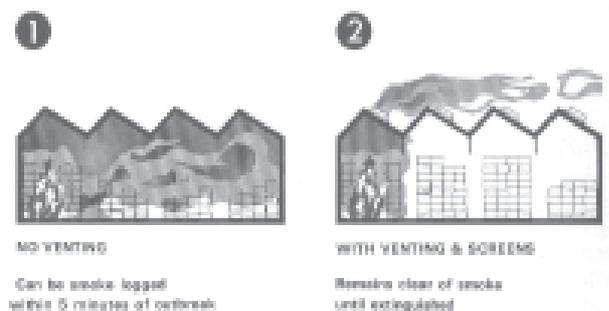
D-2.1.7. The earlier the smoke can be cleared, the better.

D-2.1.8. Venting of underground structures like metro rails, platforms etc., need special attention as it involves several human lives. Similar is the case of ordinary and high hazard industrial risks because fire and explosion potentials are higher in these premises.

These are important guide lines worthy of practical implementation.

Fig. 24.

Benefits of Fire Venting



D-2.1.10. Smoke venting and smoke control techniques adopted for multi-storeyed buildings are mostly dependent on HVAC systems and fans and controls, unlike the smoke venting procedures followed for single storey buildings.

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- D-2.1.12.** In industrial buildings of floor area less than 750m² and used as low fire hazard occupancies, conventional ventilators fitted high up near the eaves of the external walls may serve as vents for smoke and hot gases, provided care is taken to ensure that they are kept open at all times or are designed to open automatically in case of fire.
- D-2.1.13.** Extinction of fires by closing the doors and windows is not likely in the case of industrial buildings because of their large size, where sufficient air to sustain the fire at least in the initial stages can be expected to be present.
- D-2.1.14.** Of the two types of building ventilation, namely, vertical and horizontal, vertical ventilation is the one commonly adopted in the case of single storey industrial buildings.
- D-2.1.15.** Since 70 to 80 percent of heat produced in a fire is convective heat, the ventilation system has to be suitably designed to ensure early outflow of the heat and thereby minimise fire spread.
- D-2.1.16.** Combustible roof linings shall be avoided, as they themselves will contribute to the spread of fire, thereby multiplying the venting problems.
- D-2.1.17.** A wind blowing across a flat roof with a pitch under 40 degrees produces a negative pressure, that is, it tends to draw gases out of the building and so aids venting of hot gases. Wind blowing across a roof of pitch greater than 40 degree will draw gases out on the leeward side, but oppose outward flow on the windward side of the roof.
- D-2.1.18.** For vents to work at full efficiency, the area of the inlets for cold air entering the compartment must equal at least the total area of the vents. Ideally, the inlets shall be as close to the ground as possible.
- D-2.1.19.** Where roof vents are installed in a single storey building, any neighboring buildings, particularly those of more than one storey, will be subject to some degree of exposure hazard either from flying brands or radiation, or both, as a result.
- D-2.1.20.** If vents are to be installed, the size, design, number and disposition of the vents and the associated roof screens/curtain boards have to be assessed after careful analysis of the various factors stated under D-2.1.11 above, as well as other related factors like type of building construction, nature and height of roof, process

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- D-2.1.15.** This clearly proves that the smoke venting system technology followed for these premises has a dual function of removal of smoke as well as the heat generated by the fire.
- D-2.1.18.** Air inlet at lower level hence in smokes moving upwards faster due to stack effect thereby facilitating venting, and hence it is recommended to keep air inlets as close to the ground as possible.
- D-2.1.19.** Normally, window and ventilator openings in the higher building are protected by 1/4 in thick wired glasses in steel frames for explosion protection

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hazards, exposure hazard, etc.

D-2.2 Venting Area

D-2.2.1. The estimated requirements for ventilation are largely based on the assumed build-up of the fire from the time of initial outbreak to the time of effective fire fighting action by fire brigade.

D-2.2.2. The vent area required to be provided shall be approximately proportional to the perimeter fire area, because, the entrained air forms the bulk of the vented gases.

D-2.2.3. The effective area shall be minimum cross-sectional area through which the hot gases must flow out to the atmosphere.

D-2.2.4. No consideration shall be given to the increased air movement obtained by power operated fans, since it must be assumed that in the event of fire, power will be interrupted, or fans damaged by heat.

D-2.2.5. The total vent areas to be provided shall be as per the following ratios of effective area of vent opening to floor area for various occupancy classifications indicated:

- (a) Low heat release content (subdivision G-1) 1:150
- (b) Moderate heat release content (subdivision G-2) 1:100
- (c) High heat release content (subdivision G-3) 1:30 to 1:50

D-2.3. Types of vents

D-2.3.1. Venting shall be accomplished by any of the types such as monitors, continuous gravity vents, unit type vents, or saw tooth roof skylights.

D-2.3.2. Where monitor type vents are installed, wired glass or metal panels shall be used only if the sash is arranged to open automatically.

D-2.3.3. The use of plain thin glass for venting shall be avoided on account of its unpredictable behaviour during fire. However, if glass or other suitable plastic sheet materials with early disintegration characteristics are used, they should be designed for automatic operation.

D-2.3.4. Where monitors or unit type vents are used, the panels shall be hinged at the bottom and designed to open automatically. Both sides of the vents shall be designed to vent simultaneously to ensure that their effectiveness at the time of fire is not in any way impeded by wind direction.

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D-2.2.4. It has been the long standing experience that, in the event of fire, more often than not, the normal power supply fails.

D-2.3.1. By and large, all these types of vents should be designed for automatic operation.

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D-2.3.5. Where movable shutters are provided for continuous gravity vents, these shall open automatically in the event of fire.

D-2.3.6: Unit type vents shall be of relatively small area, ranging between 1m² and 9m², having light weight metal frames and housing with hinged dampers which shall be designed for both manual and automatic operation.

D-2.3.7: Saw tooth roof skylight shall be considered as satisfactory for venting purposes only when designed for automatic operation.

D-2.3.8 Likewise, exterior wall windows shall not be reckoned as satisfactory means for venting of fire gases and smoke in industrial buildings. However, they may be reckoned as additional means of venting when, they are located close to the eaves and are provided with ordinary glass or movable sash arranged for both manual and automatic operation.

D-2.3.9 Baffles shall not be installed inside vents, as they greatly reduce the effective area for venting.

D-2.4 Vent Operation.

D-2.4.1 The vents shall be automatic in operation, unless where specified in these provisions, that they shall be designed for both manual and automatic operation.

D-2.4.2. The release mechanism shall be simple for operation and independent of electrical power, since electrical services may be interrupted by fire.

D-2.4.3. The automatic operation of vents shall be achieved by actuation of fusible links or other types of heat and smoke detectors, or by interlocking with operation of sprinkler system or any other automatic fire extinguishing system covering the area. Following their release, the vents shall be designed to open by a system of counterweights and associated equipment utilising the force of gravity or spring loaded levers.

D-2.4.4. Automatic fire alarm system, where installed, shall be coupled to the automatic vents to ensure simultaneous operation.

D-2.4.5. Automatic sprinklers, where installed, shall operate before the vents open in order to avoid any likely delay in sprinkler operation. However, heat actuated devices used for vent release shall be suitably shielded from sprinkler discharge so that water does not delay their action.

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D-2.3.8. Exterior wall windows need not necessarily be kept open. Besides, smoke has a tendency to rise up rather than growing sideways and hence windows are not accepted as primary means of venting.

D-2.4.1. Normally, automatic operation is preferred. But, for certain specific requirements, like unit type vents(as mentioned in D-2.3.6.), automatic plus manual mode of operations have to be provided.

D-2.4.4. This will ensure double check of the efficiency of the systems.

D-2.4.5. As already brought out in clause T-2.1.6., sprinkler system operation should precede vent operation.

D-2.4.6. This procedure is in conformity with the established smoke control technology. Higher roofs mean delayed heat detector actuation. Also, smouldering materials not producing enough heat, delay heat detector operation. It is, therefore, advisable to link vent operation with smoke detection system in such circumstances

D-2.4.7. Notwithstanding the use of non-corrosive materials for the hinges, hatches etc., provision for carrying out periodical maintenance should also be included.

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D-2.4.6. Premises where height of roof apex is 10m or more or where the materials handled or stored have high smoke producing characteristics, in addition to fusible links, the vent release mechanism shall be interlinked to smoke actuated automatic fire detectors to ensure early operation of vents.

D-2.4.7. Non-corrosive materials shall be used for hinges, hatches and other related parts to ensure long fail-safe operation of the vents.

D-2.4.8. In case of any doubts regarding the types of vents required to be installed for any particular occupancy, authorities having jurisdiction shall be consulted.

D-2.5 Size, Spacing and Disposition Of Vents:

D-2.5.1. Vents shall be correctly sited to ensure their functional efficiency. Ideally, they shall be sited at the highest point in each area to be covered.

D-2.5.2. They shall, as far as possible, be located immediately above the risk to be protected so as to allow free and speedy removal of smoke and other combustion products in the event of fire.

D-2.5.3. The minimum dimension for an effective vent opening shall be not less than 1.25 m in any direction.

D-2.5.4. The spacing of the individual vents shall be based on the principle that more number of well distributed smaller vents are more effective than less number of badly located larger vents.

D-2.5.5. The maximum spacing between vents for the three occupancy classifications shall be as follows:

- (a) Low heat release content-45 m between centres;
- (b) Moderate heat release content-36 to 37 m between centres;
- (c) High heat release content-22.5 to 30 m between centres, depending on the severity of fire potential.

D-2.5.6. Vents shall be placed in a sheltered situation where advantage can be taken of the prevailing wind. The design of the vent shall be such as to produce a suction effect. A wind blowing across a flat roof with a pitch under 40 degrees produces a negative pressure, that is, it tends to draw gases out of the building and so aids venting of hot gases. Wind blowing across a roof of pitch

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D-2.5.4. More number of well distributed smaller vents facilitate uniform venting of explosion effect, besides reducing probability of all of them not opening, are to be preferred.

D-2.5.5. More number of well distributed smaller vents facilitate uniform venting of explosions effect, besides reducing probability of all of them and opening, and hence are to be preferred.

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greater than 40 degree will draw gases out on the leeward side, but oppose outward flow on the windward side of the roof.

D-2.5.7. Lowlevel inlets, with total area not less than the total area of vents, shall be provided to permit outside air to be drawn in to aid automatic venting. These inlets, which may be in the form of doors, windows or such other openings, shall be designed for manual operation when desired.

D-2.6 Roof Screens or Curtain Boards:

D-2.6.1. Industrial buildings with large areas and having no subdivision/separating walls limiting the area of individual compartments to 750 m² or less, shall be provided with roof screens or curtain boards.

These screens which extend from the roof downwards at specific intervals not only prevent lateral spread of heat and smoke in the event of fire below, but substantially assist in early operation of automatic sprinklers and vents.

D-2.6.2. They shall be of sheet metal or any other substantial non-combustible material strong enough to withstand damage by heat or impact.

D-2.6.3. They shall be reasonably gas-tight, although small openings for passage of pipes, conduits, etc shall be permitted.

D-2.6.4. They shall extend down from roof / ceiling for minimum depth of 2.2m. Around specific hazards, the depth shall be 4 m. Where roof/ceiling height exceeds 15m they shall extend down to within 3 m of the floor. For pitched saw-toothed roofs, they shall extend down to truss level dividing the roof into compartments.

D-2.6.5. In moderate hazard occupancies, the distance between the screens/curtain boards shall not exceed 75 m and the curtained areas shall be limited to maximum of 4500m².

D-2.6.6. In high hazard occupancies, the distance between screens shall not exceed 30 m and the curtained area shall be limited to 750 m²

D-2.6.7. The curtained roof area shall be so arranged that they effectively aid in the venting of smoke and hot gases through the automatic vents provided in each area.

D-2.6.8. In sprinklered buildings, the screens shall preferably be so located as to coincide with the individual sprinkler system areas.

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D-2.6. Roof screens or curtain boards:

Provision of roof screens at regular intervals allow products of combustion reach faster towards sprinkler heads facilitating early detection of fire, which otherwise would take much more time to actuate sprinklers because of lateral spread of products of combustion

D-2.8.5. The degree of heat release of the contents(materials inthe building) generally is governed by the calorific value of the materials involve(calorific values of common materials are given in Table-25, Annex-A)

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D-3 EXPLOSION RELIEF VENTS

D-3.1. Industrial premises where combustible dusts can accumulate or where flammable gases, vapours or mists in explosive concentrations may be present are constantly exposed to explosion hazards. Pressures developed by such explosions may be of the order of 7×10^5 Pa and ordinary buildings will not be able to withstand the shock of such pressures. Hence, such buildings require explosion relief vents for preventing structural damage.

D-3.2. Basic principle/consideration:

D-3.2.1. Most ordinary building walls will not withstand a sustained internal pressure as great as 6.9×10^3 Pa. Hence, explosion relief vents for buildings must be designed to operate at pressures well below those at which the building walls will fail.

D-3.2.2. There is a rise in pressure during an explosion within an enclosure even with open, unobstructed vents, and any delay in opening the venting devices increases that pressure.

D-3.2.3. Structural damage can be minimised by locating hazardous operations or equipment outside buildings and cut off from other operations by a pressure resisting wall. Such isolated processes or equipment shall be housed in single-storey buildings properly vented and a device provided at the inlet of the collector which will prevent an explosion from blowing back through the duct work into the building.

D-3.2.4. Where highly hazardous operations cannot be located outside of main buildings they shall be segregated by pressure resisting walls and each such unit shall be ventilated outdoors. External walls may be of heavy construction if equipped with suitable vents or high weight panels which blow out easily.

D-3.2.5. Operations or equipment involving explosion hazards shall not be permitted in basements or areas partially below grade.

D-3.2.6. Fire can be expected to follow an explosion in most occupancies, therefore any fixed fire extinguishing equipment, like sprinklers, if installed, shall be such that only minimum damage is caused to it.

D-3.2.7. For a given material, the finer the particle size of the dust, the more violent is the explosion. Some materials, such as aluminum powder, hydrogen, and acetylene, are difficult to vent effectively due to the rapid rate of pressure rise.

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D-3.2. Basic principle/consideration:

If vents are not designed properly, in case of explosion the walls supporting the structure would collapse, bringing down the whole structure.

D-3.2.5. Venting of explosions in basements is almost impossible. If an explosion occurs in the basement it can weaken the whole structure beyond repairs, if not bring it down.

D-3.2.6 If sprinkler system is affected because of an explosion, it will be rendered useless for fighting the fire that ensues explosion. It is therefore necessary to protect sprinkler installation against the explosion damage.

D-3.2.7. A special note needs to be taken for dusts like magnesium, titanium, zirconium and metal hydrides which react and ignite with common inert gases like nitrogen and carbon dioxide because these are the gases which are also used for fire fighting.

Special extinguishing methods need to be employed for such material.

D-3.2.8. This means that with larger vents explosion pressures reduced and with smaller vents they increase.

D-3.2.10. This means that the thicker the diaphragm, it will take more time to rupture than a thinner diaphragm, for the same purpose.

D-3.4.16. The principle adopted for provision of the explosion relief vents is, lighter the construction (of the building), the greater should be the relief vent area provided

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Some slow burning materials, such as coal dust in a confined space, may do much damage because of longer duration of their presence. Some dusts, such as magnesium, titanium, zirconium and metal hydrides may react with water and ignite in some common inert gases, such as nitrogen and carbon dioxide.

D-3.2.8. The maximum explosion pressure in a vented structure decreases as the size of the vent increases, but is independent of the rupturing pressure of the diaphragm.

D-3.2.9. The most effective vent for the release of explosion pressures is an unobstructed vent opening.

D-3.2.10. Pressure required to rupture diaphragms of the same area and material directly varies with the thickness of the material.

D-3.2.11. The slower the rate of pressure rise, the more easily can the explosion be vented.

D-3.2.12 The degree of venting required is directly proportional to the degree of explosion hazard.

D-3.2.13 Experience has shown that most explosions of dusts, vapors and gases do not involve a large part of the total volume of the enclosure, and frequently occur near the upper or lower limits of the explosive range. Consequently, such explosions are relatively weak compared with the optimum.

D-3.2.14. Rectangular unrestricted vents are as effective as square vents of equal area.

D-3.3. Types Of Explosion Relief Vents.

D-3.3.1. The explosion relief vents shall be any one or more of the following types, depending on individual requirements as assessed by the Authority. Open or unobstructed vents, louvers, open roof vents, hanger type doors, building doors, windows, roof or wall panels or movable fixed sash.

D-3.3.2. The effect of external wind pressure of suction on these devices shall be taken into consideration while designing and selecting the type of vents, since wind pressures may reach over 2×10^5 Pa in severe wind storms.

D-3.3.3. The type of vent for explosion relief for any occupancy shall be selected with life safety as the primary aim followed by minimum damage to property.

D-3.3.4. Where large hanger type doors or metal

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curtain doors in side walls are used as vents care shall be taken to ensure that they are kept wide open during operations.

D-3.3.5. Where weather hoods are used to cover roof vents they shall be as light as possible and attached so as to enable them to be blown off quickly when an explosion occurs.

D-3.3.6. Doors and windows when used as explosion vents shall be installed to swing outwards. Doors shall have friction, spring or magnetic latches that will function automatically to permit the door to open under slight internal pressure.

D-3.3.7. Movable sash shall be of top or bottom hinged or protected type. These shall be equipped with a latch or friction device to prevent accidental opening due to wind action or intrusion. Such latches or locks shall be well maintained.

D-3.3.8. Fixed sash shall be set in place with very light wall anchorages, or, if right, shall be securely fitted and glazed with plastic panes in plastic putty.

D-3.3.9. where the process is such that the whole of the building or a room may be desirable to arrange for a lightly constructed wall or roof to collapse and thus avert the worst effects of an explosion.

D-3.4 Design, size and Disposition of vents.

D-3.4.1 The required area of explosion vents shall ordinarily depend on the expected maximum intensity of an explosion in the occupancy, the strength of the structure, the type of vent closure and other factors.

D-3.4.2 Venting shall be planned in such a manner as to prevent injury to personnel and damage to exposures. In congested locations, substantial ducts or diverters shall be provided to direct the blast.

D-3.4.3 when ductwork is used, the ducts shall be of sufficient strength to withstand the maximum expected explosion pressure.

D-3.4.4 Where explosions are likely within duct and piping system, they shall be vented by the use of suitable diaphragms designed to blow out at a predetermined pressure. There shall be no physical connection between ductwork system for more than one collector.

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- D-3.4.5.** In large structures, the position of vents shall be relative to the point of origin of explosion, when it can be determined.
- D-3.4.6.** Where relatively slow explosions involving coal dust, chlorinated solvents, etc, are involved, light, hinged swinging panels may be preferred to diaphragm type of vents.
- D-3.4.7.** Obstructions of any kind blocking the vents from the risk covered shall be avoided, particularly where risks of rapid violent explosions are present.
- D-3.4.8.** Counter weights add to the inertia of the vents and so shall be avoided.
- D-3.4.9.** Various relieving devices, including devices actuated by detonators, shall start to open at as low a pressure as possible. They shall be of light construction, so that full opening can be quickly attained.
- D-3.4.10.** Vents shall be of such size and design as to prevent rupture of the protected device or apparatus.
- D-3.4.11.** Skylights or monitors with movable sash that will open outwards, or fixed sash containing panes of glass or plastic that will blow out readily under pressure from within, can be used to supplement wall vents or windows, provided resistance to their displacement or opening is kept as low as consistent with the requirements for structural strength.
- D-3.4.12.** Flexible plastic sheets when used for vent closures shall be installed in slotted frames in such a way that pressure from within bulges the sheet and releases them from the holding frame.
- D-3.4.13.** Fragile sheets made of plastic, when used for vent closures, shall be thin sheets that will crack or rupture under less pressure than single strength glass. For this reason use of transparent or translucent plastic sheets is more advantageous instead of glass in window sash.
- D-3.4.14.** If closed vents are used they shall be larger in area than unenclosed vents to provide equivalent explosion pressure relief.
- D-3.4.15.** Small enclosures, such as machines, shall be vented more generously than buildings, because if an explosion occurs in a machine, its entire volume may be involved.
- D-3.4.16.** Vents for the protection of buildings and equipment shall be installed on the following

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basis:

D-3.4.16.1. Small enclosures of less than 30m³, machines and ovens of light construction: 1000 cm² for each 0.3m³ to 0.9 m³;

D-3.4.16.2. For small enclosures of more substantial construction having reasonably high bursting strength: 1000 cm² for each 0,9 m³;

D-3.4.16.3. Fairly large enclosures of 30 to 700 m³, such as bins, silos, rooms, storage tanks, etc: 1000 cm² for each 0.9 m³ to 1.5 m³. In these cases attempt shall be made to the extent possible to predict the likely point of origin of the explosion in relation to the vent.

D-3.4.16.4. Large rooms and buildings over 700 m³ containing hazardous equipment comprising a small fraction of the entire volume

(a) For heavy reinforced concrete, walls: 100 cm² for 2.25 m³.

(b) For light reinforced concrete, brick or wood construction: 1000 cm² for each 1.65 m³ to 2.25 m³.

(c) For lightweight construction such as prefabricated panels: 1000 cm² for each 1.5 m³ to 1.65 m³.

D-3.4.16.5. Large rooms or building over 700 m³ containing hazardous equipment comprising a large part of the entire volume of a room or building shall be vented as generously as possible 1000 cm² for each 0.3 m³ to 1.05 m³.

D-3.4.16.6. In order to obtain these ratios, the size of the building or room must be limited. For some hazardous materials, such as hydrogen, acetylene, carbon disulphide, etc, these limits are extremely low.

D-3.4.17. Emphasis shall always be placed on segregating hazardous areas by means of firewalls or separating walls to prevent spread of fire.

D-3.4.18. Interior walls of light construction, such as tile, shall be avoided in hazardous locations, since they cause injuries to personnel in the event of an explosion.

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**ANNEX E
(Clause C-8)**

**GUIDELINES FOR FIRE DRILL AND EVACUATION
PROCEDURES FOR HIGH RISE BUILDINGS
(ABOVE 15m IN HEIGHT)**

E-1 . INTRODUCTION:

In case of fire in a high rise building, safe evacuation of its occupants may present serious problems unless a plan for orderly and systematic evacuation is prepared in advance and all occupants are well drilled in the operation of such plan. These guidelines are intended to assist them in this task.

E-2. ALARMS

Any person discovering fire, heat or smoke shall immediately report such condition to the fire brigade, unless he has personal knowledge that such a report has been made. No person shall make, issue, post or maintain any regulation or order, written or verbal, that would require any person to take any unnecessary delaying action prior to reporting such condition to the fire brigade.

E-3. DRILLS:

E-3.1. Fire drills shall be conducted, in accordance with the fire safety plan, at least once every three months for existing buildings during the first two years. Thereafter, fire drills shall be conducted at least once every six months.

E-3.2. All occupants of the building shall participate in the fire drill. However, the occupants of the building, other than building service employees, are not required to leave the floor or use the exits during the drill.

E-3.3. A written record of such drills shall be kept on the premises for a three years period and shall be readily available for Fire Brigade inspection.

E-4. SIGNS AND PLANS:

Annex-E

**GUIDE LINES FOR FIRE DRILL AND EVACUATION
PROCEDURES FOR HIGH RISE BUILDINGS (ABOVE
15m IN HEIGHT)**

General:

It is mentioned here for information that these Guidelines have been adopted from US practice(NFPA Codes)

E-1. Introduction:

Generally it is the responsibility of the management of the building(possibly, the Fire Officer, as mentioned under C-6) to prepare and promulgate these guidelines for the Fire Drills. The ultimate aim for this exercise is for ensuring the life safety of the occupants of the premises, which is the responsibility of the management/owner/occupier.

E-2. The intention is that local Fire Brigade should be informed about the fire outbreak without any delay.

E-3. Drills:

E-3.1. If the fire drills are regularly conducted at a minimum frequency of three months for the initial 2yrs., the occupants would have by then become adequately conversant with their assigned duties and role, according to the Emergency Plan. Hence, the frequency of the fire drills after the initial 2 years. could be reduced to once in 6 months subsequently. However, the practical experience of many of our Fire Chiefs have been that these guidelines and instructions are at the most explained to the building occupants by the representative of the management (possibly by the Fire Office for the premises), but the Fire Drills, or the 'mock fire practices,' are seldom carried out, due to several practical difficulties.

E-3.3. If records are not maintained properly, it becomes difficult to convince the authorities at the time of their inspection. Maintenance of such records gives immense psychological advantage to the occupants while dealing with the authorities concerned.

CODE**COMMENTARY****E-4.1. Signs at Lift Landings:**

A sign shall be posted and maintained in a conspicuous place on every floor at or near the lift landing in accordance with the requirements, indicating that in case of fire, occupants shall use the stairs unless instructed otherwise. The sign shall contain a diagram showing the location of the stairways except that such diagram may be omitted., provided signs containing such diagram are posted in conspicuous places on the respective floor.

A sign shall read "IN CASE OF FIRE, USE STAIRS UNLESS INSTRUCTED OTHERWISE". The lettering shall be at least 12.5 mm block letters in red and white background. Such lettering shall be properly spaced to provide good legibility. The sign shall be at least 250 mm x 300mm, where the diagram is also incorporated in it, and 62.5 mm x 250 mm where the diagram is omitted. In latter case, the diagram sign shall be at least 200 mm x 300 mm. The sign shall be located directly above a call-button and squarely attached to the wall or partition. The top of the sign shall not be above 2 m from the floor level.

E-4.2. Floor Numbering Signs:

A sign shall be posted and maintained within each stair enclosure on every floor, indicating the number of the floor, in accordance with the requirements given below:

The numerals shall be of bold type and at least 75 mm high. The numerals and background shall be in contrasting colours. The sign shall be securely attached to the stair side of the door.

E-4.3. Stair and Elevator Identification Signs:

Each stairway and each elevator back shall be identified by an alphabetical letter. A sign indicating the letter of identification shall be posted and maintained at each elevator landing and on the side of the stairway door from which egress is to be made, in accordance with the requirements given below.

The lettering on the sign shall be at least 75 mm high, of bold type and of contrasting colour from the background. Such signs shall be securely attached.

E-4.4 Stair Re-Entry Signs:

A sign shall be posted and maintained on each floor within each stairway and on the occupancy side of the stairway where required, indicating whether re-entry is provided into the building and the floor where such re-entry is provided, in

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accordance with the requirements given below:

The lettering and numerals of the signs shall be at least 12.5 mm high of bold type. The lettering and background shall be of contrasting colours and the signs shall be securely attached approximately 1.5 m above the floor level.

E-4.5. Fire command station shall be provided with floor plan of the building and other pertinent information relative to the service equipment of the building.

E-5. FIRE SAFETY PLAN

E-5.1. A format for the Fire Safety Plan shall be as given in C-8 & E-8.

E-5.2. The applicable parts of the approved Fire Safety Plan shall be distributed to all tenants of the building by the building management when the Fire Safety Plan has been approved by the Fire Authority.

E-5.3. The applicable parts of the approved Fire Safety Plan shall then be distributed by the tenants to all their employees and by the building management to all their building employees.

E-5.4. Where the owner of the building is also an occupant of the building, he shall be responsible for the observance of these rules and the Fire Safety Plan in the same manner as a tenant.

E-5.5. In the event there are changes from conditions existing at the time the Fire Safety Plan for the building was approved, and the changes are such so as to require amending the Fire Safety Plan, within 30 days after such changes, an amended Fire Safety Plan shall be submitted to the fire brigade for approval.

E-6. FIRE COMMAND STATION:

A Fire Command Station shall be established in the lobby of the building on the entrance floor. Such Command Station shall be adequately

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E-4.5. The Fire Command Station mentioned here, as well as under E-6, is referring to the fire control room, requirements of which, where given in clause C-5.

Availability of the floor plan and details of service equipment in the fire command station, which is located at the lobby level, helps Fire Brigade in getting familiar with the building layout immediately on their arrival.

E-5.2. Making of an Emergency Plan is one thing, and its implementation another. It is to be implemented by the occupants of the premises and hence it is important that the Plan contents are made known to all concerned in advance. It helps to obtain their organised response in toto in case of practice drills and in actual emergency.

E-5.3. These provisions have been made keeping in mind the evacuation plan requirements of a high rise building, coming under Business Occupancy. (utilised as offices of various organisations)

E-6. Fire Command Station:

The reference here is to the fire control room covered under C-5.

Location of the fire command station at the lobby level only helps to keep it relatively safe from any fire on the upper floors and also for easy accessibility. The need for adequate illumination of command station by emergency lighting need not be over emphasised because, in case of a fire, the first reaction of people around is to put off the normal electric supply.

E-7. Communications and Fire Alarm:

Transmission of a fire alarm by means of a manual call point or an automatic fire alarm system to a central command station will be immensely useful to reduce the time gap between the initiation of the fire and the commencement of actual fire fighting operation

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illuminated.

E-7. COMMUNICATION & FIRE ALARM

A means of communication and fire alarm for use during fire emergencies shall be provided and maintained by the owner or person in charge of the building.

E-8. FIRE SAFETY PLAN FORMAT:

E-8.1. Building Address

Street and Pin Code Number.

Telephone Number.....

E-8.2. Purpose and Objective

E-8.2.1. Purpose:

To establish method of systematic, safe and orderly evacuation of an area or building by its occupants in case of fire or other emergency, in the least possible time, to a safe area by the nearest safe means of egress; also the use of such available fire appliances (including sounding of alarms) as may have been provided for controlling or extinguishing fire and safeguarding of human life.

E-8.2.2. Objective

To provide proper education as a part of continuing employee indoctrination through a continuing written programme for all occupants, to ensure prompt reporting of fire, and response of fire alarms as designated, and the immediate initiation of fire safety procedures to safeguard life and to contain fire until the arrival of the Fire Brigade.

E-8.3. Fire Safety Director:

- a) Name
- b) Regularly assigned employment-Title
- c) Regularly assigned location
- (d) How is he notified when at regular location?
- e) How is he notified when not at regular location?
- f) Normal working hours
- g) Duties of Fire Safety Director- **(seeE-9.1)**

E-8.4. Deputy Fire Safety Director

- (a) Name
- (b) Regularly assigned employment-Title
- (c) Regularly assigned location
- (d) How is he notified when at regular location?
- (e) How is he notified when not at regular location?
- (f) Normal Working hours

E-8.2.2. Objective:

The objectives of the Plan have been made amply clear here.

E-8.3. These designations (Fire Safety Director, Fire Wardens etc.) are only assigned to appropriate persons designated by the building management, or by the heads of respective organisations/offices working in the building.

Telephone numbers (including mobile phone numbers) could also be indicated against each.

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- (g) Duties of Deputy Fire Safety Director(See-E-9.2)

E-8.5. Fire Wardens and Deputy Fire Wardens

- (a) Are their names on Organisation Charts for each floor and/ or tenancy?
 (b) Submit typical completed Organization Chart for Fire Drill and Evacuation Assignment.
 (c) Duties of Fire Wardens and Deputy Fire Wardens-(See E-9.3).

E-8.6. Building Evacuation Supervisor

- (a) Name
 (b) Regularly assigned employment-Title
 (c) Regularly assigned location
 (d) How is he notified when at regular location?
 (e) How is he notified when not at regular location?
 (f) Normal working hours
 (g) Duties of Building Evacuation Supervisor (seeE-9.4)

E-8.7. Fire Party

- (a) Submit a completed Organization Chart for Fire Parties naming person in charge, and his title in the building.
 (b) Indicate standards of selection from building employees based on background and availability
 (c) How are they notified
 (d) How are they notified when they are not at their regular locations?
 (e) Means of responding
 (f) Duties of each member of Fire Party-(see E-9.5)

E-8.8 Occupants Instructions

Distribution of instructions to all tenants, tenant's employees and building employees (see **E-9.6**)

E-8.9. Evacuation Drills

- (a) Frequency of drills
 (b) How conducted?
 (c) Participation? Who participated? How?
 (d) Controls and supervision
 (e) Recording of details of drills

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<p>E-8.10. Fire command station</p> <p>(a) Location</p> <p>(b) Requirements</p> <p style="padding-left: 20px;">(1) Adequate illumination</p> <p style="padding-left: 20px;">(2) Adequate communication to mechanical equipment room and elevator control room on each floor;</p> <p style="padding-left: 20px;">(3) Copy of Fire Safety Plan</p> <p style="padding-left: 20px;">(4) Copy of Building Information Form</p> <p style="padding-left: 20px;">(5) Representative floor plans showing location of signs, floor remote station, communication etc.</p> <p>E-8.11. Signs:</p> <p>(a) Signs at elevator landings, floor diagrams</p> <p>(b) Floor numbering</p> <p>(c) Stairway identification</p> <p>(d) Elevator identification</p> <p>(e) Stair re-entry</p> <p>E-8.12. Fire prevention and Fire Protection Programme - (see E-9,7)</p> <p>E-8.13. Building information Form-(see-E-9.8)</p> <p>R-8.14. Representative Floor Plan-(see E-9.9)</p> <p>E-8.15. Fire Safety Plan Prepared by- (see E-9.10)</p> <p>(a) Date when prepared</p> <p>(b) Date when revised</p> <p>E-9. DUTIES</p> <p>E-9.1. Fire Safety Director's Duties</p> <p>E-9.1.1. Be familiar with the written Fire Safety Plan providing for fire drill and evacuation procedure in accordance with orders on the subject.</p> <p>E-9.1.2. Select qualified building service employees for a Fire Party and organize, train and supervise such Fire Brigade.</p> <p>E-9.1.3. Be responsible for the availability and state of readiness of the Fire Party.</p> <p>E-9.1.4. Conduct fire and evacuation drills.</p>	

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E-9.1.5. Be responsible for the designation and training of a Fire Warden for each floor, and sufficient Deputy Fire Wardens for each tenancy in accordance with orders on the subject.

E-9.1.6. Be responsible for a daily check for the availability of the Fire Wardens and see that up-to-date organization charts are posted.

Note- if the number of fire wardens and Deputy Fire Wardens in the building is such that it is impractical to individually contact each one daily, a suggested method to satisfy the requirements is to make provisions for the Fire Warden, or a Deputy Fire Warden in the absence of the Fire Warden, to notify the Fire Safety Director when the Fire Warden or required number of deputy Fire Wardens are not available. In order to determine the compliance by the Fire Warden and Deputy Fire Wardens, when this method is used, the Fire Safety Director shall make a spot check of several different floors each day.

E-9.1.7. Notify the owner or some other person having charge of the building when any designated individual is neglecting his responsibilities contained in the Fire Safety Plan. The owner or the other person in-charge of the building shall bring the matter to the attention of the firm employing the individual. If the firm fails to correct the condition, the Fire Department shall bring the matter to the attention of the firm employing the individual. If the firm fails to correct the condition, the Fire Department shall be notified by the owner/ person in charge of the building.

E-9.1.8. In the event of fire, shall report to the Fire Command Station to supervise, provide for and coordinate the following:

- (a) Ensure that the Fire Department has been notified of any fire or lire alarm.
- (b) Manning of the Fire Command station.
- (c) Direction of evacuating procedures as provided in the Fire Safety plan.
- (d) Reports on conditions on fire floor for information of Fire Department on their arrival
- (e) Advice the Fire Department Officer in charge in the operation of the Fire Command Station.

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E-9.1.9. Be responsible for the training and activities of the Building Evacuation Supervisor.

E-9.2. Deputy Fire Safety Director's Duties

E-9.2.1. Subordinate to the Fire Safety Director.

E-9.2.2. Perform duties of Fire Safety Director in his absence.

E-9.3. Fire Wardens and Deputy Fire Wardens Duties.

The tenant or tenants of each floor shall, upon request of the owner or person in charge of building, make responsible and dependable employees available for designation by the Fire Safety Director as Fire Warden and Deputy Fire Wardens.

E-9.3.1. Each floor of the building shall be under the direction of a designated Fire Warden for the evacuation of occupants in the event of fire. He shall be assisted in his duties by the Deputy Fire Wardens. A Deputy Fire Warden shall be provided for each tenancy. When the floor area of a tenancy exceeds 700 m² of occupiable space, a Deputy Fire Warden shall be assigned for each 700 m² or part thereof.

E-9.3.2. Each Fire Warden and Deputy Fire Warden shall be familiar with the Fire Safety Plan, the location of exits and the location and operation of any available fire alarm system.

E-9.3.3. In the event of fire, or fire alarm the Fire Warden shall ascertain the location of fire, and direct evacuation of the floor in accordance with directions received and the following guidelines:

- a) The most critical areas for immediate evacuation are the fire floor and floors immediately above.

Evacuation from the other floors shall be instituted when the instructions from the Fire Command Station or conditions indicate such action. Evacuation shall be via uncontaminated stairs. The Fire Warden shall try to avoid stairs being used by the Fire Department. If this is not possible, he shall try to attract the attention of the Fire Department Personnel before such personnel open the door to the fire floor.

- (b) Evacuation to two or more levels below the fire floor is generally adequate. He shall keep the Fire Command Station informed regarding his location.

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- (c) Fire Wardens and their Deputies shall see that all occupants are notified of the fire, and that they proceed immediately to execute the Fire Safety Plan.
- (d) The Fire Warden on the fire floor shall, as soon as practicable, notify the Fire Command Station of the particulars.
- (e) Fire Wardens on floors above the fire shall, after executing the Fire Safety Plan, notify the Fire Command Station of the means being used for evacuation and any other particulars.
- (f) In the event that stairways serving fire floor and/or floors above are unusable due to contamination or cut off by fire and/or smoke or that several floors above fire involve large numbers of occupants who must be evacuated, consideration may be given to using elevators in accordance with the following:
 - (1) If the elevators servicing his floor also service the fire floor, they shall not be used. However, elevators may be used if there is more than one bank of elevators, and he is informed from the Fire Command Station that one bank is unaffected by the fire.
 - (2) If elevators do not service the fire floor and their shafts have no openings on the fire floor, they may be used, unless directed otherwise.
 - (3) Elevators manned by trained building personnel or firemen may also be used.
 - (4) In the absence of serviceable elevator, the Fire Warden shall select the safest stairway to use for evacuation on the basis of the location of the fire and any information received from the Fire Command Station. The Fire Warden shall check the environment in the stairs prior to entry for evacuation. If it is affected by smoke, alternative stair shall be selected, and the Fire Command Station notified
 - (5) The Fire Warden shall keep the Fire Command Station informed of the means being employed for evacuation by the occupants of his floor.
- (g) Ensure that an alarm has been transmitted

E-9.3.4. Organization Chart for Fire Drill and Evacuation Assignment

A chart designating employees and their assignments shall be prepared and posted in a conspicuous place in each tenancy and on each

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floor of a tenancy that occupies more than one floor and a copy shall be in the possession of the Fire Safety Director.

E-9.3.5. Have available an updated listing of all personnel with physical disabilities who cannot use stairs unaided. Make arrangements to have these occupants assisted in moving down the stairs to two or more levels below fire floor. If it is necessary to move such occupants to a still lower level during the fire, move them down the stairs to the uppermost floor served by an uninvolved elevator bank and then **remove the street floor by elevator**. Where **resistance** is required for such evacuation, notify Fire Safety Director.

E-9.3.6. Provide for Fire Warden identification during fire drills and fires, such as using armband, etc.

E-9.3.7. Ensure that all persons on the floor are notified of fire and all are evacuated to safe areas. A search must be conducted in the lavatories to ensure all are out. Personnel assigned as searchers can promptly and efficiently perform this duty.

E-9.3.8. Check availability of applicable personnel on Organization Chart and provide for substitute when the position on a chart is not covered.

E-9.3.9. After evacuation, perform a head count to ensure that all regular occupants known to have occupied the floor have been evacuated.

E-9.3.10. When alarm is received, the Fire Warden shall remain at a selected position in the **civinity** of the communication station on the floor, in order to maintain communication with the Fire Command Station and to receive and give instruction.

E-9.4. Building Evacuation Supervisor's Duties.

A building Evacuation supervisor is required at all times other than normal working or business hours when there are occupants in the building and there is no Fire Safety Director on duty in the building.

E-9.4.1. He should be capable of directing the evacuation of the occupants as provided by the Fire Safety Plan.

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E-9.5. Fire Party Duties.

On receipt of an alarm for fire the Fire Party shall:

- (a) Report to the floor below the fire to assist in evacuation and provide information to the Fire Command Station.
- (b) After evacuations of fire floor, endeavor to control spread of fire by closing doors, etc.
- (c) Attempt to control the fire until arrival of the Fire Department, if the fire is small and conditions do not pose a personal threat.
- (d) Leave one member on the floor below the fire to direct the Fire Department to the fire location and to inform them of conditions.
- (e) On arrival of the Fire Department, the Fire Party shall report to the Fire Command Station for additional instructions,
- (f) Have a member designated as runner, who shall know the location of the nearest telephone, and be instructed in its use. Such member shall immediately upon receipt of information that there is a fire or evidence of fire, go to the telephone, transmit an alarm and await the arrival of the Fire Department and direct such department to the fire.

NOTE- A chart designating employees and their assignments shall be prepared.

E-9.6. Occupant's Instructions:

- (a) The applicable parts of the approved Fire Safety Plan shall be distributed to all tenants of the building by the building management when the Fire Safety Plan has been approved by the **Fire Commissioner**.
- (b) The applicable parts of the approved Fire Safety Plan shall then be distributed by the tenants to all their employees and by the building management to all their building employees.
- (c) All occupants of the building shall participate and cooperate in carrying out the provisions of the Fire Safety Plan.

E-9.4.2. During fire emergencies, the primary responsibility of the Building Evacuation Supervisor shall be to man the Fire Command Station, **and the direction and execution of** the evacuation as provided in the Fire Safety Plan. The Building Evacuation Supervisor's training and related activities shall be under the direction of the Fire Safety Director in accordance with these rules, and the Fire Safety Plan, Such activities shall be subject to Fire Department Control.

CODE

COMMENTARY

E-9.7. Fire Prevention and Fire Protection Programme

- (a) A plan for periodic formal inspections of each floor area, including exit facilities, fire extinguishers and house keeping shall be developed. A copy of such plan be submitted.
- (b) Provision shall be made for the monthly testing of communication and alarm systems.

E-9.8. Building Information Form

It shall include the following information :

- (a) Building address..... Pin Code...
- (b) Owner or person in-charge of building -Name, Address and Telephone Number.
- (c) Fire Safety Director and Deputy Fire Safety Director's Name and Telephone number.
- (d) Certificate of occupancy. Location where posted, or duplicate attached.
- (e) ...Height, area, class of construction.
- (f) Number type and location of fire stairs and/ or fire towers.
- (g) Number, type, location of horizontal exits or other areas of refuge
- (h) Number, type, location and operation of elevators and escalators.
- (j) Interior fire alarms, or alarms to central stations.
- (k) Communications systems and/or Walkie talkie, telephones etc.
- (m) Standpipe system: Size and location of risers, gravity or pressure tank, fire pump, location of siamese connections, name of employee responsible with certificate of qualification and number of certificate.
- (n) Sprinkler system: Name of employee with Certificate of Fitness and Certificate Number. Primary and secondary water supply, fire pump and areas protected.

CODE

COMMENTARY

- p) Special extinguishing system, if any, its location components and operation.
- q) Average number of persons normally employed in building, Daytime and Night time
- r) Average number of handicapped people in building; location Daytime and Night time
- s) Number of persons normally visiting the building; Daytime and Nighttime.
- t) Service equipment such as
 - (1) Electric Power; Primary, Auxiliary
 - (2) Lighting: Normal, Emergency: type and location
 - (3) Heating: type, fuel, location of heating unit.
 - (4) Ventilation-With fixed windows, emergency means of exhausting heat and smoke;
 - (5) Air conditioning systems-Brief introduction of the system, including ducts and floors serviced;
 - (6) Refuse storage and disposal
 - (7) Fire Fighting Equipment and appliances, other than standpipe and sprinkler system.
 - (8) Other pertinent building equipment.
- (u) Alteration and repair operations, if any. and the protective and preventive measures necessary to safeguard such operations with attention to torch operations.
- (w) Storage and use of flammable solids, liquids and/or gases.
- (y) Special occupancies in the building and the proper protection and maintenance thereof. E.g. Places of public assembly, studios and theatrical occupancies.

E-9.9. Representative floor plan

A floor plan representative of the majority of the floor designs of the entire building, shall be at the command post, in the main lobby, under the authority of Fire Safety Director. One copy of the representative floor plan shall be submitted to the Fire Department with the Fire Safety Plan.

CODE

COMMENTARY

E-9.10. Fire Safety plan

In planning, evaluate the individual floor layouts, the population of floors, the number and kind of exits, the zoning of the floor by area and occupants. Determine the movement of traffic by the most expeditious route to an appropriate exit and alternative route for each zone, since under fire conditions one or more exits may not be usable. This format is to be used in the preparation of the Fire Safety Plan. Nothing contained in this Fire Safety Plan format is to be construed as all inclusive. All rules and other requirements are to be fully complied with.

E-9.11. Personal Fire Instruction Card

All the occupants of the building shall be given a Personal Fire Instruction Card giving the details of the floor plan and exit routes along with the instruction to be followed in the event of fire. A typical Fire Instruction Card shall be as follows:

PERSONAL FIRE INSTRUCTION CARD

SEAL

NAME OF THE ORGANISATION

ADDRESS OF THE ORGANISATION

NAME :

DESIGNATION:

FLOOR NO.

DATE:

FIRE WARDEN

INSTRUCTIONS:

FOR YOUR OWN SAFETY YOU SHOULD KNOW

1. Two push button Fire Alarm boxes are provided per floor. You should read the operating instructions.
2. You should read the operating instructions on the body of the fire extinguishers provided on your floor.
3. Nearest Exit from your Table is at.....
4. Your assembly point on ground floor (check with your Fire/Dy. Fire warden.)

CODE

COMMENTARY

5 FOR YOUR OWN PROTECTION YOU SHOULD REPORT TO YOUR FIRE/DY.FIRE WARDEN.

- (a) If any Exit door/route is obstructed by loose materials, goods, boxes etc.
- (b) If any staircase door, lift lobby door does not close automatically, or does not close completely.
- (c) If any push button fire alarm point , or fire extinguisher is obstructed, damaged or apparently out of order.

IF YOU DISCOVER A FIRE

- 1. Break the glass of the nearest push button Fire alarm and push the button..
- 2. Attack the fire with the extinguishers provided on your floor. Take guidance from your Wardens.
- 3. Evacuate if your warden asks you to do so.

IF YOU HEAR EVACUATION INSTRUCTIONS

- 1. Leave the floor immediately by the nearest staircase
- 2. Report to your Warden, at your predetermined assembly point outside the building.
- 3. Do not try to use lifts.
- 4. Do not go to cloak room.
- 5. Do not run or shout.
- 6. Do not stop to collect personal belongings,
- 7. Keep the lift lobby and staircase doors shut..

YOUR ASSEMBLY POINT IS.....

ANNEX - F

List of relevant Indian Standards

The following list records those standards which are acceptable as 'good practice' and 'accepted standards' in the fulfillment of the requirements of the Code. The standards listed may be used by the Authority as a guide in conformance with the requirements of the referred clauses in the Code.

(1)	IS 3808:1979	Method of test for non-combustibility of building materials (<i>first revision</i>)
(2)	IS 8757:1999	Glossary of terms associated with fire safety (<i>first revision</i>)
	IS 7673:1975	Glossary of terms for fire fighting equipment
(3)	IS 15394:2003	Fire safety in petroleum refinery and fertilizer plants – Code of practice
(4)	IS 8758:1993	Recommendations for fire precautionary measures in the construction of temporary structures and pandals (<i>first revision</i>)
(5)	IS 3809:1979	Fire resistance test of structure (<i>first revision</i>)
	IS 1641:1988	Code of practice for fire safety of buildings (general) : General principles of fire grading and classification (<i>first revision</i>)
	IS 15103:2002	Specification for fire resistant steel
(6)	IS 9668:1990	Code of practice for provision and maintenance of water supplies and fire fighting
	IS 3844:1989	Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises (<i>first revision</i>)
(7)	IS 3614(Part 1):1966	Specification for fire check doors : Part 1 Plate, metal covered and rolling type
(8)	IS 12458:1988	Method of test for fire resistance test for fire stops
(9)	IS 1646:1997	Code of practice for fire safety of buildings (general) : Electrical installations (<i>second revision</i>)
	IS 2309:1989	Code of practice for protection of building and allied structures against lightning (<i>second revision</i>)
(10)	IS XXXXX;	Specification for fire dampers for air conditioning ducts
(11)	IS 11360:1985	Specification for smoke detectors for use in automatic electrical fire alarm system
(12)	IS 659:1964	Safety code for air conditioning
(13)	IS 1649:1962	Code of practice for design and construction of flues and chimneys for domestic heating appliances (<i>first revision</i>)
	IS 1642:1989	Code of practice for safety of buildings (general): Details of construction (<i>first revision</i>)
(14)	IS 12777:1989	Fire safety-flame-spread of products – Method for classification

(15)	IS 1642:1989	Code of practice for fire safety of buildings (general) : Details of construction (<i>first revision</i>)
	IS 1643:1988	Code of practice for fire safety of buildings (general) : Exposure hazard (<i>first revision</i>)
	IS 1644:1988	Code of practice for fire safety of buildings (general): Exit requirements and personal hazard (<i>first revision</i>)
(16)	IS 9457:1980	Safety colours and safety signs
	IS 12349:1988	Fire protection – Safety sign
	IS 12407:1988	Graphic symbols for fire protection plan
	IS XXXXX:	Fire fighting equipment – Symbols for operator control and other displays
(17)	IS 2175:1988	Specification for heat sensitive fire detectors for use in automatic fire alarm system (<i>second revision</i>)
	IS 11360:1985	Specification for smoke detectors for use in automatic electrical fire alarm system
	IS XXXXX:	Specification for fire detection and alarm systems – point heat detectors
	IS XXXXX:	Specification for multisensor fire detectors (under preparation)
	IS XXXXX:	Fire detection and alarm systems – Smoke point detectors using scattered light, transmitted light or ionization
	IS XXXXX:	Fire safety engineering subsystems – Detection, activation and suppression
(18)	IS 2189:1999	Code of practice for selection, installation and maintenance of automatic fire detection and alarm system (<i>second revision</i>)
(19)	IS 636:1988	Non-percolating flexible fire fighting delivery hose (<i>third revision</i>)
	IS 884:1985	Specification for first-aid hose reel for fire fighting (<i>first revision</i>)
	IS 901:1988	Specification for couplings, double male and double female instantaneous pattern for fire fighting (<i>third revision</i>)
	IS 902:1992	Specification for suction hose couplings for fire fighting purposes (<i>third revision</i>)
	IS 903:1993	Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner (<i>fourth revision</i>)
	IS 904:1983	Specification for two-way and three-way suction collecting heads for fire fighting purposes (<i>second revision</i>)
	IS 905:1980	Specification for delivery breechings, dividing and collecting, instantaneous pattern for fire fighting purposes (<i>second revision</i>)

IS 906:1988	Specification for revolving branch pipe for fire fighting (<i>third revision</i>)
IS 907:1984	Specification for suction strainers, cylindrical type for fire fighting purpose (<i>second revision</i>)
IS 908:1975	Specification for fire hydrant, stand post type (<i>second revision</i>)
IS 909:1992	Specification for underground fire hydrant : Sluice valve type (<i>third revision</i>)
IS 910:1980	Specification for combined key for hydrant, hydrant cover and lower valve (<i>second revision</i>)
IS 926:1985	Specification for fireman's axe (<i>second revision</i>)
IS 927:1981	Specification for fire hooks (<i>second revision</i>)
IS 928:1984	Specification for fire bells (<i>second revision</i>)
IS 937:1981	Specification for washers for water fittings for fire fighting purposes (<i>second revision</i>)
IS 939:1977	Specification for snatch block for use with fibre rope for fire brigade use (<i>first revision</i>)
IS 940:1989	Specification for portable fire extinguisher, water type (gas cartridge) (<i>third revision</i>)
IS 941:1985	Specification for blowers and exhauster for fire fighting (<i>second revision</i>)
IS 942:1982	Functional requirements for 275-l/min portable pump set for fire fighting (<i>second revision</i>)
IS 943:1979	Functional requirement for 680-l/min trailer pump for fire brigade use (<i>second revision</i>)
IS 944:1979	Functional requirement for 1800-l/min trailer pump for fire brigade use (<i>second revision</i>)
IS 947:1985	Functional requirement for towing tender for trailer fire pump for fire brigade use (<i>first revision</i>)
IS 948:1983	Functional requirement for water tender, Type A, for fire brigade use (<i>second revision</i>)
IS 949:1985	Functional requirement for emergency (rescue) tender for fire brigade use (<i>second revision</i>)
IS 950:1980	Functional requirements for water tender, Type B for fire brigade use (<i>second revision</i>)
IS 952:1986	Specification for fog nozzle for fire brigade use (<i>first revision</i>)
IS 955:1980	Functional requirements for dry power tender for fire-brigade use (150 kg capacity) (<i>first revision</i>)
IS 957:1967	Specification for control van for fire brigade
IS 1941 (Part 1):1976	Functional requirements for electric motor sirens : Part 1 AC3 phase 50Hz.415 Volts type (<i>second revision</i>)
IS 2097:1983	Specification for foam making branch pipe (<i>first revision</i>)
IS 2171:1999	Specification for portable fire extinguishers, dry powder (cartridge type) (<i>third revision</i>)

IS 2175:1988	Specification for heat sensitive fire detectors for use in automatic detectors for use in automatic fire alarm system (<i>second revision</i>)
IS 2298:1977	Specification for single-barrel stirrup pump for fire fighting purposes (<i>second revision</i>)
IS 2546:1974	Specification for galvanized mild steel fire bucket (<i>first revision</i>)
IS 2696:1974	Functional requirements for 1125 l/min light fire engine (<i>first revision</i>)
IS 2745:1983	Specification for non-metal helmet for firemen and civil defence personnel (<i>second revision</i>)
IS 2871:1983	Specification for branch pipe, universal for fire fighting purposes (<i>first revision</i>)
IS 2878:1986	Specification for fire extinguisher, carbon-dioxide type (portable and trolley mounted) (<i>second revision</i>)
IS 2930:1980	Functional requirements for hose laying tender for fire brigade use (<i>first revision</i>)
IS 3582:1984	Specification for basket strainers for fire fighting purposes (cylindrical type) (<i>first revision</i>)
IS 4308:1982	Specification for dry powder for fire fighting (<i>first revision</i>)
IS 4571:1977	Specification for aluminium extension ladders for fire brigade use (<i>first revision</i>)
IS 4643:1984	Specification for suction wrenches for fire brigade use (<i>first revision</i>)
IS 4861:1984	Specification for dry powder for fighting fires in burning metals (<i>first revision</i>)
IS 4927:1992	Specification for unlined flax canvas hose for fire fighting (<i>first revision</i>)
IS 4928:1986	Specification for delivery valve for centrifugal pump outlets (<i>first revision</i>)
IS 4947:1985	Specification for gas cartridges for use in fire extinguishers (<i>second revision</i>)
IS 4989	Specification for foam concentrate (compound) for producing mechanical foam for fire fighting (Parts 1 to 3)
(Part 1):1985	Part 1 Protein foam (<i>second revision</i>)
(Part 2):1984	Part 2 Aqueous film forming foam (AFFF)
(Part 3):1987	Part 3 Fluoro protein foam
IS 5131:1986	Specification for dividing breaching with control, for fire brigade use (<i>first revision</i>)
IS 5290:1993	Specification for landing valve (<i>third revision</i>)
IS 5486:1985	Specification for quick release knife (<i>first revision</i>)
IS 5505:1985	Specification for multi-edged rescue axe (non-wedging) (<i>first revision</i>)
IS 5612	Specification for hose-clamps and hose-bandages for fire brigade use

(Part 1):1977	Part 1 Hose clamps (<i>first revision</i>)
(Part 2):1977	Part 2 Hose bandages (<i>first revision</i>)
IS 5714:1981	Specification for hydrant, stand-pipe for fire fighting (<i>first revision</i>)
IS 6026:1985	Specification for hand operated sirens (<i>first revision</i>)
IS 6067:1983	Functional requirements for water tender, Type 'X' for fire brigade use (<i>first revision</i>)
IS 6234:1986	Specification for portable fire extinguishers, water type (stored pressure) (<i>first revision</i>)
IS 8090:1992	Specification for couplings, branch pipe, nozzle, used in hose reel tubing for fire fighting (<i>first revision</i>)
IS 8096:1992	Specification for fire beaters (<i>first revision</i>)
IS 8149:1994	Functional requirements for twin CO ₂ fire extinguishers (trolley mounted) (<i>first revision</i>)
IS 8423:1994	Specification for controlled percolating hose for fire fighting (<i>first revision</i>)
IS 8442:1977	Specification for stand post type water monitor for fire fighting
IS 9972:1981	Specification for automatic sprinkler heads
IS 10204:1982	Specification for portable fire extinguisher mechanical foam type
IS 10460:1983	Functional requirements for small foam tender for fire brigade use
IS 10658:1999	Specification for higher capacity dry powder fire extinguisher (trolley mounted)
IS 10993:1984	Functional requirements for 2000 kg dry powder tender for fire brigade use
IS 11070:1984	Specification for bromochlorodifluoromethane (Halon-1211) for fire fighting
IS 11101:1984	Specification for extended branch pipe for fire brigade use
IS 11108:1984	Specification for portable fire extinguisher halon-1211 type
IS 11833:1986	Specification for dry powder fire extinguisher for metal fires
IS 12717:1989	Functional requirements of fire fighting equipment – High capacity portable pumpset (1100-1600 L/min)
IS 12796:1989	Specification for fire rake
IS 13039:1991	Code of practice for provision and maintenance of external hydrant system
IS 13385:1992	Specification for fire extinguisher 50 capacity wheel mounted water type (Gas Cartridge)
IS 13386:1992	Specification for 50 l capacity fire extinguisher, mechanical foam type

IS 13849:1993	Specification for portable fire extinguisher dry powder type (constant pressure)
IS 14609:1999	Specification for ABC dry powder for fire fighting
IS 14933:2001	Specification for high pressure fire fighting hose
IS 14951:2001	Specification for fire extinguisher, 135 l capacity mechanical foam type
IS 15051:2002	Specification for high pressure fire hose delivery couplings
IS 15105:2002	Design and installation of fixed automatic sprinkler fire extinguishing system
IS 15220:2002	Specification for halon 1211 and halon 1301 – fire extinguishing media for fire protection
IS XXXXX:	Specifications for multipurpose aqueous film forming foam liquid concentrate for extinguishing hydrocarbon and polar solvent fires (under print)
IS XXXXX:	Specification for portable fire extinguisher mechanical foam type (store pressure) (under print)
IS XXXXX:	Specification for smoke detectors for use in automatic electrical fire alarm systems
IS XXXXX:	Specification for multisensor fire detectors
IS XXXXX:	Fire fighting – Portable fire extinguishers – Performance and construction
IS XXXXX:	Fire detection and alarm systems – Point heat detectors
IS XXXXX:	Fire detection and alarm systems – Smoke point detectors using scattered light, transmitted light or ionization
IS XXXXX:	Fire safety engineering subsystems – Detection, activation and suppression
IS XXXXX:	Gaseous fire – extinguishing systems : General requirements for design, installation and commissioning
IS XXXXX:	Gaseous fire – extinguishing systems: HCFC Blend A extinguishing systems
IS XXXXX:	Specification for inert gaseous total fire protection total flooding system – Argonite, IG 55 extinguishing system (under preparation)
IS XXXXX:	Specification for inert gaseous total fire protection total flooding system – Inergen, IG 541 extinguishing system (under preparation)
IS XXXXX:	Specification for inert gaseous total fire protection total flooding system – Nitrogen, IG 100 extinguishing system (under preparation)
IS XXXXX:	Specification for inert gaseous total fire protection total flooding system – Argon, IG 01 Extinguishing system (under preparation)

	IS XXXXX:	Specification for oscillating monitor for fire fighting
	IS XXXXX:	Trailer mounted high volume long range monitor with self-inducting non-aspirating aqua foam power nozzle for fire fighting
	IS XXXXX:	Stand-post and trailer mounted-Type high volume long range water-foam monitor with self-inducting non-aspirating aqua foam nozzle for fire fighting
	IS XXXXX:	Code of practice for water mist fire protection systems – System design, installation and commissioning
	IS XXXXX:	Fire extinguishers for seamless aluminium alloy gas containers above 0.5 litre water capacity and up to 300 bar charged pressure at 15 °C
	IS XXXXX:	Gaseous fire extinguishing systems – Carbon dioxide, total flooding and local application including in cabinet subfloors systems
	IS XXXXX:	Gaseous fire extinguishing systems – HFC 227ea extinguishing system
(20)	IS 2190:1992	Code of practice for selection, installation and maintenance of portable first-aid fire extinguishers (<i>third revision</i>)
(21)	IS 884:1985	Specification for first aid hose reel for fire fighting (<i>first revision</i>)
	IS XXXXX:	Code of practice for inspection and maintenance of gaseous fire extinguishing systems
(22)	IS 3034:1993	Code of practice for fire safety of industrial buildings : Electrical generating and distributing stations (<i>second revision</i>)
(23)	IS 6382:1984	Code of practice for design and installation of fixed carbon dioxide fire extinguishing system (<i>first revision</i>)
(24)	IS 14609:2001	Specification for dry powder for fire fighting – Class ABC fires
	IS XXXXX:	General requirement for design, installation and commissioning of gaseous fire extinguishing systems (under preparation)
	IS XXXXX:	Specification for HFC – 227 ea/FM-200 total flooding system including the quality tests of heptafluoro propane (FM-200) (under preparation)
	IS XXXXX:	Specification for NAF S-III (HCFC blend A) total flooding system including quality test of the blend (under preparation)
	IS XXXXX:	Specification for inert gaseous total fire protection total flooding system – Argon, IG 01 Extinguishing system (under preparation)

	IS XXXXX:	Specification for inert gaseous total fire protection total flooding system – Nitrogen, IG 100 extinguishing system (under preparation)
	IS XXXXX:	Specification for inert gaseous total fire protection total flooding system – Argonite, IG 55 extinguishing system (under preparation)
	IS XXXXX:	Specification for inert gaseous total fire protection total flooding system – Inergen, IG 541 extinguishing system (under preparation)
	IS XXXXX:	Specification for carbon dioxide systems – including high & low pressure and incabinet subfloor system (under preparation)
	IS XXXXX:	Specification for water mist fire protection systems – System design, installation & commissioning (under preparation)
(25)	IS 13716:1993	Code of practice for fire safety in hotels
(26)	IS 4963:1987	Recommendations for buildings and facilities for the physically handicapped (<i>first revision</i>)
(27)	IS 4878:1986	Byelaws for construction of cinema buildings (<i>first revision</i>)
(28)	IS 12456:1988	Code of practice for fire protection of electronic data processing installations
(29)	IS 1646:1997	Code of practice for fire safety of buildings (general): Electrical installations (<i>second revision</i>)
	IS 2726:1988	Code of practice for fire safety of industrial buildings : Cotton ginning and pressing (including cotton seed delinting) factories (<i>first revision</i>)
	IS 3034:1993	Code of practice for fire safety of industrial buildings : Electrical generating and distributing stations (<i>second revision</i>)
	IS 3058:1990	Code of practice for fire safety of industrial buildings : Viscose rayon yarn and/or staple fibre plants (<i>first revision</i>)
	IS 3079:1990	Code of practice for fire safety of industrial buildings : Cotton textile mills (<i>first revision</i>)
	IS 3594:1991	Code of practice for fire safety of industrial buildings : General storage and warehousing including cold storage (<i>first revision</i>)
	IS 3595:1984	Code of practice for fire safety of industrial buildings : Coal pulverizers and associated equipment (<i>first revision</i>)
	IS 3836:2000	Code of practice for fire safety of industrial buildings : Jute mills (<i>second revision</i>)
	IS 4209:1987	Code of safety in chemical laboratories (<i>first revision</i>)

	IS 4226:1988	Code of practice for fire safety of industrial buildings : Aluminium/Magnesium powder factories (<i>first revision</i>)
	IS 4886:1991	Code of practice for fire safety of industrial buildings : Tea factories (<i>first revision</i>)
	IS 6329:2000	Code of practice for fire safety of industrial buildings : Saw mills and wood works (<i>first revision</i>)
	IS 9109:2000	Code of practice for fire safety of industrial buildings : Paint and Varnish factories
	IS 11457(Part 1):1985	Code of practice for fire safety of chemical industries: Part 1 Rubber and plastic
	IS 11460:1985	Code of practice for fire safety of libraries and archives buildings
	IS 12349:1988	Fire protection-safety signs
	IS 12407:1988	Graphic symbols for fire protection plans
	IS 12456:1988	Code of practice for fire protection of electronic data processing installation
	IS 12458:1988	Method of test for fire resistance test of fire stops
	IS 12459:1988	Code of practice for fire-protection of cable runs
	IS 12777:1989	Fire safety - Flame spread of products - Method for classification
	IS 13045:1991	Code of practice for fire safety in industrial buildings: Floor mills
	IS 13694:1993	Code of practice for fire safety in iron and steel industries
	IS 13716:1993	Code of practice for fire safety of hotels
	IS 14435:1997	Code of practice for fire safety in educational institutions
	IS 14689:1999	Code of practice for fire safety in printing and publishing industry
	IS 14850:2000	Code of practice for fire safety of museums
(30)	IS 655:1963	Specification for metal air ducts (revised)
(31)	IS 9583:1981	Emergency lighting units

COMMENTARY

The following six IS have been repeated twice in the above Annex. They are:

- | | | | | | |
|----|----------|---|------|-------|--|
| 1. | IS 11360 | - | 1985 | | Specification for Smoke Detectors |
| 2. | IS 12777 | - | 1989 | | Flame Spread of Products-Classification |
| 3. | IS 2175 | - | 1988 | | Specification for Heat Detectors |
| 4. | IS 884 | - | 1985 | | First-aid Hose Reels |
| 5. | IS 3034 | - | 1993 | | CP - Electrical Generating & Distributing Stations |
| 6. | IS 13716 | - | 1993 | | CP for Fire Safety in hotels |

Note: BIS may decide as to which one of the duplicate entries has to be deleted.

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Acknowledgement: The figures mentioned above have been adopted courtesy foreign Manuals / Books as indicated below:

HMSO Manual of Firemanship Book 9: Figures 1(a), 1(b), 9, 10, 11, 19, 20, 21, 24

HMSO Manual of Firemanship Book 8: Figures 3, 4, 5, 6, 22

HMSO Manual of Firemanship Book 6C: Figure 23

HMSO BRE Aspects of Fire Protection in Buildings: Figures 2, 7, 8

UK Approved Document B: Figures 13, 14, 17, 18

NFPA 5000: Figures 15(a), 15(b), 16

ANNEX-H

THE GAZETTE OF INDIA (EXTRAORDINARY)

(Part II) — Sec. 3(1)(ii)

MINISTRY OF URBAN DEVELOPMENT AND POVERTY ALLEVIATION

(DELHI DIVISION)

NOTIFICATION

New Delhi, the 28th August, 2002

S.O. 917(E)—Whereas the issue of making suitable provision in the Building Bye-laws, 1983 to ensure that the public buildings that are erected in Delhi provide barrier free environment for the persons with disabilities has been under the consideration of the Government.

Whereas the following modifications/additions which the Central Government proposed to make in the Building Bye-laws 1983 in this regard were published for the public information vide Public Notice dated 26th March, 2002 and were advertised in the leading newspapers on 4th April, 2002. In all 7 objections/suggestion were received and they were examined by a Committee under the Convenorship of Chief Planner of Town & Country Planning Organisation.

Whereas after thorough consideration of the report, Central Government has decided to make the following Modifications/additions in the Building Bye-laws, 1983.

Now, therefore, in exercise of the powers conferred by sub-section (2) of section 11A of Delhi Development Act, 1957, the Central Government hereby make the following Modifications/additions to the Building Bye-laws, 1983 with effect from the date of publication of this Notification in the Gazette of India.

Modification: To provide barrier free environment in the public building for persons with disabilities.

2. Definitions:

- 2.91 Non-ambulatory disabilities: Impairments that, regardless of cause or manifestation, for all practical purposes, confine individuals to wheelchairs.
- 2.92 Semi-ambulatory disabilities: Impairments that cause individual to walk with difficulty or insecurity. Individuals using braces or crutches, amputees, arthritis, spastics and those with pulmonary and cardiac ailments may be semi-ambulatory.
- 2.93 Hearing disabilities: Deafness or hearing handicaps that might make an individual insecure in public areas because he is unable to communicate or hear warning signals.
- 2.94 Sight disabilities: Total blindness or impairment affecting sight to the extent that the individual functioning in public areas is insecure or exposed to danger.
- 2.95 Wheel Chair: Chair used by disabled people for mobility
 - (i) Size of Small Wheel Chair: 750 X 1050 mm
 - (ii) Size of Large Wheel Chair: 800 X 1500 mm.

30.0 To provide facilities in the public building for the disabled persons.

30.1 **Scope:** These bye-laws are applicable to all buildings, recreation areas & facilities used by public. It does not apply to private domestic residences.

30.1.1 **Site planning:** Level of the roads, access paths & parking areas shall be described in the plan along with specification of materials. Every building should have at least one access to main entrance / exit to the disabled which shall be indicated by proper signage. This entrance shall be

- approached through a ramp together with stepped entry. The ramp should have a landing after every 9 Metre run and in front of the doorway. Minimum size of landing shall be 1000 X 2000 mm.
- 30.1.2 Access path/walk way: Access path from plot entry and surface parking to building entrance shall be minimum of 1800 mm. wide having even surface without any step. Slope, if any shall not have gradient greater than 5%. Selection of floor material shall be made suitably to attract or to guide visually impaired persons (limited to floor material whose colour texture is conspicuously different from that of the surrounding floor material or the material that emit different sound to guide visually impaired persons. Finishes shall have a non-slip surface with texture traversable by a wheel chair. Curbs wherever provided should blend to common level.
- 30.1.3 Parking: For parking of vehicles of disabled people the following provisions shall be made:
- Surface parking for two Equivalent Car Spaces (ECS) shall be provided near entrance for the physically handicapped persons with maximum travel distance of 30 metre from building entrance.
 - The width of parking bay shall be minimum 3.6 metre.
 - The information stating that the space is reserved for wheel chair users shall be conspicuously displayed.
 - Guiding floor materials shall be provided or a device which guides visually impaired persons with audible signals or other devices which serves the same purpose shall be provided.
- 30.2 Building requirements: The specified facilities for the buildings for disabled persons shall be as follow:
- Approach to plinth level.
 - Corridor connecting the entrance/exit for the handicapped.
 - Stair-ways.
 - Lift.
 - Toilet.
 - Drinking water.
- Braille signage shall be provided at the above specified facilities.
- 30.2.1 Approach to Plinth Level: Ramp shall be provided with non-slip material to enter the building minimum clear width of ramp shall be 1800 mm with maximum gradient 1:12, between top and bottom of the ramp. Length of ramp shall not exceed 9.00 metres having 800 mm high handrail on both sides extending 300 mm beyond the ramp. Minimum gap from the adjacent wall to the handrail shall be 50 mm.
Minimum clear opening for the entrance door shall be 1000 mm.
Threshold shall not be raised more than 12 mm.
For stepped approach, size of tread shall not be less than 300 mm and maximum riser shall be 150 mm. Provision of 800 mm high handrails on both sides of the stepped approach similar to the ramped approach shall be made.
- 30.2.2 Corridor connecting the entrance/exit for the disabled: The corridor connecting the entrance/exit for handicapped leading directly outdoors to a place where information concerning the overall use of the specified building can be provided to visually impaired person either by a person or by signs, shall be provided as follows:
- Guiding floor materials shall be provided or devices that emit sound to guide visually impaired persons.
 - The minimum width shall be 1500 mm.

- (c) In case there is a difference of level, slope ways shall be provided with a slope of 1:12.
- (d) Handrails shall be provided for ramps/slope ways.

30.2.3 Stairways: Stairways with open riser & provision of nosing are not permitted in such building.

30.2.4 Lifts: Whenever lift is required as per bye-laws, provisions of at least one lift shall be made for the wheel chair user with the following car dimensions of lift recommended for passenger lift for 13 persons capacity by Bureau of Indian Standard:

Clear internal depth	1100 mm
Clear internal width	2000 mm
Entrance door width	910 mm

- (a) A handrail not less than 600 mm long at 900 mm above floor level shall be fixed adjacent to the control panel.
- (b) The lift lobby shall be of an inside measurement of 1800 mm X 2000 or more.
- (c) The Braille signage will be posted outside the lifts.
- (d) Operational details of lifts shall conform to the National Building Code (NBC) and will be the responsibility of designer as well as manufacturer.

30.2.5 Toilets: One special WC in a set of toilet shall be provided for the use of handicapped with essential provision of washbasin near the entrance for the handicapped.

- (a) The minimum size shall be 1500 mm X 1750 mm. *1750 X 2000*
- (b) Minimum clear opening of the door shall be 900 mm and the door shall swing out/sliding type.
- (c) Suitable arrangement for vertical/horizontal handrails with 50 mm clearance from wall shall be made in the toilet.
- (d) The WC seat shall be 500 mm from the floor.

8.6 Refuge: An alternative to immediate evacuation of a building via staircases and/or lifts is the movement of disabled persons to areas of safety within a building. If possible, they could remain there until the fire is controlled and extinguished or until rescued by fire fighters.

It is useful to have the provision of a refuge area, usually at the fire protected stair landing on each floor that can safely hold one or two wheelchairs.

- Have doorways with clear opening width of 900 mm and complying with Section 4.6; and
- Have an alarm switch installed between 900 mm and 1200 mm from the floor level.

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