FIRE SAFETY PRINCIPLES

Fire safety engineering helps to save lives, reduce costs due to fire damage and bring substantial economic savings through improved fire safety design. General principles provides a performance-based methodology for engineers to assess the level of fire safety for new or existing built environments.

Fire safety is evaluated through an approach based on risk assessment and knowledge of the behaviour of fire and of people and the consequences of such behaviour on human safety, property and the environment.

The basic principles associated with fire (including fire growth, hot gases and movement of effluents, structural and compartmentation behaviour) include:

- Safety of life
- Protection of the environment
- Preservation of heritage.
- Conservation of property
- Continuity of operations

Furthermore, these basic principles can be applied to all configurations of the built environment – building, transportation systems and industrial installations.

FIRE SAFETY APPROACH

Fire protection techniques have to be based on the fire behaviour 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 minimized. An indefinite combination of variables is involved in the phenomenon of fire, all of which cannot be quantified. An engineering design approach should be adopted for ensuring a fire safe design for buildings. Creation and maintenance of fire protection facilities should be in accordance with the building code / local byelaws.
For ensuring compliance of fire protection equipments/installations to the laid down quality requirements, it is desirable to use such equipments/installation duly conforming to the standards.

In the formulation of Indian standards, the approach adopted is as follows:

1) **Fire Prevention** — Covering aspects of fire prevention pertaining to planning, 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 minimize 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.

**STANDARDIZATION IN THE FIELD OF FIRE PROTECTION**

Fire Fighting Sectional Committee, CED 22 of BIS is engaged in formulation of Indian Standards on Fire Fighting equipments/extinguishers using water, carbon dioxide, foam, dry powder and halon as extinguishing agents, detectors, sprinklers, hoses, water fittings, hydrants, water supplies etc.

More over safety of the occupants of the buildings is the fundamental requirement that the owner and the professionals involved endeavor to achieve. Fire Safety Sectional Committee, CED 36 of BIS has formulated a series of Indian Standards pertaining to General requirements and specific to various buildings & industries. BIS has formulated 38 standards on fire safety in buildings, 132 standards on fire fighting equipments & systems apart from National Building Code of India (part 4) pertaining to fire and life safety. However, some important standards have been prepared based on latest practices.

**FIRE PREVENTION**

**IS 1641 `Code of Practice for Fire Safety of Buildings (General):General Principles of Fire Grading and Classification’**

A series of Indian Standards covering fire safety of buildings in general principles of fire grading details of construction, exit requirements and exposure hazards have been formulated. This Indian Standard covers general principles of fire grading and classification, which has been adopted in various Indian standards in respect to fire safety aspects.
For determination of fire loads and fire load density for arriving at the classification of occupancy hazard, guidance including the calorific values of some common materials and a broad classification of industrial and non-industrial occupancies into low, moderate and high hazard classes is given.

**IS 1642 ‘Fire Safety of Buildings (General): Details of Construction – Code of Practice’**

The provisions given in this standard are those which are necessary at the time of construction of building new or addition or alterations for adopting fire safety measures. The provisions are applicable for all types of buildings including high rise buildings (above 15 m in height).

The essential requirements for fire safety in so far as materials and details of construction are concerned, are that the flame smoke and hot gases shall not spread so rapidly as to give the occupants insufficient time to escape. In the event of a fire, the construction shall not further tend to spread the fire.

**IS 1643 ‘Fire Safety of Buildings (General): Exposure Hazard - Code of Practice’**

A series of Indian Standards covering the fire safety of buildings in general, principles of fire grading, details of construction, exit requirements and exposure hazard have been formulated. This Indian Standard, covering the last aspect, includes the values in respect of floor area ratio, and open space to provide adequate safety against exposure hazard.

**LIFE SAFETY**

**IS 1644 ‘Fire Safety of Buildings (General) : Exit Requirements and Personal Hazard - Code of Practice’**

This standard covers requirements regarding fire safety of buildings with respect to exit requirements and personal hazard.

The exit requirements and personal hazard dealt with in this standard is considered as at least of equal importance to all other aspects; in fact in most cases, it is paramount because of the density of population associated with particular occupancy; an example is that of a cinema or similar densely occupied building when constructed with a godown of similar occupancy. Requirements for stair case, horizontal exit, compartmentation as per degree of hazard are given.
IS 2189 ‘Selection, Installation and Maintenance of Automatic Fire Detection and Alarm System – Code of Practice’

The purpose of a fire detection and alarm system is to detect fire at the earliest practicable moment and to give an alarm so that appropriate action can be taken (for example, evacuation of occupants, summoning the fire fighting organization, triggering of extinguishing processes, etc). An alarm system may be activated by automatic detection devices or by manual operation of manual call points.

This standard covers the planning, design, selection, installation and maintenance of fire detection and alarm systems.

**FIRE PROTECTION**


BIS has published IS 15683:2006 which is based on ISO 7165 :1999 ‘Fire Fighting – Portable Fire Extinguishers – Performance and Construction’ wherein the performance requirements of various types of extinguishers have been covered. IS 15683 lays down requirements for performance, reliability and safety of portable extinguishers. It is performance based standard. The construction requirements only related to safety are given and there is no manufacturing detail like dimensions of extinguishers.

It covers performance requirements for test fires based on rating suitability for various classes of fires which are not given in the existing Indian standards. This determines actual performance of extinguisher on the basis of extinguishment of different size of fires. Such requirements are given in all international standards like NFPA, UL, EN etc.

IS 2190 Selection, Installation and Maintenance of First-Aid Fire Extinguishers – Code of Practice’

Portable fire extinguishers are first-aid fire fighting equipment. Nevertheless, they are very valuable in the early stages of a fire when used promptly and effectively. Provision of unsuitable types, incorrect operation, or improper maintenance of the extinguishers have, at times, led to failure in tackling the fire effectively in the early stages, thus involving greater loss of life and property. This standard has, therefore been formulated for giving guidance regarding proper selection, installation and maintenance of portable first first-aid fire extinguishers so that such extinguishers will function at all time as intended throughout their useful life.
**IS 949 ‘Functional Requirements for Emergency (Rescue) Tender’**

The tender covered in this standard is designed both for use for fires and special service work, such as:

a) large fires in cities or large towns, difficult or special fires requiring the use of breathing apparatus, special equipment or illumination;

b) major electrical fires, for example, in power stations and transformers;

c) house collapse, lift, road transport, railway and machine accidents, etc, for which special equipment is required and is not available locally; and

d) major leakages of toxic or dangerous gases or gaseous liquids.

e) ship fires

This standard lays down the requirements regarding material, design and construction, workmanship and finish, accessories and equipment of emergency (rescue) tender.

**IS 950 ‘Functional Requirements for Water Tender, Type B for Fire Brigade use’**

Water tender, Type B are used in towns or parts of town and industries where the fire risk is such that high rate of discharge of water is necessary for fire fighting and a high degree of maneuverability is also desired of the fire appliance at the same time.

Details pertaining to body work, storage, pipe lines and valves have been covered in the standard. Provisions of water/foam monitor, telescopic light mast and alternator unit have been also included.

**IS 15105 ‘Design and Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems - Code of Practice’**

A sprinkler system consists of a water supply (or supplies) and one or more sprinkler installations; each installation consists of a set of installation control valves and a pipe array fitted with sprinkler heads.

A sprinkler has two functions to perform. It must fire detect a fire, and must then provide an adequate distribution of water to control or extinguish it. Each function is performed separately and one is independent of the other except insofar as early detection makes extinction easier because the fire has not grown large. The classic use of the sprinkler is in the hot gas layer which forms beneath the ceiling of an enclosure in which a fire is developing.
The sprinklers operate at pre-determined temperatures to discharge water over the affected part of the area below, the flow of water through the alarm valve initiating a fire alarm.

This standard lays down the requirements for the design and installation of fixed automatic sprinkler fire extinguishing system.

**IS 15493 ‘Gaseous Fire Extinguishing Systems : Part 1 General Requirements’**

This standard covers the general requirements applicable to total flooding clean agent systems like Halo Carbon agents and inert gas agents. In addition, individual requirements for each type of clean agent system are covered under separate standards. Detailed design guidelines are specified in other standards.

Gaseous fire suppression systems covered in these Indian standards are designed to provide a supply of gaseous extinguishing medium for the extinction of fire involving high value assets.

List of the important standards formulated by these committee are given in Annex.
ENVIRONMENTAL PROTECTION

HALON PHASE OUT

India has ratified Montreal Protocol Treaty in 1992 and obligated to phase out use of Ozone Depleting Substances (ODS) including Halons, being environmental concern. Halons have found extensive usage as an agent in fire extinguishers/systems and being phased out internationally. In view of the phasing out of halons as per Montreal Protocol, BIS has also published various standards on halon alternatives.

A project was undertaken by BIS for the formulation of new standards on halon alternatives and revision / updation of existing standards where halons have been referred. After extensive studies and detailed deliberations in the technical committee meetings, our Fire Fighting and Fire Safety Sectional Committees have formulated 14 standards and updated existing standards.

- ABC powder extinguisher (stored pressure)
- CO₂ light weight squeeze grip valve type extinguisher
- Hepta fluoro propane (HFC-227)
- HCFC blend – A
- HCFC 125
- Cl₃
- Inert Gases :
  - Nitrogen – IG 100 (N₂)
  - Inergen – IG 541 (N₂, Ar, CO₂)
  - Argonite – IG 55 (Ar, N₂)
  - Argotec – Argon IG 01
- Water Mist System
- CO₂ Incabinet subfloor and total flooding systems
NATIONAL BUILDING CODE (PART 4) – FIRE PROTECTION

As a major development, BIS has published NBC (Part 4) Fire Protection which includes comprehensive recommendation of minimum standards of fire protection. 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 minimize danger to life from fire, smoke, fumes or panic before the building 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.

Additional Fire Protection Requirements for High Rise Buildings – 15 Metre in height or above

In addition to the general provisions given in this part, the Authority may insist on suitable protection measures should be provided in a building 15 m in height or above.

CONSTRUCTION

All materials of constructions in load bearing elements, stairways and corridors and facades shall be non-combustible.

LIFTS

Walls of lift enclosures shall have a fire rating of 2 h; lifts shafts shall have a vent at the top of area not less than 0.2 m$^2$.

FIRE LIFTS

To enable fire services personnel to reach the upper floors with the minimum delay, one fire lift per 1 200 m$^2$ of floor area shall be provided and shall be available for the exclusive use of the firemen in an emergency.

BASEMENTS

Each basement shall be separately ventilated. Vents with cross-sectional area (aggregate) not less than 2.5 percent of the floor area spread evenly round the perimeter of the basement shall be provided in the form of grills, or breakable stall board lights or pavement lights or by way of shafts.
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 IS 1642.

All floors shall be compartmented with area not exceeding 750 m$^2$ by a separation wall with 2 h fire rating, for floors with sprinklers the area may be increased by 50 percent.

**SERVICE DUCTS/SHAFTS**

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.

**REFUGE AREA**

Provisions contained in IS 1644 shall apply for all buildings except multi-family dwellings, refuge area of not less than 15 m$^2$ shall be provided on the external walls.

**ELECTRICAL SERVICES**

The electric distribution cables/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;

**GAS SUPPLY**

Provisions for gas pipe installations, given in codes to be followed.

**ILLUMINATION OF MEANS OF EXIT**

Staircase and corridor lights shall conform to the requirements of IS 1644.

A stand-by generator shall be installed to supply power to staircase and corridor lighting circuits, fire lifts, the stand-by fire pump, pressurization fans and blowers, smoke extraction and damper systems in case of failure of normal electric supply.

**TRANSFORMERS**

It shall conform to the requirements of IS 1646.
AIR-CONDITIONING

The ducting shall be constructed of substantial gauge metal in accordance with good practice IS 9583.

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 relevant Indian Standards in consultation with the Authority.

FIRE ALARM SYSTEM

All buildings with heights of 15 m or above shall be equipped with manually operated electrical fire alarm (MOEFA) system and automatic fire alarm system in accordance with IS 2189.

LIGHTNING PROTECTION OF BUILDINGS

The lightning protection for buildings shall be provided as given in Part 8 Building services, Section 2 Electrical installations of NBC.

FIRE CONTROL ROOM

For all buildings 15 m in height or above and apartment buildings with a height of 30 m and above, there shall be a control room on the entrance floor of the building with communication system (suitable public address system) to aid floors and facilities for receiving the message from different floors.

COMPARTMENTATION

The building shall be suitably compartmentalized so that fire/smoke remain confined to the area where fire incident has occurred and does not spread to the remaining part of the building.

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.