HINDUSTAN ZINC
Zinc & Silver of India

Sustainability Framework

SAFETY STANDARD

Fire Safety Management Standard

Hindustan Zinc Limited

Corporate Standard Rules & Procedure Sub-Committee	Date	31-07-2025
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Abbreviations

- AHU - Air Handling units
- ATEX – Atmosphere Explosible
- CSC – Corporate Safety Council
- CSRP – Corporate Standards, Rules and Procedure Subcommittee
- CO2 – Carbon Dioxide
- CEA - Central Electricity Authority
- DG – Diesel Generator
- FSM - Fire Safety Management
- FSR - Fire Safety Resource
- HZL – Hindustan Zinc Limited
- HSE – Health, Safety and Environment
- IMS – Integrated Management System
- IS - Indian standard
- KVA – Kilo Volt Ampere
- LOTO – Lockout Tagout
- MCC – Motor Control Centre
- MI – Mechanical Integrity
- MVA – Mega Volt Ampere
- NBC – National Building Code
- NFPA - National Fire Protection Association
- OISD - Oil Industry Safety Directorate
- O2 – Oxygen
- QA – Quality Assurance
- UIC – Unit Implementation Committee
- ZSC – Zone Safety Committee
- SRPSC – Standards, Rules & Procedure Subcommittee

- PPE - Personal Protective Equipment
- PESO Petroleum and Explosive Safety organization
- PHA – Process Hazard Analysis
- PSSR – Pre-Start Safety Review
- PA – Public Address
- PCC – Power Control Centre
- SOPs – Standard Operating Procedures
- SMPs – Standard Maintenance Procedures

Table of Contents

1. Purpose

The purpose of this standard is to provide guidance, requirements for fire safety management and comply with fire related statutory compliance. Effective planning for fire safety is an important part of the safety program to prevent loss of life, injuries, property damage, HZL operations / business interruptions, harm to the environment and loss of trust from communities / investors.

2. Scope

The standard covers fire prevention and fire protection process and requirements for HZL operations like Smelters, Ball mill operations, Captive Power Plant, hazardous material storage and other surface Industrial and commercial operations / buildings and green field and brown field projects. The surface operations in mining area is also covered.

The scope of this standard does not cover fire requirements for underground mining operations, fire System mechanical integrity and site emergency response and their requirements.

3. Responsibilities

- Line management is responsible for implementing this standard. Fire risk assessments and mitigation and training employee and business partners/contractors coordination's. Check and ensure fire protection system functionality in the respective operational area. Provide required resources for the fire risk management.
- Engineering Head / unit operations Head is responsible to ensure fire assessment, design, installation zone level.
- Maintenance Head / Electrical Head / Utility Head is overall responsible for fire protection integrity, quality assurance and fire impairment management.
- Fire competency leader for the zone from is responsible for quality assurance of programs, and reviews of new installations, modifications, system audits, and statutory requirements at corporate and zone level.
- Safety Head is responsible to ensure the fire installation quality assurance during projects, healthiness of the fire system during operations and statutory guidance for compliance.

Note: The responsibility mentioned in the emergency response procedure must be adhered as per the ERT roles and responsibilities.

4. Definitions

Building code—a regulatory document that sets forth minimum requirements for the design and construction of buildings and structures, e.g. National Building Code (NBC).

Emergency Lighting - Lighting provided for use when the power supply for normal lighting fails.

Fire—any unplanned combustion. Evidence of combustion includes flames, smoke, or charring. Electrical arcs, faults, or overheating that does not result in a subsequent fire are electrical incidents only. A subsequent fire shows evidence of combustion beyond the immediate damage caused by the arc, fault, or overheating.

Fire safety—as used within this standard, fire safety is a common term designated to cover all aspects of fire emergency response, including fire prevention, fire protection, life safety, and related administrative systems.

Fire Door Assembly - A combination of fire door, frame, hardware, and accessories assembled to provide a specific fire-resistance rating approved for protection of openings in fire separation walls.

Fire Exit - A protected path of travel from an exit access route leading to an area of safety. This can consist of a normally closed fire-rated exterior doorway, a fire separated horizontal exit passageway, or a protected exit stairway that discharges to an area of safety located outside the fire-involved building.

Fire Load - Calorific combustion energy of the whole contents contained within a designated space or area, including facing materials of walls, partitions, floors and ceilings.

Fire Prevention - The whole set of precautions intended to prevent the outbreak of fire and/or limit its effects.

Fire Protection - Design features, systems or equipment in a building, structure or other fire risk zone, intended to minimise the danger to persons and property by detecting, containing and/or extinguishing fires.

Fire Compartment - A space within a building that is enclosed by fire barrier or fire resistant walls on all sides, including the top and bottom (floor and roof/ceiling).

Fire Load - Calorific energy, of the whole contents contained in a space, including the facings of the walls, partitions, floors and ceilings.

Fire Load Density - Fire load divided by floor area.

Fire Stop - A fire resistant material, or construction, having a fire resistance rating of not less than the fire 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.

High Rise Building - A building 15 m or above in height (irrespective of its occupancy).

Occupant Load - Maximum number of persons that might occupy a building or portion thereof at any one time.

Refuge Area - An area within the building for a temporary use during egress. It generally serves as a staging area which is protected from the effect of fire and smoke.

Shall – Indicates Mandatory requirements

Should – Indicates Recommended (non-mandatory) provisions

5. Fire Safety Principles

Fire Safety Management (FSM) covers aspects of several fire safety principles that include leadership and resources for fire prevention, fire protection, and fire emergency response .

Figure 1. Fire safety model

The following briefly describes each aspect of FSM (fire safety management) as indicated in **Figure 1**:

- Leadership
  - HZL fire safety objectives
  - System for evaluating fire risks
  - Fire safety metrics
- Resources
  - Statutory codes interpretation - National Building Code, CEA (Central Electricity Authority)
    2010, and PESO (Petroleum and Explosive Safety organisation), Factories Act, Occupational Safety, Health and Working Conditions Code, 2020 and OISD (Oil Industry Safety Directorate) standards.
  - International fire codes and standards like NFPA
  - IS standards
  - HZL fire competency resource / leader
- Prevention
  - Analysis of PHA's, fire hazards, fire load studies and mitigations
  - Ignition controls – open flame, electrical arc/flash
  - Flammable / combustible material inventory control
  - Fire safety system audits
- Protection
  - Fire safety system design (Passive and active) – construction, fire detection, alarms, fire suppression and life safety provisions
  - Fire safety systems installation and acceptance testing (QA and PSSR)
  - Fire safety systems inspection, functional testing, and maintenance (MI)
- Response

– Emergency response plans and response capabilities

Note: Response process is not covered under this standard and HZL Emergency response standard and process must be followed.

5.1 Fire Safety Resource (FSR)

HZL should have fire safety resources to manage and minimise business risk from fire hazards. Resources can be full time or part time and assigned from safety or line management at the corporate and zone level depending on the fire risk. Main roles and responsibilities of fire safety resource are the following:

- Actively soliciting input to develop consensus on fire safety goals, procedures, guidelines and practices
- To ensure incorporation of fire safety principles and concepts in design and construction of new or modified HZL facilities and infrastructures.
- Serving as technical resources for fire safety training, fire incident investigations, fire safety system acceptance testing, inspection, testing, maintenance procedures for fire safety equipment and systems, and hot work identification and permitting process.
- Review of fire risks and recommending risk management strategies for hazards against available and minimum essential protection requirements, with ability to detect vulnerabilities and recommend corrective actions
- Annual summary and communication of the fire safety evaluations to the HZL zone APEX chairman and corporate safety council.
- Developing, managing, and maintaining fire safety audit protocols, policies, goals, guidelines, and standards
- Determining which industry standards or parts of industry standards shall be adopted for HZL operations, such as the following: o IS standards o NBC codes of practice. o NFPA (National Fire Protection Association) codes and standards,
- Developing and maintaining standards / procedures / SOPs / SMPs for fire safety equipment design and inspection, testing, and maintenance, including a list of adopted or acceptable external codes, standards, and guidelines
- Coordination with line management for implementing and maintaining emergency response procedures, emergency staffing plans, and emergency equipment assessments for support of HZL operations.

5.2. Fire safety objectives

The objectives of the Fire Safety Management program include:

1) Preventing fire ignition and

2) Managing fire impact (fire protection)

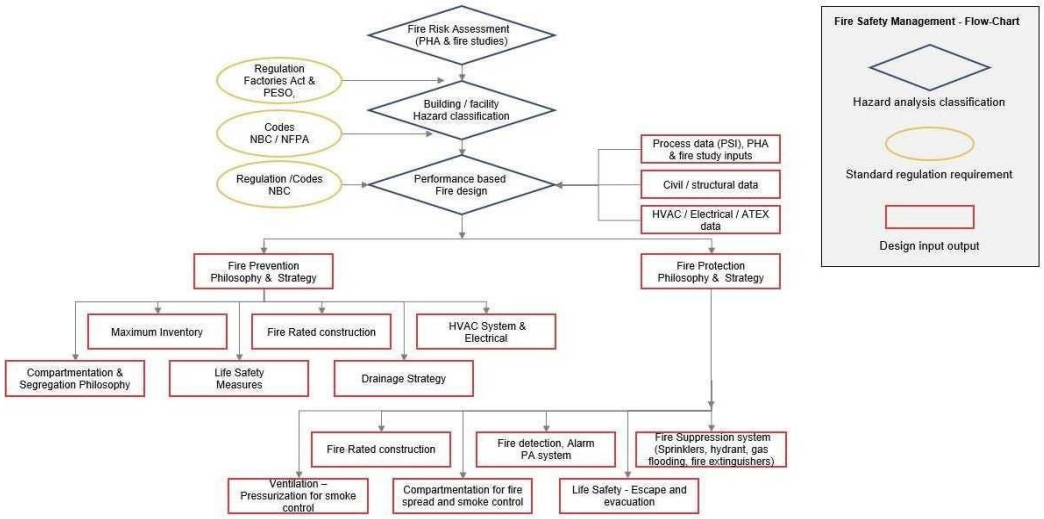
HZL is committed to achieving and sustaining the goal of zero fires. Using the fire safety model, the HZL leadership team has responsibility to address the following fire safety objectives:

- HZL facilities shall be designed and operated so as to protect personnel from serious injury and to manage risk in a way that minimizes potential property damage and business loss to an acceptable level from fire hazards.
- The load-bearing capacity of construction must not be compromised prior to the completion of the following:

  o Full occupant evacuation o Interior or close proximity emergency response activities o Safe shutdown or de-inventorying of hazardous process operations to a safe state or control of fire, as necessary to avoid escalation of an active incident
- The generation and spread of fire and smoke within any HZL facility must not create untenable conditions for people other than those in the immediate proximity of the ignition for a period of time sufficient to complete evacuation or rescue by other means.
- Occupants shall be provided safe and reliable means of egress from every facility. Where necessary, occupants shall be provided protection from exposure to fire conditions for the period of time necessary to safely control process equipment and bring the process to a safe state or to control the fire.
- Fire protection system covering
  - Passive fire protection o Active fire protection o coordination / liaising with external agencies like fire department, police, hospitals etc.
  - Local issues – availability of water, response time external agencies etc.
- Fire system operational and maintenance aspects and considerations shall be incorporated during the systems design stage.

6. Fire safety standards of practice and guidelines

The process flow for managing the fire safety system is provided below:.



6.1. Fire Risk Assessment

The first step in fire prevention is to assess the fire risks by undertaking a fire risk assessment (qualitative or quantitative) of a building or operational area in order to assess its fire risks. Review and assess the means by which a fire might start and spread, the potential consequences and the available approaches to risk mitigation. This includes day-to-day operations, risks associated with maintenance work and those arising from installing new equipment or adopting new or changing technology. The main purpose of the fire risk assessment is to consider the following:

- Elimination or reduction of ignition sources
- Reduction of fuel load / fire load
- Fire Spread reduction
- Identification of potential control measures (Mitigative measures)
- Maintenance of fire protection measures like impairment, hot works.

If there are more than 05 occupants regularly present in an area of non- industrial operations, then it is required to conduct the fire risk assessment. All industrial operations should undergo the fire risk assessment.

The Process Hazard Analysis (PHA's) for a hazardous process should be referenced to identify potential fire ignition sources, chemical reactions leading to fire risk (Runaway, exothermic), electrical area classification (ATEX), Max. storage limits, facility siting and building orientation, and drainage and containment considerations.

Fire studies should be conducted to determine fire loads, fire load densities, and mitigative measures like passive and active fire protection.

The fire risk assessment should be reviewed at every 03 years intervals in cases where no management of change is involved.

6.2. Fire Studies and Fire Load Density

Estimation, determination, or calculation of "Fuel load" is one a key factor for assessing fires that can occur, as expressed in terms of potential heat energy magnitude and combustion duration. The maximum intended storage capacity and quantity of flammable and combustible materials to be used or handled should be defined for determination of the fire mitigation challenge. Analysis of fire load density should be considered in fire safety systems design for the following purposes and objectives:

- Determine maximum fire load density (MJ/ m2 or kcal/ m2) in HZL operations
- Estimate anticipated or potential fire growth and heat release rates and peak fire size
- Determination of minimum and average fire load density values
- Define separation and fire barrier needs or usage limits for materials during project/construction to reduce fire load area and/or density and limit fire spread
- Evaluate fire quenching or suppression needs and strategies
- Define means for control or management of smoke and hazardous combustion gases
- Identify needs for passive fire protection measures for load-bearing structure, fire compartmentalization, safety clearances/distances, mechanical ventilation etc.
- Planning provisions for active fire and life-safety protection systems and fire-fighting equipment such as fire sprinklers, fire hydrants, fire detection and alarms, fire water supplies, fire pumps, fire extinguishers etc.

The formula for calculating fire load is as stated below:

Fire load = (Flammables + combustibles in kg) x calorific value in kcal/kg ÷ Floor area in square meters

6.3. Performance-based Fire Design

Building Codes and Regulations prescribe only the basic minimum requirements for achieving fire and life safety. The codes do not prohibit better types of building construction, more exits, or provision of other safer strategies than prescribed in the codes.

A performance-based fire safety design approach should be adopted to develop appropriate fire preventive and protection measures. A performance-based design must meet cited fire safety objectives and must be demonstrated and documented by satisfying specific measurable performance criteria, including those for life safety, structural integrity, business continuity and performance reliability of the fire protective systems.

Performance based design shall satisfy all mandatory statutory requirements (National Building Code).

On the basis of the hazard and regulation assessment, determination of the following safety design requirements will result:

- The maximum allowable inventory of chemical products, depending on toxicity, flammability, combustibility, and chemical reactivity properties
- Proper location and separation of incompatible substances, and specific location strategy
- Fire rating of compartments for all chemicals and protection levels
- Separation distances from internal and external walls, from other buildings, and from equipment to sensitive targets
- Spill control and drainage system requirements that take into account chemical compatibility, heat generation, water reactivity, gas formation and any other potential issues
- HVAC mechanical or natural ventilation requirements to account for potential hazardous gas formation in case of fire or in case of unintended reactions
- Smoke and gas detection systems;
- Electrical hazardous area classification (ATEX)
- Emergency power supply and associated equipment.
- Firefighting system / strategy – including passive and active protection

6.4 Fire Prevention Philosophy and General Requirements 6.4.1

Classification of Buildings

Buildings are classified into two categories. 1) Based on the occupancy. 2) Based on the type of construction.

Occupancy Based Classification: All buildings, whether existing or hereafter erected shall be classified according to intended use or character of occupancy in one of the following ***09*** groups as defined in the National Building Code:

- 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

In case of mixed (non-separated) occupancies, in so far as fire prevention and protection is concerned, all the occupancies/the entire building/facility shall be governed by the most stringent provisions of the NBC among those applicable for the individual occupancies.

Construction type based classification: The design of any building and the type of materials used in its construction are important factors in making the building resistant to loss of integrity or a complete burn-out, and in preventing the rapid spread of fire, smoke or fumes.

The fire resistance of a building or its structural and non-structural elements is expressed in minutes against a specified fire load which is expressed in kcal/m2, and against a certain intensity of fire. For the purpose, the types of construction according to fire resistance shall be classified into four categories as per NBC, namely, [Ref. NBC Part 4, 3.3.1 and 3.3.2, Table 1]

- Type 1 Construction - Load bearing components fire resistance rated for 120 to 240 minutes
- Type 2 Construction – Load bearing components fire rated for 90 to 120 minutes
- Type 3 Construction – similar to Type 2 construction with interior load bearing components fire rated for 60 minutes Type 4 Construction – Load bearing and non-load bearing components fire rated for 60 mins.

The above fire resistance rating shall be required to achieve the respective type of construction unless otherwise specified in the codes, standards and fire design. For example, warehouse used for storage of hazardous material storage must conform to Type-I of the fire resistance grading of buildings as specified in IS 1642: 1989, while those used for storage of non-hazardous goods shall conform to Type II (or Type I).

Construction of Type 3 or Type 4 is not permitted for Group G – Industrial, Group H – Storage and Group J – Hazardous buildings. Only Type 1 and Type 2 are permitted depending on the fire risk severity.

Non-combustible materials should be used for construction of buildings, and the internal walls of staircase enclosures should be of brick work or reinforced concrete or other material of construction *with minimum of 120 mins rating.* The walls for the chimney shall be of Type 1 or Type 2 Construction depending on whether the flue gas temperature is above 200°C or less, respectively.

For high rise buildings (15 m 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 2-hour rating.

Load bearing steel beams and columns shall be protected against collapse of structure in case of fire. This could be achieved by use of appropriate methodology using suitable fire resistance rated materials.

The accessories and fixtures used must comply with fire rating such as ventilation ducting support fixtures, fire sprinklers line supports, conduits used for power or control cables, and warehouse storage racks.

6.4.2. Fire Compartmentation

Buildings are often divided into compartments enclosed in fire-resisting construction. This approach provides passive fire protection by inhibiting the spread of fire within the building.

Fires on one or two floors, or when spread over a large floor area, are extremely difficult to control and extinguish by manual firefighting methods. Building designs with unprotected vertical openings, like open stairwells, large floor areas without separation walls, Ventilation duct work without dampers etc. provide avenues for fire spread vertically as well as sideways. Firefighting operations become difficult and prolonged as the fire propagation continues upwards as well as horizontally.

Judicious compartmentation of a building is considered as a primary method among passive fire protection measures. It helps to 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. Compartmentation helps to protect high value or critical areas or operations from a fire in the surrounding area (E.g., Process control rooms, server rooms, electrical transformers, Boilers, solvent storage, warehouses etc.)

6.4.3. Fire Segregation and Separation

The segregation and separation of fire load can be achieved by the following ways:

- High fire load density areas shall be segregated and separated (e.g., fire explosives and ammunitions storage away from operational areas)
- Material incompatibility study and segregation of incompatible materials by a distance of not less than 20 feet (~06 Mts.)
- Storage of flammable liquids in fire-rated storage containers, cabinets or rooms
- Flammable and combustible liquids must be separated from oxidisers by at least 25 feet (~08 Mts.)
- Materials that are water reactive shall not be stored with other liquids in the same area and shall be segregated and separated.

6.4.4. Air Conditioning, Ventilation and Smoke Control

Air conditioning and ventilating systems shall be so installed and maintained as to minimise the danger of spread of fire, smoke or fumes from one floor to another and from outside to any occupied area of a building or structure.

From a fire safety point of view, separate air handling units (AHUs) for each floor shall be provided to avoid hazards arising from spread of fire and smoke through the air conditioning ducts. The air ducts shall be separate from each AHU to its floor and in no way interconnect with the duct of any other floor. Within a floor it is desirable to have a separate air handling unit provided for each compartment.

Air handling units shall be provided with effective means for preventing circulation of smoke through the system in the case of a fire in air filters or from other sources drawn into the system, and shall have smoke sensitive devices for actuation of smoke dampers or shutdown of recirculating fans.

Shafts for ducts that penetrate multiple floors or operational areas shall be of masonry or fire-rated construction with fire dampers in connecting ductwork or shall have fire rated ductwork with fire dampers at each floor crossing. Alternatively, the ducts and equipment may be installed in rooms having walls, doors and fire dampers in ducts exiting/entering the room to provide 120 mins fire resistance rating. Such shafts and ducts shall provide passive fire control with 120 minutes of fire resistance rating to meet the objective of isolating the floor from spread of fire to upper and lower floors through the shaft/duct work.

Air filters of air handling units shall be made of non-combustible materials. Air handling unit rooms shall not be used for storage of any combustible materials.

Air ducts serving main floor areas, corridors, etc., shall not pass through exits/exit passageways/ or exit stair enclosures. Exits, lift lobbies, etc., shall not be used for return air passage.

As far as possible, metallic ducts shall be used, even for return air, instead of space above a false ceiling. Wherever ducts pass through fire walls or floors, the openings around the ducts shall be sealed with materials having a fire resistance rating equivalent to that of the compartment. Such ducts shall also be provided with fire dampers at all fire rated walls.

6.4.5. Fire or Smoke dampers

Fire dampers shall be evaluated to be located in supply air ducts, fresh air and return air ducts/ passages at the following points:

a) At fire separation walls,
b) Where ducts/passages enter a vertical shaft,
c) Where ducts pass through fire-rated floors, and
d) At supply air duct and the return air duct connection(s) for each compartment on every floor

Fire dampers are typically not motorized but use fusible links to respond to heat from fire. Smoke dampers do need to be electrically operated upon detection of smoke. Combination fire/smoke dampers incorporate both fusible link and electric operators. Dampers shall be so installed to provide complete integrity of the compartment with all passive fire protection sealing. Dampers should be accessible to maintain, test and also replace, if so required. Smoke *dampers shall be integrated with a Fire Alarm Panel and be sequenced to operate as per requirements and have interlocking arranged for fire safety of the building*.

6.4.6. Fire Stopping seals

Fire stopping seals must be 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 gap openings around penetrating items such as cable trays, conduits, ducts, pipes, etc. at fire-rated walls and floors.
Provision of non-combustible "sleeving" is also often used in conjunction with proprietary firestopping material for penetration of pipes. 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). Not all materials

will be suitable in every situation and proper selection is important. Firestop seals should be rated to preserve the construction type and rating of the associated building elements.

6.4.7. Vertical Openings

In a building fire vertical openings like stairs and lift shafts act as flues or chimneys that can convey flames, hot gases and smoke vertically and serve as channels for easy spread to 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.

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. Every vertical opening between the floors of a building shall be suitably enclosed or protected to provide reasonable safety to occupants using the means of egress by preventing spread of fire, smoke, or fumes through vertical openings from floor to floor.

6.4.8. Service Ducts/Shafts

Service ducts and shafts shall be enclosed by walls and doors of 120 minutes fire rating. All such duct / shaft penetrations shall be property sealed so that fire spread is stopped at levels.

A vent opening at the top of a service shaft shall be provided having between one-fourth and one- half of the cross sectional area of the shaft. Natural venting of service shafts helps in smoke removal to make firefighting and rescue operations easier.

Provision of fire resistant doors at every floor level helps prevent fire spread from floor to floor. Inspection panels and doors shall be tight fitting with 120 minutes fire resistance.

6.4.9. Drains

Damage caused by water used in firefighting can at times be more costly than the fire damage, possibly due to the nature of the materials involved. It is therefore important that proper drainage arrangements be provided in all the areas of a building and equally important to use non-combustible drain pipes.

Process area drains that can contain hazardous materials should be independent and collection provisions like a dump tank or recovery tank should be provided for hazardous material spills or leaks to contain fire risk.

6.4.10. Façade Glazing

The entire façade glazing assembly shall be rated for the type of construction. The use of common glass shall not be permitted for enclosures of exits and exit passageway. For fully sprinklered buildings tempered glass within a non-combustible assembly that maintains ability to hold the glass in place shall be used. It shall be ensured that sprinklers are located within 600 mm of the glass facade in order to provide full coverage of the glass.

All gaps between floor-slabs and a facade assembly shall be sealed at all levels using an approved fire-resistant sealant material of equal fire rating to that of the floor slabs to prevent fire and smoke propagation from one floor to another.

6.4.11. Fire Control Room

For buildings 15m in height and above, there shall be a fire control room preferably at the ground floor level with communication system (public address system) to serve all floors and facilities for receiving messages from different floors.

Plans for all floors along with details of firefighting equipment and installations shall be displayed in the fire control room. The fire control room shall also have facilities to detect and display the location of fire on any floor through an indicator board connection to the building fire detection and alarm system(s).

6.4.12. Electrical Installation

In general, it is desirable that wiring and cabling have flame retardant properties. Medium and low voltage wiring that is installed in shafts and within false ceiling spaces shall be run in metal conduit or other type of non-combustible conduits. Any 230 Volt wiring used for lighting or other services that runs above a false ceiling shall have 660 Volt rated insulation.

Electric distribution cables/wiring shall be installed in a separate shaft that has penetrations sealed at every floor using fire stop materials with the same fire resistance as that of the floor. High-, medium-, and low- voltage wiring in a shaft or false ceiling space shall be run in separate shafts/conduits.

Water mains, solvent/chemical lines, gas pipes, telephone lines, intercom lines, or any other service lines shall not be laid in the same duct used for electrical cables. Use of bus ducts/solid rising mains instead of cables is preferred.

All metallic items like steel structural members, etc, shall be bonded properly to the earthing system.

6.4.12.1. Substation/Transformers

The substation area should be adequately ventilated.

An independent ventilated or air-conditioned panel room shall be provided on the ground level or first basement. The panel room (PCC or MCC) shall be provided with fire resistant walls and doors of fire resistance of not less than 120 min.

Electrical main distribution panel and lift panels shall be provided with a carbon dioxide/inert gas flooding system for all panel compartments supplied from a cylinder located beside the panel.

The inert gas system integrity should be maintained as per OEM requirements.

6.4.12.2. Oil filled substation

A substation or a switch-station with oil filled equipment shall be limited to be installed in a utility building or outdoor location. Such substation/utility building shall be at least 7 m away from adjoining building(s).

Substation equipment (exceeding oil capacity of 2000 litres) inside a utility building shall have fire rated baffle walls with 240 min fire resistance rating constructed between such equipment, raised to at least 600 mm above the height of the equipment (including height of oil conservators) and exceeding 300 mm on each side of the equipment.

All transformers where capacity exceeds 10 MVA shall be protected by high velocity water spray system or nitrogen injection systems.

6.4.12.3. Dry type Electrical substation

Transformers located inside a building shall be dry type and all substation/switch room walls, ceiling, floor, and openings (including doors) shall have a fire resistance rating of 120 min. Access to the substation shall be provided from the nearest fire exit/exit staircase for the purpose of electrical isolation.

6.4.13. Emergency power for fire and life safety systems

Emergency power supplying distribution system for critical requirement for functioning of fire and life safety system and equipment shall be planned for efficient and reliable power and control supply to the following systems and equipment where provided:

- Fire pumps.
- Pressurization and smoke venting; including its ancillary systems such as dampers and actuators.
- Exit signage lighting.
- Emergency lighting.
- Fire alarm system.
- Public address (PA) system (relating to emergency voice evacuation and annunciation).
- Magnetic door hold open devices / door access control
- Lighting in fire command centre/fire control room and security room (non- exhaustive list)

Power supply to these systems and equipment shall be from normal and emergency (standby generator & UPS for control circuits) power sources with auto changeover facility.

The power supply to the panel/distribution board of these fire and life safety systems shall be through fire proof enclosures or circuit integrity cables or through an alternative route in the adjoining fire compartment to ensure supply of power is reliable to these systems and equipment. It shall be ensured that cabling from an adjoining fire compartment is protected within the compartment of vulnerability. The location of the panel/ distribution board feeding the fire and life safety systems shall be in a fire safe zone to ensure supply of power to these systems.

Circuits of such emergency power systems shall be protected at their origin by an automatic circuit breaker. Master switches controlling essential service circuits shall be clearly labelled.

Cables for fire alarm and PA systems shall be laid in metal conduits or armoured cables to provide physical segregation from power cables.

6.4.14. Lightning protection of buildings

High rise buildings and hazardous process facilities shall be provided with lightning protection. All outdoor antennae (mobile tower etc.) shall be properly grounded and protected from lightning

Routing of down conductors (insulated or uninsulated) of lightning protection through electrical or other service shafts are not allowed as it can create fire and explosion during lightning.

7. Life Safety

Life safety is the prime most important in fire safety management. Every building shall be so designed, constructed, equipped, maintained and operated as to provide adequate means of egress to avoid undue danger to the life and safety of the occupants from fire, smoke, fumes or panic during the time period necessary for escape.

For high occupancy and hazardous areas, it may be required to have an annunciation, announcements, and voice guided/aided system to direct occupants toward safe egress routes, areas of comparative safety or exits, and to avoid situations of panic during distress.

7.1. General Exit Requirements

- An exit may be a fire exit doorway, an internal fire-separated staircase, exit passageway, external doorway, or exterior staircase that provides safe access to an open outdoor place, or to a refuge area, or the terrace or roof of a building with means to access ground level.
- Every facility/building and structure shall have a means of emergency egress. A minimum of two means of egress, arranged to minimize the possibility of both becoming impassable during the same emergency, is typically required.
- Every exit for emergency use shall be clearly visible or the route to access an exit shall be marked by signs that are readily visible from every direction approaching the exit.
- Every required exit sign shall be illuminated by a reliable light source and shall be visible at all times of occupancy including during both normal and emergency-lighting modes
- Exit doors should be a side-hinged pivot or swinging type; sliding doors are generally not permitted to serve as a means of emergency egress.
- To keep occupants from traveling into dead-end spaces, any doorway that could be misconstrued as an exit should be marked “Not an exit.”
- Step-up or step-down elevation changes immediately before or after an exit shall not be permitted

- Lifts, escalators, moving walks and revolving doors shall not be considered for use as components in any means of egress
- Every exit, exit passageway and exit discharge shall be continuously maintained free of all obstructions or impediments to full use in the case of fire or other emergency.
- Every building having human occupancy shall be provided with exits sufficient to permit safe egress of occupants, in case of fire or other emergency.
- For non-naturally ventilated areas, fire doors with 120 mins. fire resistance rating shall be provided and particularly at entrances to any lift lobby and stairwell where a 'funnel or flue effect' can be created, inducing upward spread of fire and smoke.
- Exits shall be so arranged that they may be reached without passing through another occupied unit/passage in other's control. Passing from a low risk area to a higher risk operation area is prohibited.
- Doors in exits shall open in the direction of exit travel and exit doors shall not open immediately upon a flight of stair. All entries into a stairway shall at a landing.
- Exit door swings shall not reduce the required minimum travel pathway at the landing. Overhead and sliding doors shall not be installed.
- Unless otherwise specified, all exits and exit passageways to the exit discharge shall have a clear ceiling height of at least 2.4 m. , and the height of exit doors shall be at least 2.0 Mts.
- The capacity of the means of egress required from any storey of the building shall not be reduced along the path of egress travel including the exit discharge.
- Lifts, escalators, moving walks, turnstiles, and revolving doors shall not be considered in providing the required capacity of means of egress for individual floor(s) or for the building.
- Suitable means shall be provided so that all access controlled exit doors, turnstiles, boom barriers and other such exits shall automatically operate to open mode during emergencies like fire, smoke, acts of terrorism, etc, so that people can safely and quickly egress into safe areas outside. If required, a master controlling device may be installed at a strategic location to achieve this.
- Walking surfaces in exit access shall be nominally level, slip-resistant

7.2. Occupant Load, Capacities of means of Egress:

7.2.1. Occupant Load and Travel Distance

The minimum required number of exits in a building shall be determined based on *occupant load* and egress width per person as per the National Building Code requirements for the respective type of occupancy, and subject to complying with maximum travel distance requirements. Example: for occupancy classification “Group J” – Hazardous building, the occupant load factor is 10 sq. mts/person and the minimum travel distance for exit must not be more than 22.5 Mts.

The travel distance may be increased by 50% of the specified values by NBC for fully sprinklered building.

7.2.2. Capacities of means of egress

Exit capacity is the number of people that can pass through a stairway, and other exit components (doors, corridors and ramps). The total capacity of all the respective means of egress serving a floor shall be sufficient to allow egress of the entire population of the floor

7.3 Components of exit access and exits (Egress System):

Egress system components include exit access routes, exit doorways, exit stairways, horizontal exit corridors and passageways, ramps, and exit discharge.

7.3.1. Doorways

- 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
- No exit doorway shall be less than 1000 mm in width and 2000 mm in height (except Assembly buildings, where door width shall be not less than 2000mm)
- Exit doorways shall be operable from the side which they serve, without the use of a key.
- Mirrors shall not be placed on exit doors and in exits to avoid confusion regarding the direction of exit.
- Fire rated doors and frame section shall be provided with certificate and labels prominently indicating the manufacturer's identification, door details covering door type, serial/batch number, month and year of manufacture, fire resistance rating, etc. The doors and

assembly shall be certified with all prescribed hardware such as hinges, locks, panic bars, door closer, and door viewers.

- Activation of the building automatic sprinkler or fire detection system, if provided, shall automatically unlock the doors for access controlled doors / electromagnetic doors
- Loss of power to the part of an access control system that locks the doors shall automatically unlock the doors.
- A manual release device shall be provided in the readily accessible vicinity of the egress door with a signage 'PUSH TO EXIT' and when the same is operated, it shall result in direct interruption of power to the lock, independent of the access control system electronics.

7.3.2. Corridors and passage ways of means of egress

- Corridors and passageways shall be of width not less than the calculated aggregate width of exit doorways leading from them in the direction of travel to the exit as per NBC.
- In the case of buildings where there is a central corridor, which is part of exit access, the doors of rooms (except for rooms having assembly occupancy) shall open inwards to permit smooth flow of traffic in the corridor.

7.3.3. Staircases

All multi-story buildings shall have a minimum of two staircases. The actual number of staircases shall comply with the NBC exit travel distance and capacity requirements.

The *internal staircases* may be constructed with an external wall, or otherwise, and shall comply with the following:

a) Internal stairs shall be constructed of non-combustible materials throughout, and shall have fire resistant rating of minimum 120 min.

b) A staircase shall not be arranged round a lift shaft.

c) The minimum width shall be provided for staircases as required for each respective occupancy type. Example: Industrial, Storage and Hazardous occupancies require the staircase width to be a minimum of 1.50 Meters.

d) A handrail shall be provided

- One / one side handrail for staircase having width less than 1500 mm

- Two / both sides handrail for staircase of width 1500 mm and more

e) The minimum headroom in a passage under the landing of a staircase and under the staircase shall be 2.2 m

f) Access to an exit staircase shall be through a fire door with minimum 120 mins. fire resistance rating.

g) No living space, storage, or other fire risk shall be within or open directly into a staircase.

h) The exit (including staircases) shall be continuous from refuge floors or terrace levels, as applicable, to the level of exit discharge.

i) No electrical shafts/air conditioning ducts or gas pipes, etc, shall pass through or open in the staircases.

j) Exits shall not be used as a portion of a supply, return or exhaust air system serving adjoining areas. Any opening(s) shall not be permitted in walls or in doors, separating exits from adjoining areas.

k) Lifts shall not open into a staircase.

l) No combustible material shall be used for decoration/wall panelling in a staircase.

m) A floor indication board/sign, indicating the location/designation number of the staircase, the respective floor number, and the direction to exit discharge shall be placed inside the staircase, on the wall nearest to the fire door.

n) All staircases shall terminate at the level of exit discharge. Access to a basement shall be by a separate staircase

o) Storage below a staircase (bottom landing) is prohibited

External staircases are stairs provided on the external wall/facade, and shall comply with the following:

a. All external stairs shall be directly connected to the ground.

b. Entrances to external stairs shall be separate and remote from internal staircases.

c. Where an external staircase is provided, it shall be ensured that the use of it at the time of fire is not prejudiced by smoke and flame from openings (for example, windows, doors) in the external face of the building.

d. External stairs shall be constructed of non-combustible materials, and any doorway leading to it shall have minimum 120 min fire resistance.

e. No external staircase, shall be inclined at an angle greater than 45° from the horizontal.

f. External stairs shall have straight flight not less than 1500 mm wide.

g. Handrails, shall be provided on both sidesand be at a height not less than 1000 mm and not exceeding 1200 mm.

8. Fire Prevention Philosophy and General Requirements

Fire Protection system covers *Active and Passive fire protection* and both play a key role in protecting buildings, equipment and people. Passive fire protection is about containing the fire while active fire protection is about stopping the fire. While the systems work independently, but both systems need to be functioning properly to suppress and stop a fire.

Passive fire protection breaks the building into "compartments" and prevents the spread of fire through the use fire resistant rated walls and floors. It utilizes fire doors to help further compartmentalize the structure and dampers to prevent the spread of fire and smoke throughout the ducts of the building e.g. fire rated construction, compartmentation etc.

Active fire protection, on the other hand, focuses on some sort of action to stop a fire. Some of these systems are automatic, such as a sprinkler system, and others may be manual, like a fire extinguisher. Fire alarms, smoke detectors, and even firefighters are all considered active fire protection systems. In general, there are 03 main categories of active protection:

I. **Fire Detection system** - primarily covering heat, smoke, or flame detectors, manual call points and control panel, hooters/alarms and public address system

II. **Fire Suppression System** – Primarily covering fire extinguishers, fire sprinklers, fire hydrants, gas flooding systems, etc.

III. **Smoke control - Compartmentation and Ventilation (Pressurisation)** - primarily for preventing spread of fire and smoke and keeping evacuation routes smoke free using fire-resistant fans/ventilation blowers.

8.1. Fire Detection System

Automatic Fire detection and alarm system is primarily a life safety system meant for detecting the fire at the early stages and alarm the occupants. Fire Alarm System is designed to alert people to an emergency so that we can take action to protect ourself.

A fire detection system is also used for automatic activation of fire extinguishing systems such as spray systems, water mist systems and gas suppression systems. The control relay modules in addressable detection systems enable the integration and operation of ancillary services such as electrical systems, fire dampers, access control systems, video surveillance, emergency

lighting systems, emergency communication systems etc. to activate/deactivate in case of emergencies.

The key components of a fire detection and alarm system are:

1. Fire detectors
2. Manual call points
3. Alarms and hooters
4. Public address system
5. Control panel (Conventional and Addressable Systems)

8.1.1. Fire Detectors

The core of a fire alarm system is the detection devices, from sophisticated intelligent smoke detectors to simple manually operated break glass units (manual call points). There is a wide array of different types. The efficiency of a fire detection and alarm system depends on various factors such as selection of suitable type of detector, spacing between detectors, mounting locations, rate of air flow, room temperature, humidity level, presence of dust particles, height and type of ceiling, etc.

Types of Detectors:

a. Spot type detectors: - Photo electric smoke detector - Ionisation type smoke detector - Heat detectors (Fixed temperature & Rate of Rise types) - Multi sensor detectors	b. Projected Beam type detectors - Visible light spectrum - Infra-Red spectrum detectors -
c. Flame type detectors - UV sensing - IR sensing - Combination UV/IR detectors	d. Spark/Ember detectors (IR) e. Air Sampling type smoke detection - light scattering photo sensor - particle detector f. Linear Heat sensing Cable g. Video Imaging Fire Detection

Required spacing between detectors depends on the sensor type and sensitivity, protection objectives, and installed environment. For example as per NFPA code #72, typical indoor spot device spacings are the following:

- On smooth ceiling, spacing of spot-type smoke detectors: 9.1m (30ft) max.
- Spacing for fixed temperature heat detectors: 4.6m (15 ft.)
- Where beams project more than 460mm below a ceiling and are more than 2.4m on centre, each bay formed by the beams shall be treated as a separate area.

8.1.2. Manual Call Points

Manual call point is a device which enables personnel to raise an alarm in the event of a fire incident/emergency by pressing a frangible element to activate the alarm system.
The following are the requirements for manual call points:

- Manual call points shall be located that, no person in the premises has to travel distances of more than 30 Mts. to reach them.
- Manual call points shall be located on escape routes preferably near entry to staircases at every level and fire exits
- Additional manual call points are recommended to be placed near hazardous operations and in fire risk locations/areas. The travel distance of 30 Mts. is not applicable.
- When manual call points are also installed external to a building, the travel distance shall be <45 Mts.
- Call points shall be fixed at a height of 1.4 m above the surrounding floor level

8.1.3. Fire Control panel

The “Brain” of a fire detection system is the Fire Alarm Control Panel. It is the central hub for all detector signals to be wired to and provides a status indication to users/operators.
Control units can also be set up to simulate an alarm for use when conducting scheduled fire and evacuation drills, so that staff/people know what actions to take in the event of a real fire.
The following requirements apply to a fire control panel system:

- Electrical power should be provided from a UPS system in addition to an inbuilt battery backup (double backup)
- The fire control panel should be installed away from fire risk areas and protected from fire exposures.

8.1.4. Alarms and hooters

Alarms and hooters must be audible throughout the building/facility

- Sounders should be electronic hooters/horns
- A minimum sound level of either 65 dBA or 5 dBA above the ambient level shall be produced
- Sound levels exceeding 100 dBA should be avoided
- Visual alarms should be provided for hearing impaired people and high noise operations area

8.1.5 Public Address System

A public address system must be installed for operations areas and high rise occupancies. Speakers should be audible throughout the operations area / building. The electrical power supply must be UPS.

8.2. Fire Suppression System

8.2.1. Fire Extinguishers and Fixed Firefighting Installations

All buildings depending upon the occupancy use and height shall be protected by fire extinguishers, hose reels, wet riser, down-comer, yard hydrants, automatic sprinkler installation, deluge system, high/medium velocity water spray, foam system, water mist systems, gaseous or dry powder system, fire alarm and public address system, etc, in accordance with the provisions of National Building codes and IS standards as applicable

a. The fire extinguishing equipment and their installation shall be in accordance with IS standards (Refer annexure # 3 for the IS codes). The extinguishers shall be mounted at a convenient height to enable its quick access and efficient use by all in the event of a fire incidence. Fire extinguishers should be positioned at prominent fire points, usually sited on an exit route. Extinguishers should be clearly signed

b. The requirements of fire extinguishers/yard hydrant systems/wet riser/down-comer installation and capacity of water storage tanks and fire pumps, etc, shall be as specified in National Building Code (Refer Annexure – 1; Fire Fighting Requirements Table as per NBC). The requirements regarding size of mains/risers shall be as given in Fire Fighting

Requirements Table. The wet riser shall be designed for zonal distribution ensuring that unduly high pressures are not developed in risers and hose- pipes.

c. First-aid firefighting equipment (fire extinguishers & hose reels), shall be provided and installed.

d. Valves in fixed firefighting installations shall include a supervisory switch with signalling to a fire alarm panel, or have chain(s), pad lock(s), label, and tamper-proof security tag(s) with serial number to prevent tampering/unauthorized operation. These valves shall be kept in their intended 'open' position (i.e. safe open lock condition).

e. In addition to wet riser or down-comer, first-aid hose reels shall be installed in buildings (where required as per Annexure – 1; NBC Fire Fighting Requirements Table) on all the floors. 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.

f. Wet risers shall be interconnected at terrace level(s) to form a ring and cut-off shall be provided for each connection to enable repair/ maintenance without affecting rest of the system.

g. Fire hydrant system across the facility should be interconnected to form a ring and isolation provisions shall be provided for each connection to enable repair/ maintenance without affecting rest of the system.

h. Pressure at the hydraulically remote hydrant and at the highest hydrant shall not be less than 3.5 bars (water pressure required for fire fighting at the fire source).

i. Hydrants for firefighting and hose reels shall be located in the lobbies of a firefighting shaft. Those hydrants planned to be provided near fire exit staircase on the floor shall be within 5 Mts. from exit door in exit access.

8.2.2. Static water storage tanks

A satisfactory supply of water for the purpose of firefighting shall always be available in the form of underground/terrace level static storage tank with capacity specified for each building with arrangements for replenishment.

Water for the hydrant services shall be stored in an easily accessible surface/underground lined reservoir or above ground tanks of steel, concrete or masonry. The effective capacity of the reservoir above the top of the pump casing (flooded suction) for various types of occupancies shall be as indicated in Annexure – 1; NBC Fire Fighting Requirements Table

Water for firefighting shall be stored in two or more interconnected compartments of equal size to facilitate cleaning and maintenance of the tanks without interrupting the water availability for firefighting.

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 from the fire water storage tanks to maintain the level therein at the minimum specified capacity.

Alternatively, domestic and fire water can be stored in two interconnected compartments as mentioned above. The suction inlet(s) for the domestic water pumps shall be so located at an elevation that minimum water requirements for firefighting as stated in Annexure – 1; NBC Fire Fighting Requirements Table will be always available for fire pumps.

The static storage water supply required for the above mentioned purpose shall entirely be accessible to the fire engines of the local fire service.. The underground fire water storage tank(s) shall not be more than 7 Mts. in depth from the level having fire brigade draw-out connection, while the draw-out connection shall not be more than 5 Mts away from the tank wall.

The static water storage tank shall be provided with a fire brigade collecting head with 4 number 63 mm diameter (2 number 63 mm diameter for pump with capacity 1400 litre/min) instantaneous male inlets arranged in a valve box at a suitable point at street level. The same shall be connected to the static tank by a suitable fixed galvanized iron pipe not less than 150 mm in diameter to discharge water into the tank when required at the rate of 2250 litre/min, if tank is in the basement or not approachable for the fire engines.

Each of the static water storage tanks shall also be provided with a fire brigade draw out collecting head with 63 mm diameter instantaneous male draw out arranged in a valve box at a suitable point at street level. This draw out shall be connected to galvanized iron pipe of 100 mm diameter with foot valve arrangement in the tank.

8.2.3. Firefighting pump house

The requirements for pump house shall be as given below:

a) It is preferable to install the pump house at ground level. Pump house shall be situated so as to be directly accessible from the surrounding ground level.

b) Pump house shall be installed not lower than the second basement. When installed in the basement, staircase with direct accessibility (or through enclosed passageway with 120 min fire rating) from the ground, shall be provided. Access to the pump room shall not require to negotiate through other occupancies within the basement.

c) Pump house shall be separated by fire walls all around and doors shall be protected by fire doors (120 min rating).

d) Pump house shall be well ventilated and due care shall be taken to avoid water stagnation.

e) No other utility equipment shall be installed inside fire pump room.

f) Installation of negative suction arrangement and submersible pumps shall not be allowed.

g) Pump house shall be sufficiently large to accommodate all pumps, and their accessories like PRVs, installation control valve, valves, diesel tank and electrical panel.

j) Battery of diesel engine operated fire pump shall have separate charger from emergency power supply circuit.

k) Exhaust pipe of diesel engine shall be insulated as per best engineering practice and taken to a safe location at ground level, considering the back pressure.

m) Fire pumps shall be provided with soft starter or variable frequency drive starter.

8.2.4. Firefighting pumps

The fighting pump system basically must have 03 pumps

- Jockey pump: A jockey pump is a small pump connected to a fire hydrant / sprinkler system to maintain pressure in the fire lines. Any pressure drop will be sensed by the jockey fire pumps automatic controller, which will cause the fire pump to start.

- Electrical Operated main pump: These pumps must be installed (one or more) and be capable of delivering required head pressure (8.0 Kg/Cm2) to be maintained at the base of the most remote location during water take-off.

- Diesel Engine Operated fire pump (DG – fire pump): These pumps act as backup for electrical operated main pump(s) and also use to ensure the required line pressure along with electrical operated main pump during emergencies.

8.2.5. Automatic Sprinkler Installation

The key requirements for automatic fire water sprinklers shall be as given below:

a) Automatic sprinklers shall be installed wherever required as per Annexure – 1; NBC Fire Fighting Requirements Table.

b) Automatic sprinklers shall be installed in false ceiling voids exceeding 800 mm in height.

c) In areas having height 17 Mts. or above such as in atria, sprinkler installations may be rendered ineffective and hence may be avoided.

d) Pressure in sprinkler system shall not exceed 12 bars or else high pressure sprinklers shall be installed for above 12 bars operation.

e) The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser from an installation control valve shall be based on system protection area limitations considering maximum floor area on any one floor to be 4500 m2 for all occupancies except industrial and hazardous occupancies, where Authorities shall be consulted for advice based on type and nature of the risk.

f) Sprinkler flow switches shall be provided and be monitored by a fire alarm panel.

For hazardous material storage / warehouse, where the materials are stored in pallet racks, the provision of in-rack sprinklers as well as roof level sprinklers is recommended. Sprinklers in the rack activate more quickly than those at roof level, and water is discharged in a more localised area of the fire. Fire can be generally be contained with a lower amount of water damage than expected from water Discharged from roof level sprinklers.

8.2.6. Automatic High Velocity and Medium Velocity Water Spray Systems (Deluge system)

High velocity water spray systems are installed to extinguish fires and for cooling purpose involving liquids with flash points 65C (150F) or higher. The system comprises of network of underground and above ground piping, control valve (Deluge Valve), sprinkler bulb detectors, water spray nozzles/Projectors.

Medium Velocity Water Spray System) is a water-based fire protection system. MVWS systems are used to provide cooling and/or control the burning in many large scale industrial applications, such as in thermal power plants.

Automatic high velocity water spray or emulsifying system shall be provided for protection of outdoor and/ or indoor oil-cooled transformers. Also, medium velocity water spray system should be provided for flammable storage tankers (where applicable), conveyors, cable galleries / trenches and other occupancies.

8.2.7. Fixed Foam Installation

Fixed foam generating system shall be provided for protection of flammable storage tanks, oil storage area for boilers with its ancillary storage of furnace oils in basement. Fixed foam installations can be low, medium or high expansion types, provided based on the type of fire hazards identified in the facility. High expansion foams are used for cable tunnels and other confined, large volume spaces.

Foam concentrate properties (including pH)should be monitored and checked as per SDS and recommendations supplied by the manufacturer. Third party testing by an authorised lab should be conducted to ensure the foam agent quality at every one year interval or as per OEM.

8.2.8. Gaseous and Powder Suppression Systems

Gaseous agent fire extinguishing installation (gas flooding) shall be provided where water or foam cannot be used for fire extinguishing because of the special nature of the contents of the buildings /areas to be protected where either the building(s) have very limited manpower or unmanned.

Inert gas systems i.e. Inert gas total flooding systems (CO2, Argon, Nitrogen, mixtures of these gases) can in principle be used for fire suppression in fire damage sensitive areas like cold rooms, server rooms, records rooms, electrical control rooms, battery rooms, electrical distribution at room level or localised equipment level.

Powder based fire extinguishing systems cand and are used for protection of [high-value] vehicles like mining “Jumbo” and other risk based operations.

Gaseous system activation can lead to asphyxiation hazards and hence should include provisions for low oxygen level monitoring, detection, alarm, and manually operable area exhaust ventilation.

9. Fire Spread and Smoke control – Compartmentation and Pressurization

In building design, compartmentation plays a vital part in limiting the spread of fire and smoke. The design should ensure avoidance of spread of smoke to adjacent spaces through the various leakage openings in the compartment enclosure, such as cracks, openings around pipes ducts, airflow grills and doors. In the absence of proper sealing of all these openings, smoke and toxic gases will obstruct the free movement of occupants of the building through the exits.

Pressurization is a method adopted for protecting exits from ingress of smoke, especially in high-rise buildings. In pressurization, air is injected into the staircases, lobbies, etc., as applicable, to raise pressure slightly above the pressure in adjacent parts of the building. As a result, ingress

of smoke or toxic gases into the exits will be prevented. Pressurization of staircases is of great importance for the exclusion of smoke and toxic gases from the protected exit.

The following requirements must be ensured for pressurization:

a) For pressurized stair enclosure systems, the activation of the systems shall be initiated by signalling from a fire alarm panel.

b) Pressurization system shall be integrated and supervised with the automatic/manual fire alarm system for actuation.

c) Wherever a pressurized staircase is to be connected to an unpressurized area, the two areas shall be segregated by 120 min fire resistant walls.

d) Fresh air intake for pressurization shall be away (at least 4 m) from any exhaust outlets/grille.

All exit passageways (from exit to exit discharge) shall be designed with mechanical pressurization system or be naturally ventilated. The mechanical pressurization system shall be automatic in action with manual controls in addition. Doors provided in such exit passageway shall be fire rated doors of 120 mins rating. The pressurization system where provided shall develop a minimum positive pressure differential of 25-30 Pa in relationship to other areas.

A smoke exhaust system, where required for an area or occupancy, shall provide a minimum of 12 air changes per hour for smoke exhaust .

Smoke exhaust fans in the mechanical ventilation system shall be fire rated for 250°C exposure and operation for at least 120 minutes. The mechanical smoke extraction system is required for high rise buildings (>15 Mts. height)

10. Fire Safety controls for Electrical Cable Trenches / Tunnels

The following fire control measure must be considered for Electrical Cable trenches / tunnels:

- Conductors or cables inside the trenches shall be so mounted on insulated racks or other supports as to be at least 75 mm above trench bottoms (as per IS1646 for Electrical installation)
- In case of long trenches, it is recommended that trenches of more than 1000 cm2 cross-sectional area be divided by incombustible barrier walls at intervals not exceeding 45 m. Such barrier walls shall be of at least 50 mm thickness and of the same height as of the cable trench. The cables shall be carried through holes in these barrier walls, which shall be made good thereafter to prevent passage of fire beyond the barriers (as per IS1646 for Electrical installation)

- Compartmentation of Cable Tunnels/ Galleries must be done and the requirements for compartmentation of cable tunnels/galleries should be as per IS 12459
- The cable trench construction must be Type 1 as per NBC
- The following fire protection for cable tunnels / trenches should be considered based on the risk assessment determinations: o Fire detection – linear heat detectors o High expansion foam system o Medium velocity water spray (Deluge) / water mist system

11. Mechanical Integrity of Fire Protection systems

Mechanical integrity of the fire system, both passive and active should be ensured by adopting RAGAGEP. Inspection, testing, and maintenance are especially critical for fire protection equipment and systems because equipment and systems are not actuated frequently and yet, when needed, are expected to perform flawlessly.

HZL shall have a formal tracking mechanism for fire protection equipment and systems to follow inspection, testing, and maintenance requirements. This may be a separate system that tracks only fire protection systems and equipment, or it may be included as part of the HZL overall program for preventive maintenance, inspection, and testing. The mechanical Integrity must be a SAP based program and shall adopt a zero tolerance approach.

12. Fire Protection System Mapping

Each HZL location shall maintain a fire protection system map/plan that depicts the fire protection system in its current design state. This map should be drawn to scale and accurately indicate fire protection equipment locations like hydrants, sprinklers, pump rooms, access roadways, and other fixed fire protection equipment.

Each fire equipment must be coded /numbered and designations shall be noted on the map and those designations shall also be prominently displayed on the equipment in the field by sign boards. All fire equipment should be tagged and monitored using SAP based program.

13. Training

The objective of training is to help ensure that all sites have an adequate number of people trained in aspects of fire safety, including life safety, fire principles, fire prevention, fire protection equipment and systems, and statutory requirements.

In order to help ensure proper fire awareness, each site must develop and conduct training programs aimed at fire hazards recognition, fire prevention measures, fire protection, life safety, fire protection equipment / facilities and uses.

The training programs must be prepared by knowledgeable persons, and training must be conducted for all personnel on an annual basis to help ensure personnel remain competent in the fire prevention and protection techniques/measures that they are expected to adopt on day to day activities.

The recommended minimum frequency for training employees and business partners is annual. However, depending on turnover of personnel, it may be appropriate to increase this frequency. The training must include class room and as well as functional training.

Training for Engineering, Maintenance, and Fire and Safety teams must be delivered on an annual basis and must cover statutory requirements like NBC, fire system adequacy assessment, functional training and integrity of installed systems.

14. Management Systems

- **Audit requirements/ Performance Metrics**
  This standard shall be audited as part of the safety audit protocol every year. Corporate and zone safety leaders shall develop the system audit plan and track metrics.
- **Standard Renewal**
  This standard shall be reviewed and revised as necessary and, at intervals not greater than two years from the date of last review. The standard should renewed as and when changes takes place to National Building codes and regulations.
- **Deviation**
  Deviations from provisions of this Standard must be authorized by HZL corporate Central Safety Committee, in consultation with the corporate safety leader. Deviations must be documented, and documentation must include relevant facts that support the deviation decision and the period for which the deviation is allowed or requires subsequent review for continued authorization approval.

15. References

- National Building code – 2016
- Factories Act
- CEA (Central Electricity Authority)
- PESO (Petroleum and Explosive Safety organization)
- OISD (Oil Industry Safety Directorate)
- NFPA 101® – Life Safety Code®
- IS codes:

o IS 1641: Fire safety of buildings (general) : General principles of fire grading and classification
o IS 1642 : Fire safety of buildings (general), Details of construction
o IS 1643 : Fire safety of buildings (general), Exposure hazard
o IS 1644 : Fire safety of buildings (general) : Exit requirements and personal hazard
o IS 1645 : Fire safety of buildings
o IS 1646 : Fire safety of buildings (general) : Electrical installations
o IS 1647 : 1960 Code of practice for fire safety of buildings
o IS 12459 Fire Safety in Cable Run;

16. Annexures:

• Annexure – 1: Fire Fighting Requirement Table for Building occupancy types
• Annexure – 2: Fire Safety Management Audit Protocol
• Annexure – 3: List of IS standards for fire safety
• Annexure – 4: Schedule For Hydrostatic Testing Of Fire Extinguishers
• Annexure – 5: Life Of Fire Extinguishers
• Annexure – 6: List of fire Equipment's Banned/Obsolete

Note :- Annexture 1,2 & 3 Separately attached.

Annexure – 4

Schedule For Hydrostatic Testing Of Fire Extinguishers

(As Per IS 2190)

S.N.	Type Of Fire Extinguisher	Test Interval (Year)	Minimum Test Pressure (Kg/Cm2)	Time for Which Pressure is Maintained (Sec.)
1	Water Type	3	35	150
2	Foam Type	3	35	150
3	Dry Powder Type	5	35	150
4	Carbon Dioxide Type	5	225	30
5	Clean Agent	5	35	150

Every extinguisher installed in premises shall be hydrostatically pressure tested as per the schedule given. There shall not be any leakage or visible distortion. Extinguishers which fail in this requirement shall be replaced.
The carbon dioxide type and clean agent type fire extinguishers shall be pressure tested every time when the cylinders are sent for recharging (after periodic discharge test or otherwise) to the pressure specified in the relevant Indian Standard specifications.

Annexure – 5

Life Of Fire Extinguishers

(As Per IS 2190)

S.N.	Type Of Fire Extinguishers	Lifetime
1	Water Type	10 Years
2	Foam Type	10 Years
3	Dry Powder Type	10 Years
4	Carbon Dioxide Type	15 Years
5	Clean Agent	10 Years

Note:-

1. Life of fire extinguishers will be considered from date of manufacture.
2. In case of failure in hydrostatic pressure testing, the extinguisher shall be discarded immediately and replaced by similar type and fire rating.

Annexure – 6

List of fire Equipment's Banned/Obsolete

1. CTC (Carbon Tetrachloride) Type Fire Extinguishers (As Per IS 2179)
2. Halon Type Fire Extinguishers (As Per IS 2179)

OBSOLETE FIRE EXTINGUISHERS:

The following types of fire extinguishers are considered obsolete and shall be removed from service:

(1) Soda acid (2) Chemical foam (excluding film-forming agents) (3) Vaporizing liquid (e.g., carbon tetrachloride) (4) Cartridge-operated water (5) Cartridge-operated loaded stream (6) Copper or brass shell (excluding pump tanks) joined by soft solder or rivets (7) Carbon dioxide extinguishers with metal horns (8) Solid charge–type AFFF extinguishers (paper cartridge) (9) Pressurized water fire extinguishers manufactured prior to 1971 (10) Any extinguisher that needs to be inverted to operate (11) Any stored pressure extinguisher manufactured prior to 1955 (12) Any extinguishers with 4B, 6B, 8B, 12B, and 16B fire ratings (13) Stored-pressure water extinguishers with fiberglass shells (pre-1976) (14) No plunger Type Fire Extinguisher Usage Inside HZL Premises (Fatality Recommendation)