Handbook Series on Fire Safety

Educational Buildings

A basic guide for Fire Prevention, Life Safety & Fire Protection requirements for Educational Buildings

GUJARAT INSTITUTE OF DISASTER MANAGEMENT
BUILDING RESILIENCE

Handbook Series on Fire Safety

Educational Buildings

A basic guide for Fire Prevention, Life Safety & Fire Protection requirements for Educational Buildings

GUJARAT INSTITUTE OF DISASTER MANAGEMENT
BUILDING RESILIENCE

GUJARAT INSTITUTE OF DISASTER MANAGEMENT
BUILDING RESILIENCE

Handbook Series on Fire Safety

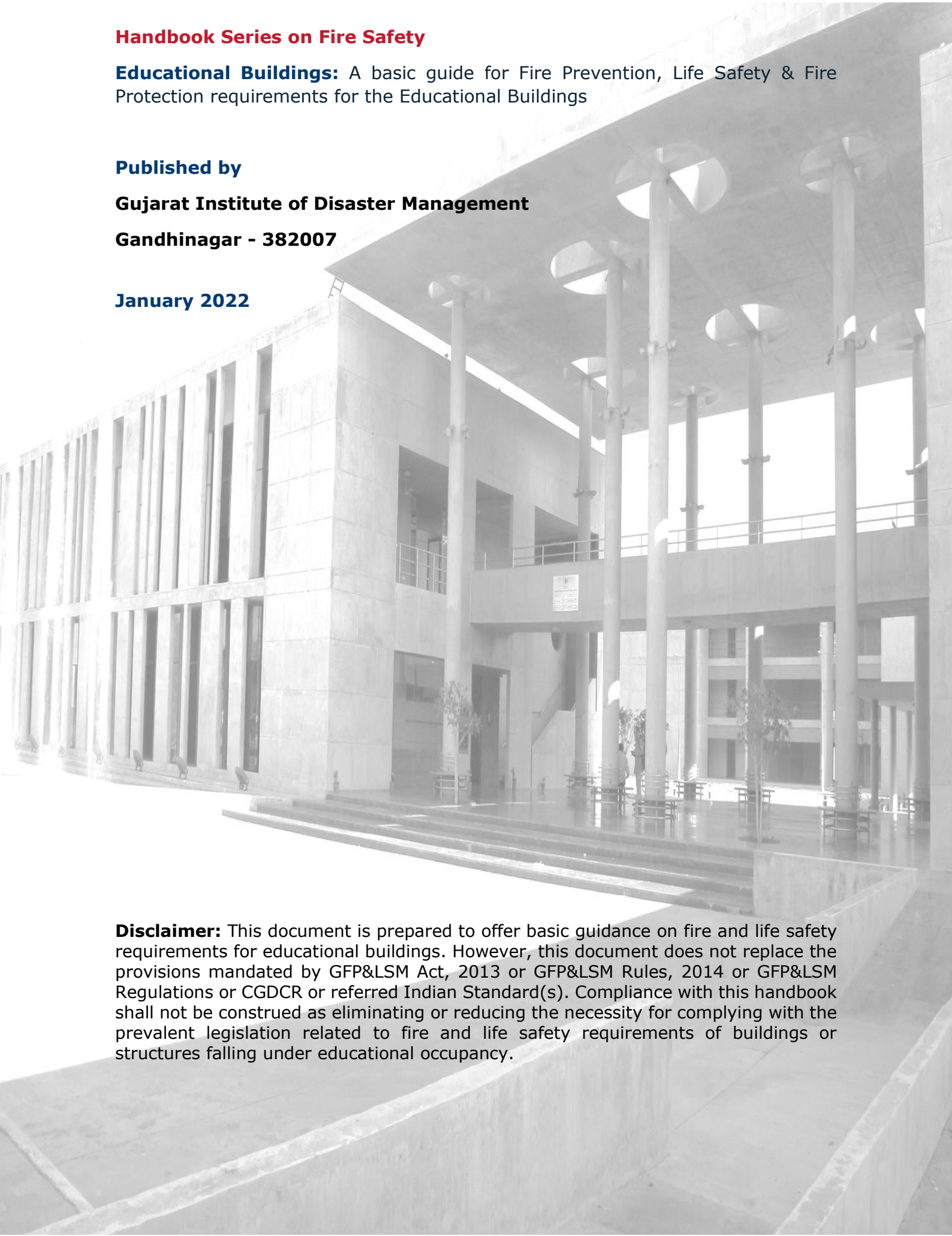
Educational Buildings: A basic guide for Fire Prevention, Life Safety & Fire Protection requirements for the Educational Buildings

Published by

Gujarat Institute of Disaster Management

Gandhinagar - 382007

January 2022



Disclaimer: This document is prepared to offer basic guidance on fire and life safety requirements for educational buildings. However, this document does not replace the provisions mandated by GFP&LSM Act, 2013 or GFP&LSM Rules, 2014 or GFP&LSM Regulations or CGDCR or referred Indian Standard(s). Compliance with this handbook shall not be construed as eliminating or reducing the necessity for complying with the prevalent legislation related to fire and life safety requirements of buildings or structures falling under educational occupancy.

Message

Educational establishments are the most important institutions influencing the development of a country and are primarily entrusted with the responsibility of creating the citizens of tomorrow. No task is as important as creating a safe learning environment for our nation's children. Considering the past fire incidents, it becomes the priority of management of educational establishments to take necessary steps towards making the building/ premise a safer place by generating awareness and taking necessary measures to effectively prevent and/or respond to any fire situations.

The objective of preparing the document is to enhance the knowledge of all the stakeholders directly related to educational activities and engineers / architects on the basic fire safety measures to be implemented in educational buildings/ premises. The document is divided in two parts i.e. Part A and Part B. Part A of the document focuses on basic understanding on fire safety concepts. Part B of the document consist of Fire Prevention, Life Safety and Fire Protection measures that engineers / architects need to understand for implementation in educational buildings/ premises.

I am happy to acknowledge the support and cooperation extended by Mr. Snehanshu Choudhari for his contribution in drafting and Mr. Abhay Purandare, for patiently reading the various drafts, and offering constructive criticism, guidance and suggestions.

Finally, the efforts made by GIDM team especially, Mr. Nisarg Dave, Mr. Piyush Ramteke, Mr. Himalay Kotadiya and Ms. Shilpa Boricha for coming up with this handbook are highly appreciated. I hope this handbook will benefit the stakeholders immensely. Further, I am sure concerted efforts in this direction would help in building and creating a culture of fire prevention, life safety and fire protection which in turn would lead to a resilient society and nation.

(P K Taneja)
Director General, GIDM

January, 2022
Gandhinagar

Part - A

How Fire Starts?

The three things, a fire needs to start are heat, fuel and oxygen. These three elements work together to start a fire. Fuel is the first element in the fire triangle. The fire will need a fuel source in order to continue to burn. The fuels readily available in school premises are piece of paper, wood, cardboard, laboratory chemicals, cooking oils etc. Heat is the second essential element that a fire needs. A fire can't even start or spread unless there's a significant amount of heat involved. That's why in majority of fires water is applied to cool the fire source. Commonly available heat sources in the schools are matches, gas stoves, candles etc. Finally, the third thing that is needed is oxygen. Oxygen is in the air all around us. So all the three things when they come together they cause fire.

Figure 1: Fire Triangle

If we need all of these things for a fire to burn, how do you put a fire out? You only need to take away one of these three things, and the fire will go out.

What are the types of fire?

According to IS 15683:2018, there are five classes of fires, namely:

- **Class A fire**: Fires involving solid combustible materials of organic nature such as wood, paper, rubber, plastics, etc.
- **Class B fire:** Fires involving flammable liquids e.g. kerosene, petrol, laboratory chemicals etc.
- **Class C fire:** Fires involving flammable gases under pressure including liquefied gases e.g. LPG etc.

- **Class D fire:** Fires involving combustible metals, such as magnesium, aluminium, zinc, sodium, potassium, etc,
- **Class F fire:** Fires involving cooking oils and fats. The characteristic of these fires is that the boiling point of these liquids is quite high (> 200 C) and as the heated oil reaches these temperatures, water cannot be applied as it will convert to steam and cause the burning oil to splash out and increase the fire.

Different types of fire extinguishers are designed to fight above classes of fire. The four most common types of fire extinguishers are: dry chemical type, foam type, water type, CO_2 (carbon dioxide) type. The following figure provides information regarding the type of fire and which fire extinguisher to be used. Fire Extinguishers should be installed in line with IS 15683 requirements.

Type (Fire Type / Extinguisher Type)	Class A Organic Materials (e.g Paper & Coal)	Class B Flammable Liquids (e.g Petrol & Paint)	Class C Flammable Gases (e.g Butane & Methane)	Class D Combustible Metals (e.g Lithium & Magnesium)	Electrical Electrical Equipment (e.g Computers & Servers)	Class F Cooking Oils (e.g Olive Oil & Fat)
Water	✓	✗	✗	✗	✗	✗
Foam	✓	✓	✗	✗	✗	✗
Dry Powder	✓	✓	✓	✓	✓	✗
CO2	✗	✓	✗	✗	✓	✗
Wet Chemical	✓	✗	✗	✗	✗	✓

Figure 2: Types of Fire and Suitable Fire Extinguishers

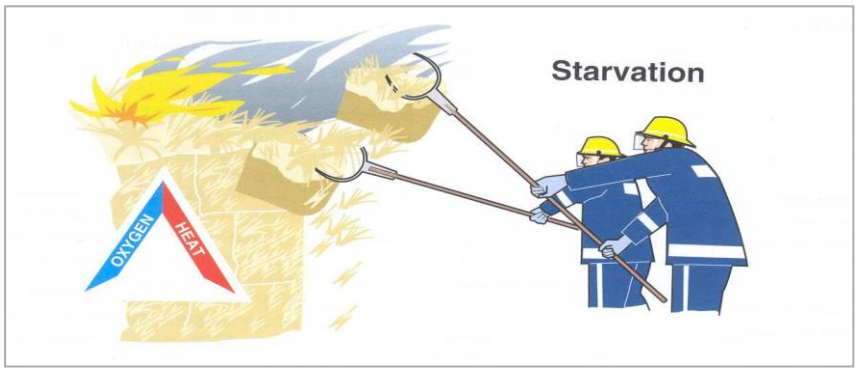
The principles of fire extinguishment consist of one of the following three elements:

1. Starvation: Starvation is achieved in three ways:

i. By removing potential fuel from neighborhood of fire. e.g. Draining out fuel from burning tank, counter burning in forest fire, etc.

ii. By removing the fire from the mass of combustible material for instance, pulling apart burning haystack.

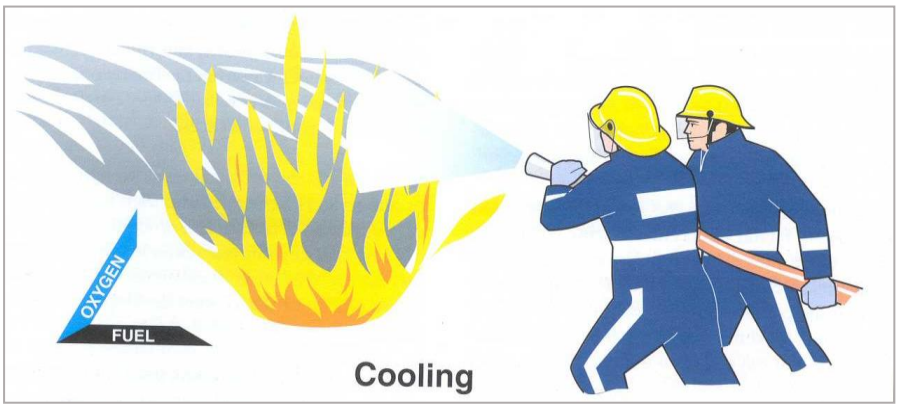
iii. By dividing burning material into smaller fires which may be left to burn out or which can be extinguished more easily.



2. Smothering: In this method, oxygen is excluded in the surrounding atmosphere, thereby leading to fire extinguishment. Smothering can be achieved by using sand, blanketing, or by the use of dry chemical extinguishers.

3. Cooling: The most commonly used firefighting medium is water. Water, cools the burning material thereby achieving fire extinguishment. When it is applied to a fire, the extinguishing medium, water itself undergoes changes as it absorbs heat from the fire: (i) Its temperature will rise, (ii) It may evaporate (boil)

Further, smothering effect of the steam produced during boiling process plays important part in fire extinguishment.



Why do Fires occur in Educational Buildings?

Educational buildings (schools) have multiple or single building with a large number of children/ students of different age groups. The most common cases of fires are as under;

- The classrooms have combustible materials like furniture and the laboratories have chemicals that can easily catch fire.
- Many schools have an in-house kitchen. These kitchens have LPG cylinders that could be stored dangerously.
- Faulty electrical wiring or frayed wires could cause electrical short circuits in schools. Typically, in modern constructions, these wires are concealed and many times it becomes difficult to track the right source of the fire.
- Children playing with matchsticks or candles. Or by careless disposal of cigarettes by staff.

How to safeguard educational buildings from fires and human loss?

- Fire drills should be conducted periodically in educational buildings. Fire drills help the building occupants to understand their roles and responsibilities during a fire scenario.

- Fire exit forms a primary route of egress during a fire scenario. Fire exits should be inspected on regular basis. It should be ensured that stairways, doors are not locked or blocked by material and in proper working condition.
- Regular training for students / staff members should be conducted on fire drills. Students / staff members should be trained on how to respond to a fire alarm during a fire drill.
- The firefighting equipment should be readily available during a fire emergency. The location of the firefighting equipment should be identified and the building occupants should be aware of the location of the fire protection equipments, manual call points, smoke detectors.

- An assembly point should be designated outside the educational building. All the occupants in the building should be aware of the location of assembly point and the path to reach the assembly point.
- Firefighting system, fire alarm system are the means of extinguishing the fire and alerting the occupants. Same should be regularly inspected, maintained and tested.
- Cooking activity should be performed in kitchen only. No other place should be designated as cooking area.
- Laboratory in schools/ colleges handle flammable materials and pressure vessels. It should be ensured that laboratory experiments or pressure vessels should not be left unattended, else there is chances of fire taking place.

- Educational buildings / hostels in premises should always have a proper functioning fire alarm system. The fire alarm system should be designed in line with the requirements mentioned in the legislation / standards.
- Regular third party audit should be conducted for the educational campus. This helps to understand

the areas of improvement in the current systems / practices adopted by school/ college.

- While designing the fire prevention, fire protection and life safety system it should be ensured that same meets the relevant legislative requirements.
- Ensure Fire Safety Certificate (FSC) is obtained for the building from the local fire authorities, if required.

Take fire seriously, move quickly.

Know your evacuation plan.

Focus on Fire Prevention.

Fire can kill, don't be static.

Part - B

Background:

Part B of the document provides the basic information to the developer/ architects / engineers/ designers on what measures to be adopted during construction of the educational building. The educational building presents unique fire safety challenges especially for children, which needs to be focused at the very onset of construction / design of the school buildings. This part is divided into three sub-parts i.e. Fire Prevention, Life Safety and Fire Protection measures which need to be taken/installed in the school premises. Further reading on requirements of NBC 2016, Gujarat Fire Prevention and Life Safety Measures Act, Rules & Regulations, General Development Control Regulations (GDCR) & different IS standards is necessary, since this handbook provides only an overview of the fire safety requirements.

Educational occupancy Classification:

Educational occupancies are classified as Group B in National Building Code 2016. These buildings are used for instruction, education or recreation for not less than 20 students. E.g. Schools, colleges and other training institutions.

Subdivision [1]:

B1: Subdivision B-1 Schools up to senior secondary level - This subdivision includes any building or a group of buildings under single management which is used for students not less than 20 in number.

B2: All others/training institutions - This subdivision includes any building or a group of buildings under single management which is used for students not less than 100 in number.

If residential accommodation is provided in the schools that portion of the occupancy should be classified as A-3[2](Dormitories) as per NBC 2016 part IV.

In case of mixed occupancy[3], i.e. training institution in a mercantile occupancy etc. fire protection of the entire occupancy / building should be governed by most

[1] Subdivision of the educational occupancy is based on the number of occupants. This subdivision is based on the NBC 2016 (Part IV) requirements.

[2] A-3 classification is used for hostels, dormitories etc. where students / staff have sleeping accommodation, with or without dining facility, in one room or series of closely associated room under joint occupant and single management.

[3] Buildings having more than one type of occupancy like – Educational, business etc.

restrictive provision of the entire code. The provision of the life safety should however apply to individual occupancy.

Chapter 1: Fire Prevention Measures

The educational buildings should be designed and constructed in such a way that, in the event of fire, its stability, integrity and load bearing capacity will be maintained for a reasonable period. The design of the educational building and the types of material used in its construction are important factors in making the building resistant to a complete burn-out and in preventing the rapid spread of fire, smoke or fumes which may contribute to the loss of lives and property. For further details on fire prevention systems / measures Section 3, section 6.2 & Annex. E of NBC 2016 (Part IV), IS 14435 should be referred.

Non-combustible material should be used for construction of the educational building, and internal walls of staircase enclosure should be of brick work or reinforced concrete or any material having a fire resistant rating of 120 minute. Load bearing members and non-load bearing members must be constructed to a fire resistant rating as detailed in table 1 of NBC 2016 (Part IV), Section 3 of NBC 2016 (Part IV) and Gujarat Fire Prevention and Life Safety Measures Regulations.

Fire Resistant Walls and Floors:

The fire resistance of an element of construction (such as wall / floor etc.) is a measure of its ability to withstand the effects of fire in one or more ways i.e. its ability to resist collapse, resistance penetration from fire / smoke, resist heat transfer during a fire. Fire resistance of a constructional element is defined in minutes or hours e.g. 120 minute or 1 hour. The fire resistance property of an element of construction influences the life safety and property protection requirements.

In educational buildings, the openings in the fire resistant walls and floors should be sealed to prevent spread of fire / smoke from one area to another. For Type 1 to 3 constructions, a doorway or opening in a fire resistant wall on any floor should be limited to 5.6 m^2 in area with a maximum height/width of 2.75 meter. Every wall opening should be protected with fire-resisting doors, having the fire rating of not less than 120 minute. The openings in the floors must be protected by

vertical enclosures extending above and below such openings, such enclosures having a fire resistance of not less than 120 minute and all openings therein being protected with a fire-resisting assembly.

For Type 4 construction, openings in the fire separating walls or floors must be fitted with 120 minute fire-resistance rated assemblies.

In educational buildings, openings in walls or floors which are provided for passage of cables, electrical wirings etc. must be protected by enclosure in the form of ducts / shafts with fire resistance rating of 120 minute The space between the electrical cables / conduits and walls / slabs must be filled with a fire stop material with fire resistant rating of 120 minute

Figure 3: Example of Fire Stop Material

All vertical openings in the educational buildings should be suitably enclosed / protected. This should be required to prevent spread of smoke from floor to floor to allow the occupants to evacuate safely.

Electrical Installation:

In educational buildings, critical electrical cables should continue to function during a fire. The potential for damage to cables forming circuits should be limited by the use of sufficiently robust cables, careful selection of cable routes and/or by the provision of physical protection in areas where cables may be susceptible to damage. Methods of cable support should generally be non-combustible and such that circuit integrity will not be reduced below that afforded by the cable.

The cables and wires used in schools should be with flame retardant property. Electrical cables / wiring should be laid in separate shaft. Electrical cables must

not run in shafts containing water mains, gas pipes, telephone lines, intercom lines or similar building service. The shaft should be sealed on every floor with fire stop material with same fire resistant rating as that of a floor.

Medium and low voltage wiring running in shafts, and within false ceiling must run in metal conduit. Any 230 V wiring for lighting or other services, above false ceiling, should have 660 V grade insulation.

Electric meters should not be located below the staircase or along the exit route. Electric meters room should be adequately ventilated & easily accessible.

The electrical installation provided in the educational buildings should be compliant to the Regulation No. 5A and 30 of the Central Electricity Authority (Measures relating to Safety and Electric Supply) Amendment Regulations, 2015.

Emergency power (i.e. power supply when main electrical power is not working) should be provided to the following equipment / systems:

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

Power supply to the above systems must be through the normal power and emergency power with changeover facility. The power supply to the panel / distribution board of the above systems must be through fire proof enclosures or circuit integrity cables or through alternate route in the adjoining fire compartment to ensure supply of power is reliable to the above systems and equipment's.

Substation in educational buildings should not be used for storage of material or material for other utility purposes other than those required for the functioning of the substation. Adequate ventilation must be ensured in substation. Independent

AC / ventilation must be provided for MV (Medium voltage) panel room located on the ground level or first basement. The MV panel room must be provided with fire resistance of not less than 120 minute

In educational buildings, the substation / switch station with oil filled equipment should be located at least 7 m away from the adjoining buildings. All oil filled transformers exceeding 10 MVA capacity must be protected with high velocity water spray system or nitrogen injection system. Transformer located inside the educational buildings should be dry type.

Diesel generator (DG) set must not be installed on ground floor / first basement of the educational buildings. The DG set if installed indoor, proper ventilation and exhaust should be planned. The DG set rooms should have 120 minute fire resistance rating. For detailed information regarding fire safety requirements for hazardous petroleum products, reference may be made to The Petroleum Act, 1934 and the Rules framed there under.

Lightning protection of the educational buildings should be ensured by routing of down conductors (insulated or uninsulated) through electrical shafts. For further details, see Part 8 "Building Services, Section 2 Electrical and Allied Installation" of the NBC 2016 and Central Electricity Authority (Measures relating to Safety and Electric Supply) Amendment Regulations, 2015.

Escape Lighting and Exit Signage:

In the educational buildings, exit access, exits and exit discharge should be properly identified and continuously illuminated. Emergency lighting should be provided from an independent source i.e. from different source supplying normal lighting. The horizontal luminance at the floor level on the escape route must be not less than 10 lumens / m^2. Required illumination should be arranged such that failure of any single luminaire will not leave any area in darkness. The emergency lighting should be provided to be put on within 5 sec of the failure of the normal lighting supply. Also, emergency lighting should be able to maintain the required illumination level for a period of not less than 90 minutes in the event of failure of the normal lighting even for smaller premises. The emergency lighting system should be well maintained and periodically inspected and tested to ensure perfect serviceability.

In educational buildings, exit access corridors / paths must be provided with exit signage. The exit signs should be located such that no point in exit access is more than 30 m of viewing distance. The exit sign indicating the direction should be installed in all changes of direction. Exit signs should be illuminated and wired to an independent electrical circuit on an alternative source of supply. All exit way marking signs should be so installed that no mechanical damage should occur to them due to moving of furniture or other heavy equipment. Further, all landings of floor should have floor indicating boards prominently indicating the number of the floor. The sizes and colours of the exit signs should be in accordance with IS 9457, IS 12349, IS 12407. The colour of the exit signs should be green.

Figure 4: Exit Signage

Air Conditioning, Ventilation and Smoke Control:

In educational buildings, the system of mechanical ventilation should be designed to ensure that, in a fire, the ductwork does not assist in transferring fire, smoke and fumes through the building and put at risk the protected means of escape and accommodation areas. Any exhaust points should be sited so as not to further jeopardize the building, i.e., away from exits, combustible building material or roofing materials and openings into the building.

In educational buildings, separate Air handling unit (AHU) should be provided for each floor so as to avoid the hazards arising from spread of fire and smoke through the air conditioning ducts. The air ducts should be separate from each AHU to its floor and in no way should interconnect with the duct of any other floor.

In educational buildings, shafts or ducts, if penetrating multiple floors, must be of masonry construction with fire damper in connecting ductwork or should have fire rated ductwork with fire dampers at floor crossing. Alternatively, the duct and equipment may be installed in room having walls, doors and fire damper in duct exiting/entering the room of 120 minute fire resistance rating. The air filters of the air handling units should be made of non-combustible materials.

In educational buildings, air ducts serving main floor areas, corridors, etc, should not pass through the exits/exit passageway/ exit enclosure. Wherever the ducts pass through fire walls or floors, the opening around the ducts should be sealed with material having the fire resistant rating of the compartment. The materials used for insulating the duct system (inside or outside) should be of non-combustible type. Any such insulating material should not combustible in nature.

Fire or Fire/smoke dampers[4] should be provided in supply air ducts, fresh air and return air ducts/ passages. The damper should be so installed to provide complete integrity of the compartment with all passive fire protection sealing. Damper should be accessible to maintain, test and also replace, if so required. There should also be provision for manual operation of the dampers.

Glazing:

In schools, no glass facades should be permitted.

Surface Interior Finish:

Interior finishes in the educational buildings have been a leading factor in flame spread. Interior finishes are considered to consist of those materials or combination of materials that form the exposed interior surfaces of walls and ceilings in a building.

In educational buildings the use of combustible surface finishes on walls and ceilings affects the safety of the occupants. Such finishes tend to spread the fire and add intensity to the fire. It also produces toxic fumes and leads to property damage. It is essential that the finishing material used in the building should be such as to limit the spread of fire and should not generate toxic fumes / smokes.

4 A device installed in ducts and air transfer openings of an air distribution or smoke control system designed to close automatically upon detection of heat / smoke.

educational buildings should not be used for storage of volatile flammable liquids except in laboratories. The gymnasium, indoor stadium and similar occupancies are permitted to have floors / running tracks of wood, cinder, synthetic or like.

We should not tolerate losing life of innocent children/ students that could have been prevented by taking simple measures at the time of building construction.

Chapter 2: Life Safety Measures

Life safety measures are made up of elements that are designed to protect the occupants in the building during a fire situation. There are many components that make up life safety systems in a building. Having an integrated and fully functioning life safety system can improve the safety in the educational buildings. Life safety can be termed as strategies / methods to protect occupants in buildings based on building construction, protection, and occupancy features that minimize the effects of fire and related hazards.

The life safety measures in an educational occupancy mainly consist of means of egress requirements, compartmentation, smoke control systems, Gas supply systems, fire detection and alarm system, Fire drills, fire orders. For further details on life safety systems it is advised to read section 4 & 6.2, Annex. E in NBC 2016 (Part IV), IS 14435, Gujarat Fire Prevention and Life Safety Measures Regulations.

Means of Egress Requirements:

In an educational building the means of egress comprises of exit access, exits and exit discharge. These components play a major role for a safe evacuation of the occupants from the building. All three components i.e. exit access, exit and exit discharge must be maintained obstruction free and in working condition. Now let us look into the details of the egress components and important features highlighted in NBC 2016 (Part IV).

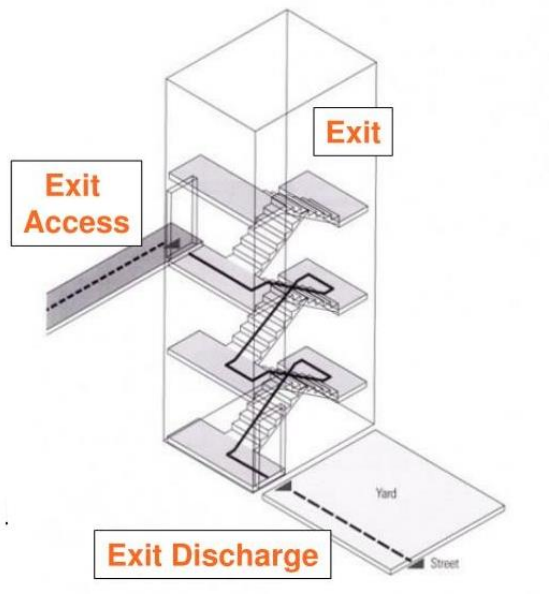


Figure 5: Means of Egress, Exit, Exit Discharge

Exit access is defined as the portion of the means of egress that leads from an occupied portion to an exit. Exits are components like doorways, staircases etc.

which is between the exit access and exit discharge or public way. Exits are separated by fire resistant rated construction and opening protectives to provide a protected path of egress travel. Exit components include exterior exit doorways, exit passageways, exterior exit stairways, exterior exit ramps etc. Exit discharge is defined as component of a means of egress between the termination of exit and public way.

Every exit, exit passageway and exit discharge must be maintained obstruction free, to aid free movement of the students / teachers during emergency.

All the exit and exit passageways to exit discharge must have a clear ceiling height of at least 2.4 meter. However, the height of exit door should be at least 2.0 meter.

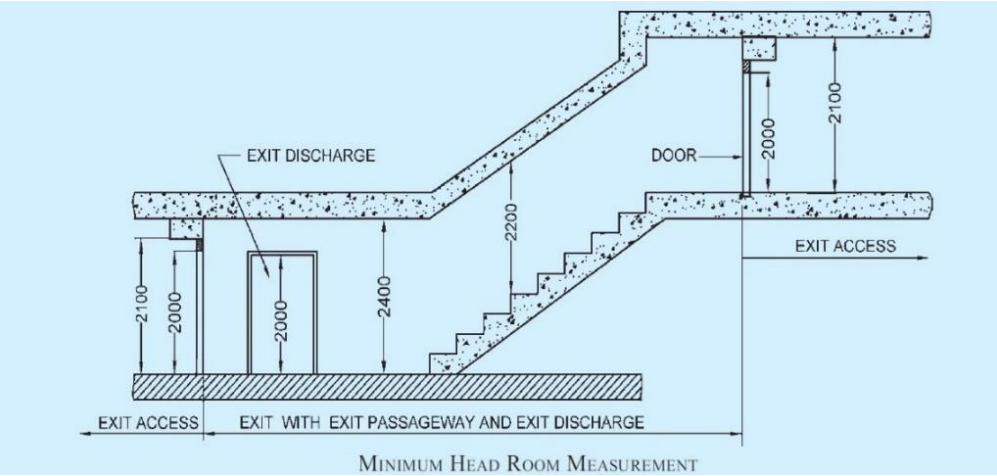


Figure 6: Exit Height

In educational buildings, the capacity of the means of egress need not be reduced along the path of egress travel until arrival to the exit discharge. Wherever changes in elevation are envisaged for more than 300 millimeter, ramps with handrails must be provided. Floor finish of ramps should contrast the adjacent finish material. Penetrations such as fire protection piping, ducts for pressurization and for life safety systems should only be allowed in exits, with adequate passive fire protection.

Walking surface along the exit access must meet the following requirements:

1. Levelled and slip resistant surface.
2. Slope should not exceed 1 in 20, unless ramp is provided.
3. Slope perpendicular to the direction of travel should not exceed 1 in 48.

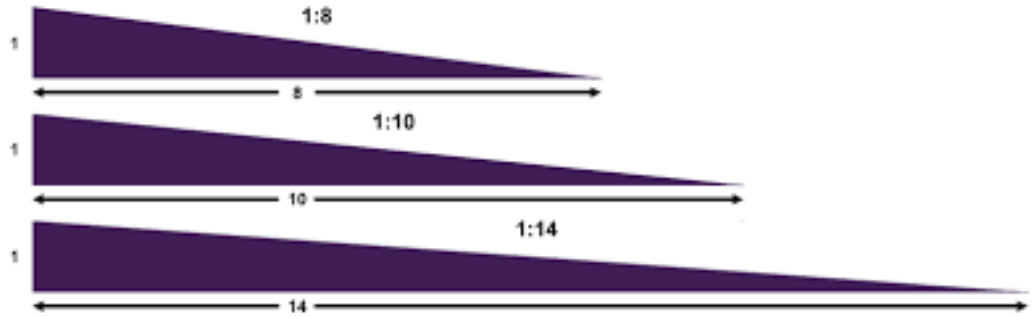


Figure 7: Ramp Slope

In educational buildings, the number of escape routes and exits to be provided will depend on the occupant load[5] (i.e. number of people) in the room or storey and the limits on travel distance to the nearest exit as mentioned in NBC 2016 (Part IV).

For educational buildings requiring more than one staircase, it must be ensured that, every part of each storey will have access to more than one staircase. This does not prevent areas from having a dead end condition provided that the alternative stair is accessible in case the first one is not usable. Though dead end corridors are not desirable, however maximum distance to a dead end should not exceed 6m.

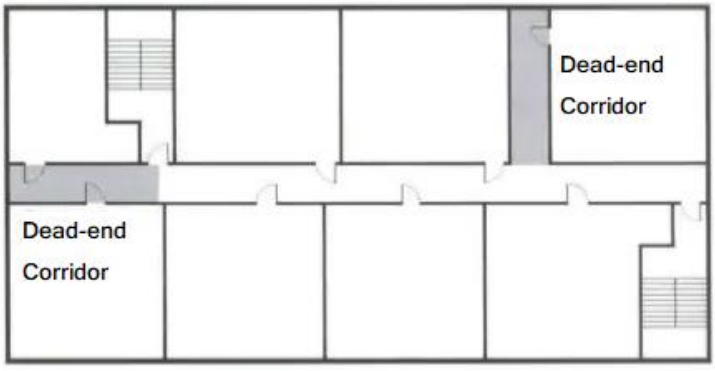


Figure 8: Dead End

Travel distance to the nearest exit should be limited to the NBC 2016 (Part IV) requirements. There are benefits to limit the travel distance like -

- Limited travel time; safety may be reached without serious exposure to smoke;
- Limited size and complexity of enclosure;

[5] The total number of people that might occupy a building or space at any point of time.

- Provision of sufficient alternative escape capacity within a reasonable distance. increased likelihood that an exit is visible, and remains so during a fire;
- Reduced likelihood that a fire can occur unseen, or grow large before detection/alarm; and
- Reduced likelihood of a fire between occupant and exit.

The maximum travel distance from any point within the building to a final exit should not exceed the limits mentioned in NBC 2016 (Part IV). If the travel distance limits are exceeded, then one more exit provision should be made.

	Maximum Travel Distance	
	Type 1 / Type 2	Type 3 / Type 4
Educational Occupancy	30	22.5

Note:

- *For sprinklered building, the travel distance may be increased by 50 percent of the value specified.*
- *Ramps should not be counted as an exit in case of basement below the first basement in car parking.*

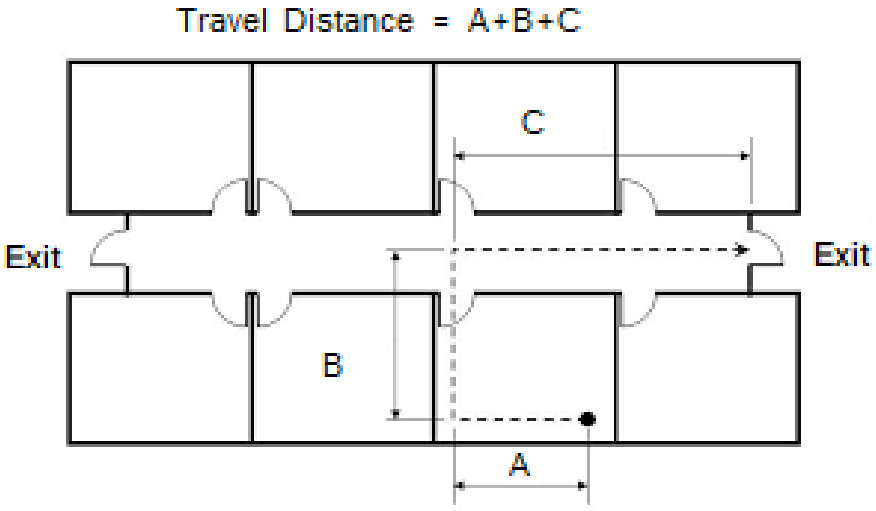


Figure 9: Travel Distance Calculation

The occupant load factor mentioned in NBC 2016 (Part IV) should be used as the basis for arriving at the occupant load of a floor / room in the educational facility. When the number of occupants likely to use a room or storey is not known, the

capacity should be calculated on the basis of the appropriate floor area & occupant load factors as per NBC 2016.

The number of occupants (occupant load) arrived from table 3 of NBC 2016 (Part IV) is the number of persons during the normal level of occupancy in a room or storey. If the number of occupants are anticipated to exceed, then the exit design should consider the increased occupant load.

Example:

As per NBC 2016 (Part IV), the occupant load factor for an educational room is 4 m^2/person. Assume the area of the room is 100 m^2.

The occupant load for the room will be 100 / 4 = 25 persons. Hence the exit requirements will be based on 25 persons, subject to minimum requirements stated.

If it is anticipated that the number of occupants in the room is 40 instead of 25, then the exit requirements will be based on 40 persons.

The width of escape routes and exits depends on the number of persons needing to use them. NBC 2016 states that the minimum width of the staircase for educational occupancy should be 1.5 meter. The aggregate width of all the escape routes should be not less than that required to accommodate the maximum numbers of people likely to use them. Where the maximum number of people likely to use the escape route and exit is not known, the appropriate capacity should be calculated on the basis of the occupant load factor mentioned in NBC 2016 (Part IV).

Example:

The width of the escape route should be calculated based on the capacity factors for stairways i.e. 10 millimeter / person and for level components / ramps i.e. 6.5 millimeter / person.

Example an exit doorway with 1000 millimeter clear width will have an exit capacity for 1000 / 6.5 occupants that is 154 persons.

Exit components:

Doorways

Exit doorways in educational buildings must open into an enclosed stairway or horizontal exit of a corridor or passageway, and should always be operable from direction of egress.

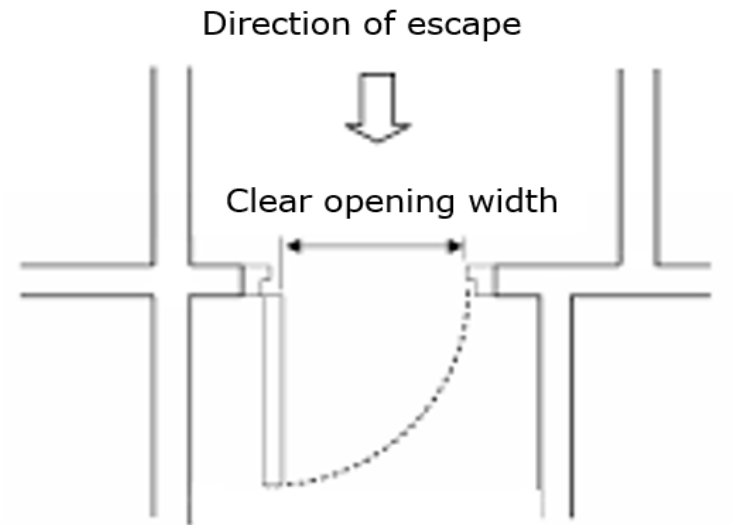


Figure 10: Doorway Opening

In educational buildings, doorway dimension should be 2 meter (height) X 1 meter (width).

Measures incorporated into the design of an educational building to restrict access to the building or parts of it should not adversely affect fire safety provisions. The activation of the building automatic sprinkler system or fire detection system should automatically unlock the access control system. Any loss of power must unlock the access control system. A manual release device must be provided near the access control doorways with signage "Push to Exit".

In educational buildings, every room with a capacity of over 45 persons must have atleast 2 doorways. All exit doorway should be operated by panic bars except that doors leading from classrooms directly to the outside may be equipped with the same type of lock as used in the classroom doors leading to corridors. Rooms for preschool, kindergarten, class 1 students should be located at ground level / level of exit discharge.

Corridor and Passageways of Means of Egress:

For educational occupancy, width of the corridor must be not less than the aggregate width of exit doorway leading from them.

Wherever there is central corridor, which is part of exit access, the doors of rooms must open inwards.

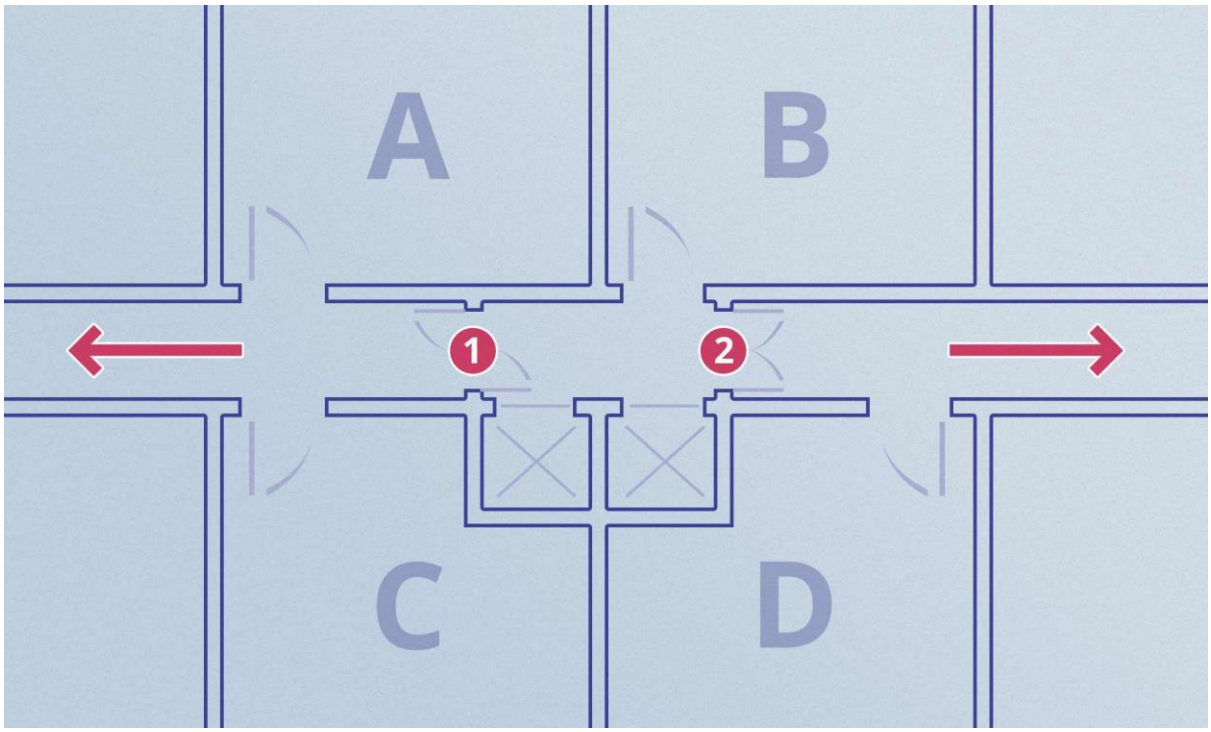


Figure 11: Doorway Opening in Corridor

Staircase:

In educational buildings, the flights and landings of every escape stair should be constructed of non-combustible material. All educational buildings must have minimum 2 staircases.

Dimensional constraints on the design of stairs are kept, to meet requirements for safety while using staircase. The preferred rise for each step should be not more than 150 millimeter, and the tread 300 millimeter and there should be between maximum 12 riser per flight.

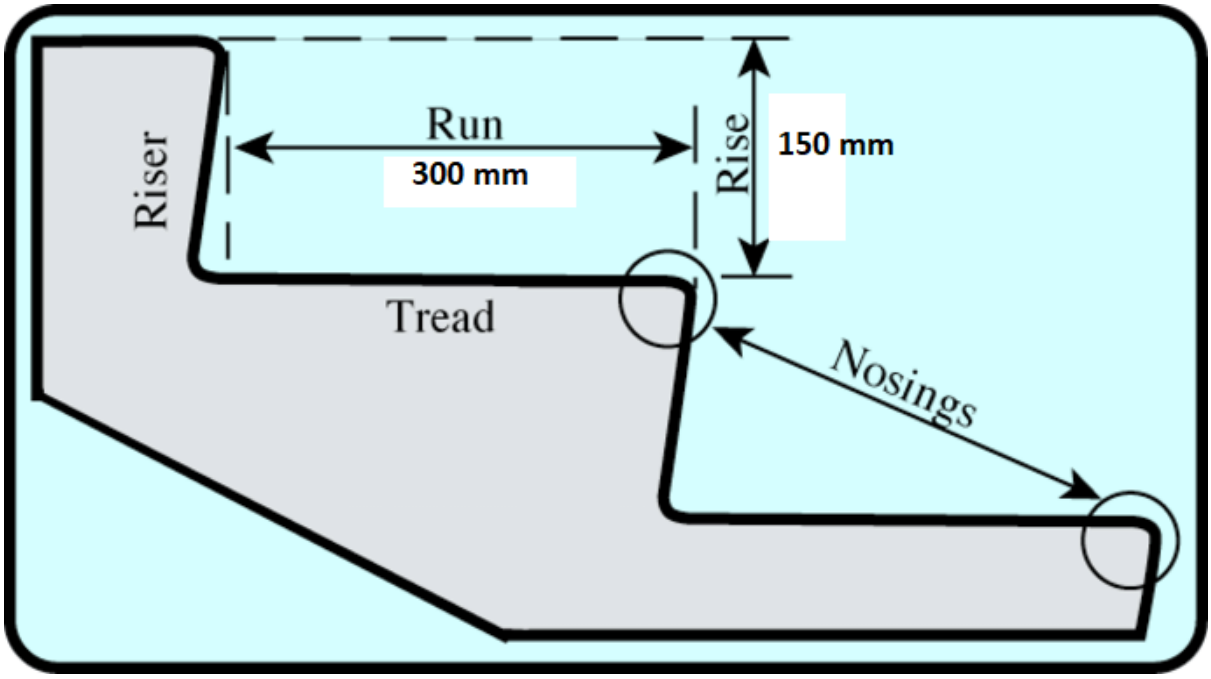


Figure 12: Riser and Tread of Staircase

Internal staircase[6] inside the educational building must be constructed of fire resistant material with minimum 120 minute fire resistant rating.

Internal staircase should not be arranged around a lift. Lift must not open inside a staircase. No electrical shaft / AC ducts / gas pipelines should pass through the staircase. All naturally ventilated exit staircase are not required to have a fire door. However fire door[7] are required for all other staircase and pressurized staircase.

The minimum width of the internal staircase must be 1.5 meter. Handrail must not project more than 90 millimeter. The Floor indication board should be pasted inside the internal staircase, with a minimum size of 300 millimeter X 200 millimeter.

Figure 13: Staircase Indication Board

[6] It is a staircase which is inside the premises of the building, and leads a to inside of the building.
[7] A door with a fire resistant rating used to limit the spread of fire and smoke from one portion to other portion of building

All external staircase[8] must be connected to the ground.

External staircases must be constructed of non-combustible material and staircase must be kept in usable conditions. The external staircase must not be blocked / obstructed under any condition.

External staircase must have a flight of not less than 1500 millimeter wide.

Figure 14: External Staircase

Ramps:

Ramps are sloped surfaces inside / outside of the school buildings to aid access to vertical levels. These are specifically made for physically challenged people with mobility issues.

In educational buildings, ramp width should not decrease along the direction of travel and slope should not exceed 1 in 12 inch. The ramp surface should be slip resistant and water accumulation should be minimised. The ramps should be

[8] It is a staircase which is open to outdoor and leads directly to the exterior of the building.

provided with handrails on both sides. For further guidance on ramps refer Part 3 "Development Control Rules and General Building Requirements" of NBC 2016.

Smoke Control Systems:

Smoke control in an educational buildings play a very vital role in ensuring the life safety of the occupants in air tight buildings. The purpose of smoke control is to reduce the build-up of smoke within an enclosed space in order to provide the occupants of building sufficient time to escape to a safer area in the building or outside the building. Smoke control systems are also designed to reduce the rate of growth of the smoke in a fire affected zone such that height of smoke layer does not impair the movement of school occupants from hazardous area.

In educational building, one of the means to achieve smoke control is through pressurization. Pressurization is adopted for protecting the exits from ingress of smoke, especially in high rise building. In pressurization air is injected into the staircase, lobbies etc, to raise the pressure slightly above the pressure in adjacent parts of the building.

The pressurization system is initiated by the fire alarm panel. Once a fire alarm panel receives a signal from detection system or manual signal regarding a fire in any premises, the pressurization system is actuated to ensure escape of the school occupants. Pressurization system is not required for a naturally ventilated corridor with openable windows.

In educational buildings, the other method for smoke control is the exhausting of the smoke as it gets accumulated in a layer in the exit pathway, atria etc. In this method of smoke control, the design for rate of smoke extraction must be equal to the rate of smoke generation. The air intake ducts should be located 5meter away from the smoke exhaust ducts. Smoke exhaust system must ensure at least 12 air changes per hour in the area affected by fire / smoke.

For further guidance on smoke control systems refer Part 8 "Building Services, Air Conditioning, Heating and Mechanical Ventilation" of NBC 2016.

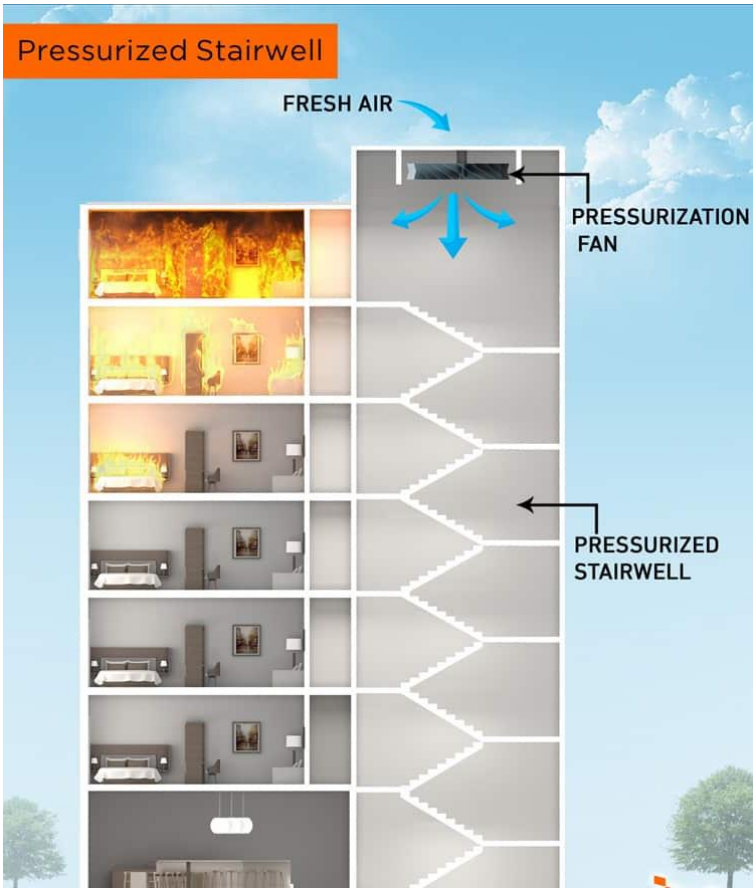


Figure 15: Staircase Pressurization System

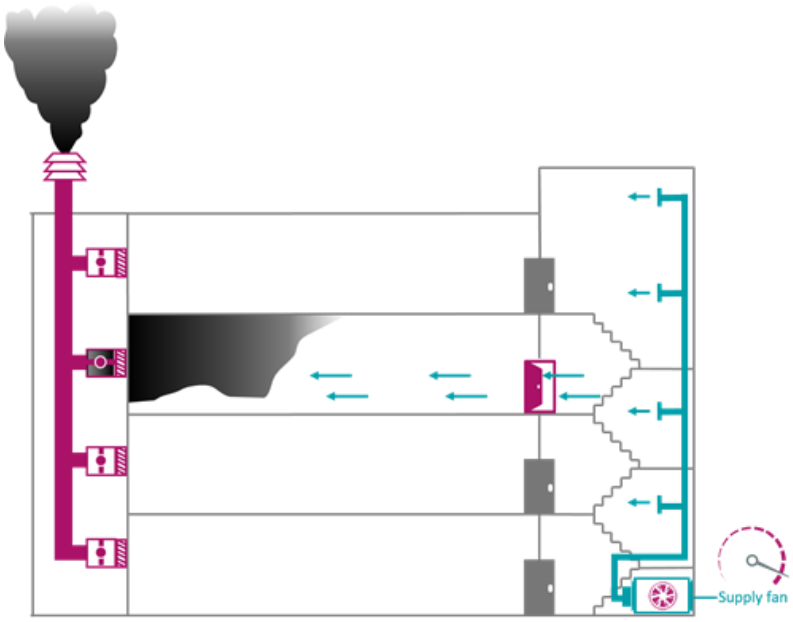


Figure 16: Smoke Exhaust System

Compartmentation:

In educational buildings, compartmentation is an important component of the fire safety design as it aims to divide large spaces into smaller and manageable fire compartments. Fire compartmentation is used to create a safe, protected means of escape for the school occupants in the event of a fire. Generally, these fire compartments are separated from each other by compartment walls and compartment floors made of a fire-resisting construction which acts as a barrier to the spread of fire and smoke for a specific period of time.

All floors should be compartmented with area of each compartment equal to 750 m^2. The compartmentation should be achieved by a fire barrier wall of 120 minute fire rating.

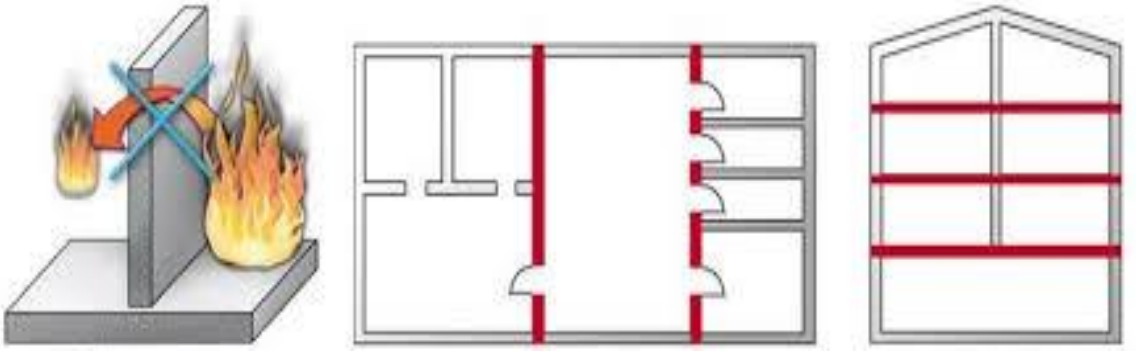


Figure 17: Fire Compartment in Building

Gas Supply:

In schools, gas pipelines are installed to supply natural gas / LPG to the kitchens. The gas pipelines should always run in separate shafts in the building premises. The gas pipeline shafts should run on external walls and away from staircases. The pipeline length should be as short as possible. Emergency valves to shut off the gas supply connection should be located in accessible location.

Wherever gas cylinder manifold is installed in the school premises, same should be adequately ventilated. Kitchens working on the LPG fuel should not be located in basements.

For further guidance on gas pipeline installation refer Part 9 "Plumbing services, section 4 gas supply" of NBC 2016.

Fire Detection and Alarm System:

The purpose of fire detection and alarm system in building is to early warning and intimation regarding fire situation to the occupants of the building. The fire detection and alarm system consist of smoke detectors, heat detectors, manual alarm call points, visual and audible warning system, fire alarm panels etc.

The fire detection and alarm system in building should be programmed with fire alarm panel to operate smoke control systems, hold up of the fire doors, visual and audible waning systems etc. All components of the fire alarm and detection system must be maintained and ensured in healthy working condition.

In buildings provided with automatic fire alarm system, following must be monitored:

- Water level in tanks
- Hydrant and sprinkler pressures of respective zones as provided
- Pump "ON/OFF" status
- All isolation valves, wherever provided with supervisory switch

For further guidance on smoke control systems refer Part 12 "Asset and Facility Management" of NBC 2016 & IS 2189.

Figure 18: Smoke Detector

Figure 19: Manual Call Point

Fire Safety Executive, Fire Drills and Fire Orders:

In large educational complexes, a qualified fire safety executive, with experience not less than 3 years, must be appointed. The fire safety executive should be responsible for following:

- Maintain the fire fighting equipment in school in good working condition.
- Prepare fire orders and fire operational plans and promulgated.
- Impart training to the occupants in buildings for use of fire fighting equipment and keep them informed about fire emergency evacuation plan.

- Keep liaison with the fire brigade.
- Ensure that all fire precautionary measures are observed at all times.

Fire orders / fire notices should be prepared to fulfil the requirements of fire fighting and evacuation from the building in event of fire and other emergency. The occupants of the building must be made thoroughly conversant with their action during fire emergency and fire notices at prominent locations and regular training must be imparted. For guidelines for fire drills and evacuation procedures for educational buildings qualifying as high rise buildings refer annex. D of NBC 2016 (Part IV).

The rates of death and disability caused by fire hazard are alarming. Let's unite and pledge to follow Fire Safety Standards and show our society that we care.

Chapter 3: Fire Protection Measures

Educational buildings must have proper fire protection system[9] in place for occupants of the building to be protected in event of fire emergency. Depending on the height and number of storey, NBC 2016 (Part IV) details the necessary fire protection measures required for educational buildings. For further details on fire protection systems, it is advised to read section 5 in NBC 2016 (Part IV), Annex. E in NBC 2016 (Part IV), IS 14435, IS 15325, Gujarat Fire Prevention and Life Safety Measures Regulations.

The fire protection measures to be considered for the educational buildings may include the following:

Fire Extinguishers:

Fire extinguishers are the first line of defence against a fire. Fire extinguishers should be installed throughout the educational buildings / premises. Fire extinguishers should be mounted at a convenient height. The fire extinguishers should be suitable to the fire hazard anticipated in the area. e.g. near an electrical apparatus CO_2 type fire extinguisher should be installed, in laboratory DCP type fire extinguisher should be installed. Further details on selection, installation and maintenance of fire extinguisher IS 2190 should be referred.

Figure 20: Fire Extinguishers

[9] A system of fire protection which comes into action once there is a fire. This system consist of actions to control the effects of fire.

First Aid Hose Reel:

The first aid hose reel should be installed on the downcomers / wet risers installed in the building premises. The first aid hose reels are the first line of defence for incipient stage fires. Minimum diameter of the hose reel should not be less than 19 mm.

Figure 21: Fire Aid Hose Reel

Wet Risers:

An arrangement of fire fighting in the building by means of vertical fire water line with diameter not less than 100 millimeter and fire hydrant valves on each floor / landing. Wet risers are permanently charged with water. The wet risers are fed with fire water pumps. The pressure available at the hydrant points should be between 3.5 to 7 bar. Fire hose should be connected to the hydrant landing valves to supply water at the site of fire. Trained personnel should handle the fire hose connected to the wet risers.

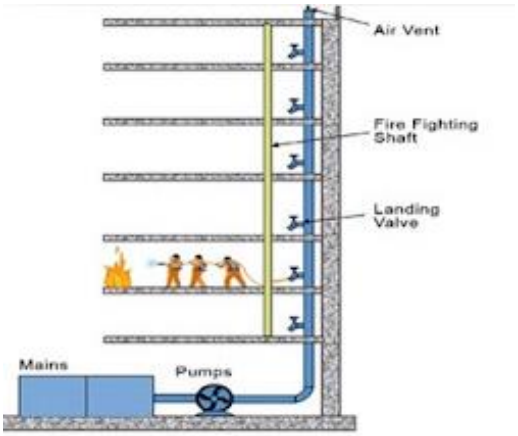


Figure 22: Wet Riser

Downcomer:

An arrangement of firefighting within the building by means of down-comer pipe connected to terrace tank through terrace pump, gate valve and non-return valve and having mains not less than 100 millimeter internal diameter with landing

valves on each floor/landing. It is also fitted with inlet connections at ground level for charging with water by pumping from fire service appliances and air release valve at roof level to release trapped air inside. The pressure available at the hydrant points should be between 3.5 to 7 bar. Trained personnel should handle the fire hose connected to the wet risers.

Figure 23: Downcomer

Yard Hydrant:

A network of fire hydrant installed in the premises outside the building. The yard hydrant network is fed through fire water pumps. The pressure in the yard hydrants should not exceed 7 bar. Fire hose should be connected to the yard hydrants to supply fire water to the fire area. Trained personnel should handle the fire hose connected to the yard hydrants.

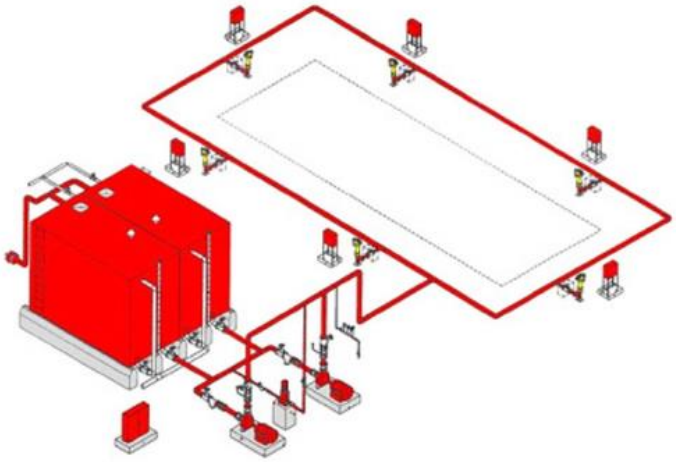


Figure 24: Yard Hydrant

Automatic Sprinkler System:

One of the most important part of fire protection is a fire sprinkler system. A properly designed and functional fire sprinkler system can prevent fire from spreading to different parts of building, help in ensuring life safety and reduce property damage. Automatic sprinklers should be installed in all areas except in

substation and DG set area. Pressure in sprinkler system should not exceed 12 bar. The Sprinkler system flow switches must be monitored from fire alarm panel. Provision should be made to ensure water from sprinkler do not enter the lift and electrical rooms. Sprinkler system control valve must be installed in fire pump room.

Figure 25: Automatic Sprinkler System

Manual Operated Electronic Fire Alarm System (MOEFA):

MOEFA systems include the manual call points, talk back system and public address systems installed in the educational buildings. The purpose of the MEOFA systems is to provide a means for manual activation of alarm system to give warning to the occupants.

Automatic Detection and Alarm System:

This system comprises of components to automatically detect fire, heat, smoke in the educational buildings. The automatic detection and alarm system should be kept operational 24 X 7. It is essential that fire detection and warning systems are properly designed, installed and maintained. Alarm systems should be standardised across a building.

Underground Static Fire Water Storage Tank:

Water for fire fighting purpose should be stored in the fire water storage tanks. The fire water tanks should be filled to the complete capacity and maintained on

24 x 7 basis. Water should be stored in two or more interconnected compartments of equal size to facilitate cleaning and maintenance. The static water storage must be easily accessible to the fire engines. The underground fire water storage tank must not be more than 7 meter deep from the level of fire draw of connection. The covering slab of the storage tank should be able to withstand 45 ton (or as applicable) vehicular load. The static water storage should be provided with fire brigade collecting head and a fire brigade tank filling connection.

Terrace Tank over respective towers:

Water for fire fighting may be stored in overhead terrace tanks located on buildings. The fire water tanks should be filled to the complete capacity and maintained on 24 x 7 basis. Water should be stored in two or more interconnected compartments of equal size to facilitate cleaning and maintenance.

Fire Water Pumps:

It is preferable to install the fire water pumps at ground level. The fire water pump house should be accessible from ground level. The fire water pumps should not be installed in second basement. The fire water pumps should be kept operational at all times. The fire water pump house should be separated by fire wall all around and doors should be protected by fire doors (120 minute) rating. The pump house should be well ventilated and care should be taken to prevent water stagnation. The fire water pump house should not have negative suction arrangement and submersible pumps should not be used. Fire water pumps house should be sufficiently large to accommodate all pumps and supporting accessories. Exhaust of the diesel engine should be insulated and routed to a safe location at ground level.

High Velocity Water Spray System:

Automatic high velocity water spray system should be installed on transformers in line with requirements of IS 15325.

Following **requirements relating to the fire protection** features should be considered for educational occupancy buildings, based on NBC 2016 (Part IV) Table 7:

Sr. No.	Educational Building Occupancy (Note 5)	Type of Installation								Water Supply (Litre)		Pump Capacity (liter/ minute)	
		Fire Extingui-Sher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm System (Note 1)	Automatic Detection System (Note 2)	Under-ground storage tank	Terrace tank over respective tower	Pump near underground storage tank (minimum 3.5 bar pressure at remotest point)	Pump at terrace tank with minimum pressure of 3.5 bar
1	Less than 15 meter height with ground plus one or more storey	R	R	NR	NR	NR	R (Note 3)	NR	NR	NR	10000 (5000) Note 4	NR	450 (450) Note 4
2	15 meter and above but not exceeding 24 meter height	R	R	NR	R	NR	R (Note 3)	R	NR	NR	25000	NR	900
3	Above 24 meter but not exceeding 30 meter in height	R	R	R	NR	R	R (Note 3)	R	NR	50000	(5000) Note 4	Note 5	NR

R = Required
NR = Not Required

Notes:

1. MOEFA must also include talk back system and public address system for 15 meter in height and above buildings.
2. Automatic detection and alarm system is not required to be provided in car parking area. Such detection system should however be required in other areas of car parking such as electrical rooms, cabins and other areas.
3. Required to be installed in basement, if area of basement exceeds 200 m^2.
4. Additional value given in parenthesis should be added if basement area exceeds 200 m^2
5. Max. height of the educational building must be in accordance with Gujarat Fire Prevention and Life Safety Measures Regulations.

Fire Safety Inspection Checklist for Educational Buildings:

Sr. No.	Item	Yes	No	NA	Remarks
Exits					
1	Are all exits free from obstructions or impediments?				
2	Are all exits unlocked and can be readily open in direction of travel?				
3	Can all egress doors open fully?				
4	Are exits signs in place, visible and illuminated?				
5	Are the openings in the floors / walls sealed with fire stop material?				
6	Is there any combustible material storage in exit, exit corridors and in areas other than designated storage rooms?				
7	Is glass façade installed in the school building?				
Electrical Safety					
8	Are all electrical system maintained and there are no loose or open wirings?				
9	Are ELCB / RCCB / GFCI / MCB present in the electrical system maintained and tested?				
Fire Fighting Systems					
10	Are all emergency power systems tested and inspected on regular basis?				
11	Are the fire extinguishers installed as per the anticipated fire hazard?				
12	Are the fire extinguishers tested on periodic basis?				
13	Is the fixed fire protection system (Fire pumps, downcomers, wet risers, hydrant valves, first aid hose reels,				

	automatic sprinkler systems) maintained and in working condition?				
14	Is the fire water storage tank cleaned on periodic basis?				
Fire Detection System					
15	Is the fire detection system installed in building and in working condition?				
16	Is the fire detection system installed in building tested and inspected on periodic basis?				
17	Is the fire alarm system in working condition?				
18	Is the fire alarm system inspected and tested on periodic basis?				
Emergency Preparedness					
19	Are regular fire evacuation drills conducted in building?				
20	Is there a documented emergency management plan?				
21	Are all employees trained in usage of fire extinguishers / fixed fire protection systems?				
22	Are all employees provided training on emergency preparedness?				
23	Are all employees aware of the roles and responsibilities during emergency?				
24	Are emergency evacuation plans pasted in building?				
25	Is there a public address system installed in building and is it working?				
General Points					
26	Is fire safety executive appointed in building?				
27	Are periodic fire safety audits undertaken for educational building?				
28	Is Fire Safety Certificate (FSC) obtained for building?				

Do's and Don'ts during Fire Emergency

Do's

- Don't panic and stay calm.
- Raise alarm and alert everyone in the premises
- Escape first and then call for help.
- Use nearest available exit route.
- While leaving the premises, close all doors and windows behind you if possible but must ensure that nobody is left behind and you are safe.
- Use only escape route as they are built for the egress purpose
- Use staircase, "Don't use lifts".
- If you are trapped in room, close the door and block the gaps which might let smoke and fumes come inside.
- Shout from window to attract the attention of the rescue team as well as others.
- Always crawl low under the smoke and try to keep your mouth covered.

Don'ts

- Never stand up in fire.
- Never go back into burning building for any reason.
- Don't secure open fire and smoke check doors as they limit the spread of fire and smoke when they are in closed position.
- Don't be tempted to clutter the stairs, corridors and lobbies as they are your escape routes.
- Never use lift in case of fire, always use staircase.
- Don't shout or run. This tends to cause panic to others.

Link to Important Documents

Sr. No.	Description	Link
1	National Building Code – 2016	https://gidm.gujarat.gov.in/codes-and-standards-related-fire-safety
2	IS 15683:2018 – Portable Fire Extinguishers – Performance & Construction Specifications	
3	IS 2190 - Selection, Installation and Maintenance of first-aid fire extinguishers —code of practice	
4	IS 15105 Design and Installation of fixed automatic sprinkler fire extinguishing systems— code of practice	
5	IS 9457: Safety colours and safety signs - Code of Practice	
6	IS 12349: Fire protection-safety signs	
7	IS 12407: Graphic symbols for fire protection plans	
8	IS 15325 : Design and installation of fixed automatic high and medium velocity water spray system - code of practice	

Save yourself, save others

Be prepared and stay alert!

GUJARAT INSTITUTE OF DISASTER MANAGEMENT

BUILDING RESILIENCE

Gujarat Institute of Disaster Management

Koba-Gandhinagar Road, B/h Pandit Deendayal Energy University,
Village – Raisan. Gandhinagar—382007. Gujarat, India.
Ph. (079) 23275804 to 25 | Fax: (079) 23275814
Email: info-gidm@gujarat.gov.in | Website: www.gidm.gujarat.gov.in