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FIRE SAFETY GAPS IN SUPER HIGH-RISE BUILDINGS IN SRI LANKA

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ABSTRACT

Increasing population and building density in cities, have left numerous risks in vertical developments. As a result of the competing requirements, limitations in fire safety could be observed among many super high-rise buildings. To overcome these situations, existing fire safety regulations have been revised. They are established by the legislation to be opportune so that designers and developers are adequately aware of what to apply and not to apply. However in Sri Lanka, by the time most of the super high-rises initiated, local fire regulations did not have any provision to serve that type of buildings. Hence, the regulations that needs to be implemented to ensure life and property safety of occupants from fire damages are still not in proper practice. This study reviewed the extent of safety in local fire safety regulations and the current fire safety practice in super high-rise buildings. The results indicate limitations in local fire safety regulations with respect to international fire safety code and gaps in current fire safety practices in super high-rise buildings. Local fire safety could fully cover only 7.14% of the international code. Remaining 92.86% needs improvements to address current fire safety requirement. In the existing context, all the case studies fully cover more than 60% of local code. Yet, 11%-16% were not covered by all three of them. Hence the study could identify design and operational level gaps in case studies. Findings of the research provided an insight to potential causes that generate these gaps in fire safety. 50% of the 16 proposed potential causes were recognized in every case study. Direct regulation driven causes comprised 62.5% of them. These findings could impact increasing the level of fire safety offered in local fire regulation, subsequently super-high rise buildings in local context. In-depth study of international fire safety code will help taking the local fire safety code to the next level. Encouraging researchers and increasing research opportunities on the subject locally, could contribute to society and its inhabitants by applying and sharing knowledge with.

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LIST OF ABBREVIATIONS

AHJ	Authority Having Jurisdiction
NFPA	National Fire Protection Association
BSS	British Standard Specifications
BCE	Before Common Era
CIDA	Construction Industry Development Authority
PBD	Performance Based Design
GFA	Gross Floor Area
N/A	Not Applicable
N/R	Not Relevant
Ed.	Edition
ICC	International Code Council
IRC	International Residential Code
IBC	International Building Code
IEBC	International Existing Building Code
NFPCA	National Commission on Fire Prevention and Control
GIS	Geographic information systems
CFPA E	Confederation of Fire Protection Association in Europe
MEP	Mechanical, Electrical, Plumbing
ELV	Extra-low voltage System

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CHAPTER ONE
INTRODUCTION

1.1 Background of Study

Urbanization is a social phenomenon that has been happening with the industrial revolution (Gollin, Jedwab, Vollrath, 2015; Yasumoto, 1973). Due to the increasing rate of urbanization, multiple social and economic challenges have risen in the past few decades (Mckinnon, 2011; Moore, Gould, Keary, 2002). Evolution in building structures is one such phenomenon under urbanization. “Urbanization is a land-use change process” (Seto & Satterthwaite, 2010, p.128). As the population and building densities in cities increase, land becomes the most scarce resource (Kudarsamy, 2015; Urbanization in China, 2007; Vlahov & Galea, 2002; Xiuyu, Hao & Qingming 2012). This scenario raises the need for 'Upward or Vertical development' in buildings. In terms of business, living, etc. every year, Sri Lanka is also adding another residential or multi-purpose tall building that exceeds 30m or 60m in height, respectively, to its list of high-rises or super-high-rises (J. Kannangara, personal communication August 12, 2019). Due to its growing peculiarity in architecture, complexity in managing high-rise buildings' every component is increasing rapidly (Poliakova & Grigoriyan, 2018). Together, urbanization and densely built physical environment in cities or close-proximity of buildings it has unveiled numerous risks (Lia, Liu, & Sang, 2012; Moore et al., 2003; Seto &Satterthwaite, 2012). Among them, fire risk is fatal. "It is well known that fires are not only a threat to the building occupants but also the property and the environment" (Nadzim & Taib, 2014, p.1).

From the initiation, design, construction, and operation of tall buildings in urban areas have increased the fire risk. A few well known examples are the fire caused by a terrorist attack to the world trade center in the USA in 11.09.2001, Fire in Grenfell Tower in London, UK in June 2017, and CCTV/TVCC tower building fire in

Beijing, China in February 2009. As Asgary, Ghaffari, & Levy, (2010) state in the year 2002, 53, 589 fires were recorded in Canada, out of which 304 deaths, 2547 injuries, and property losses in billions were reported. Statistical surveys have proven that the damages caused by fire could cost an enormous amount of money. "In the United Kingdom (UK), the direct cost of the fire was estimated at 8 billion GBP in 2003. In addition, the health and safety commission (HSC) approximated the annual cost of health and safety failure as 18 billion GBP." (Ebenehi, Mohamed, Sarpin, Masrom, Zainal & Azmi, 2017, p.4). Jennings (2013) states that loss from fires among industrialized nations record between .05 and 22% of GDP.

Due to the close proximity of buildings in cities, the risk of a fire spreading from an adjacent building to another is high in densely built areas. Restricted lands, complexity of designs, lack of implementation of building regulations, poor evacuation strategy, issues in structural stability, practicing haphazard construction, could be seen as few direct and indirect causes for these fire hazards (Abir, 2014; Kodur, Kumar & Rafi, 2019; McGranahan & Martine, 2014; Navitas, 2014;Wu, 2001; Zhao, Mao & Chen, 2019). During the design Phase, its architecture mainly focuses on addressing the needs of client-facing challenges inherited with the site and its topography, compelled by the building regulations (Imrie, 2006,2007; Lawson, 1982). Then the progression of spaces, space planning, increased sellable area, required other services, and aesthetic aspects are considered giving priority to the client's interests (Anderson, 2017; Norouzi, Shabak, Embi & Khan, 2015). Since the client's perception is to maximize the sellable floor area, architects are expected to address the client’s needs until the client is fully satisfied with the design. On the other hand, safety, building compliance, maintenance, etc. are being narrowly focused on. And these requirements are not necessarily supported by implementing fire safety into the design (Allen, 1989). Correspondingly there are many other situations in the design phase in which fire-safety is being set aside. Without the correct definition of fire resistance in a particular building, the structure itself may fail to withstand a fire hazard (Poliakova & Grigoryan, 2018). This usually is in conjunction with the cost of construction. Required fire resistance can lead to increased building mass & volume; consequently, the cost of construction and the complexity of construction increases. In such situations, the consultant's ability to respond to fire-safety may limit since the budget affect the design vice versa. In relation to this, no special procurement methods are followed in selecting contractors giving priority to stop fire-occurring and spreading during construction. Due to these reasons, a high-rise building can easily be a victim of fire-hazards.

To minimize the risk of fire, regulations, guidelines for design, construction, and operation were introduced globally. However, most of these do not cover special considerations for super high rises. Considering the fact that an increased no of floors in a building enhances difficulty in evacuation thereby increasing the rescue time in an emergency; a fire, followed by a great risk for a large number of people in and around the building. (Hu, Milke & Merci, 2017; Chow, 2017). The risk of a fire spreading from an adjacent building to another has not been covered by the fire-regulations to adopt. Most of the time, minimum requirements are addressed, clashing with fire-safety parameters.

1.2 Problem Identification

The provision of buildings and fire safety regulations aimed at ensuring life and property safety should be in collaboration with each other. Each element of the building should be designed according to the given specifications by the rules. Those will be checked later, to assess the compliance. (Kurniawan, Tambunan & Imaniar, 2018). Fire safety regulations and procedures established by the legislation need to be opportune so that designers and developers are adequately aware of what to apply and not to apply. By the time most of the super high-rises initiated, local fire regulations did not have any provision to serve that type of buildings. Regulations that are needed to implement to ensure life safety and protect property from damages are still not in proper practice.

The common two codes applying in the local context are NFPA 101 Life Safety Codes and CIDA Fire Regulations. However, international code; NFPA 101 Life

Safety Codes undergo regular updates while local code; CIDA Fire Regulations has not been able to produce regular updates. The gap between last updates of fire safety regulations is 12 years when the 2nd edition performed in 2006 and the latest edition published in 2018. Hence, buildings are being constructed already without covering the local codes. Such buildings have fire safety gaps. Inadequacy of approved regulations that give recommendations and guidance for meeting safety performance of the buildings. Therefore the level of adequacy of fire safety is minimum for occupants. The incapability of approved regulation to cover a certain type of buildings left them unsafe from fire risks. Even though the fire safety regulations and procedures are presented, the awareness level of users towards the implementation of fire safety procedures and regulations in buildings are not presented. These disconnections to interrupt the flow of actions against fire-risks and obstructions to practice proper fire-safety can be identified as fire safety gaps.

1.3 Aim

Investigate limitations in fire safety that occurs consciously or unintentionally throughout the design and operation phases of super high-rise buildings.

1.4 Objectives

1) Identify the fire safety requirements of super high rises provided in the local code and the international code.

2) Analyze the limitations in local fire safety code with respect to international code.

3) Analyze the gaps in fire safety in super high-rises with respect to local code.

4) Propose recommendations to minimize the fire safety gaps in super high-rise buildings in Sri Lanka.

1.5 Research Methodology

A comprehensive literature survey and review are carried out to understand the evolution of fire safety as a fundamental affair for a country both socially and economically. The existing condition of fire safety worldwide is also identified through the literature review. A comprehensive study of the common two codes for fire safety applying in the local context, NFPA 101 Life Safety Codes (2015) and CIDA Fire Regulations (2018), was conducted. The fire safety level in Sri Lanka is investigated through observations and findings.

1.5.1 Case study

Three scenarios of super high-rise buildings were subjected to investigate based on a prepared framework. Primary data collected through field observations were followed by expert interviews organized according to the framework.

1.5.2 Analysis

The qualitative approach adopted for the analysis, and all the data gathered were analyzed using cross-case analysis method. Case studies were carried out for collecting data from super high-rises to understand the current practice of local context. Findings were then reviewed to identify reasons behind the gaps. Suggestions to discontinue these identified gaps were later presented based on those observations.

1.6 Scope and Limitations

The scope of this research is to identify the limitations of the current level of fire safety in Sri Lanka. For the purpose, fire safety legislation requirements currently being practiced in Sri Lanka subjected to evaluate compared to NFPA 101 life safety code (2015). Due to the broadness in the subject area and limited time and resources available, the study is limited to means of egress section, which is one of the main objectives of fire safety. The sample size of case studies was limited to super high-rise buildings with a height above 60m, located in the heart of Colombo city.

1.6 Chapter Breakdown

This dissertation comprises of five chapters.

Chapter 1 - Introduction to the research with a research background, problem statement, aims, objectives, research methodology, scope, and limitation.

Chapter 2 - A critical review of the literature, carried out on the subject area of fire safety and current safety level.

Chapter 3 - Research methodology explaining the data collection methods and analysis together with the justification for using the particular approach

Chapter 4 - Data collection and an analysis of the research findings which will ultimately achieve the research objectives

Chapter 5 - Conclusion, recommendations, and suggestions for further research

CHAPTER 02

LITERATURE SURVEY

2.1 Introduction

This chapter explores the evolution of fire safety as a fundamental affair for a country. The foundations for evolving fire safety as a culture is being discussed with the study of relative literature. Also, the existing condition of fire safety worldwide is identified through the literature review. Also, the social and economic importance of establishing a fire safety culture is stressed by many historical pieces of evidence. The need for Fire safety as a science and part of the legislation is being developed over the decades due to growing complexity in the physical environment as well as human actions.

2.2 Definition for Fire Safety

A fire has no political or economic boundaries; globalization has made aware that every developed and developing country has a lack of fire safety in buildings (Walls, 2001). As society's values, technology, economy, and physical biosphere make changes, risk and its inherited danger change priorities. "In place of religious beliefs, we now find natural causes and chance. In pre-modern times threat and danger emerged from nature; in modern times, danger and threat emerge from the reflexivity of modernity itself…" (Gehandler, 2017, p.975). Different groups in a single society may embrace different perspectives on how they perceive, define, study, value, and communicate risks (Gehandler, 2017). In the macro context, societies also can diverse with how they see danger and act against them. Similar to the scenario of fire risk, i.e., different regions may perceive fire risk with some dissimilarities, and therefore their regulations might be specific to address specific goals. Bukowski (1991) has shortlisted such goals, as cited by Richardson (1993).

- Prevent fire or retard its growth and spread
- Protect building occupants from the effects of fire
- Minimize the impact of fire
- Support fire service operations

As an example, some regions such as the USA, Australia's experience of fire losses with wildfires are common, while some regions are not. "…the civilian casualties due to wildfires have been relatively low. In 2012, an estimated 15 civilians died as a direct result of a wildfire, close to the average of 13 people per year." (Thomas, Butry, Gilbert, Webb and Fung, 2017, p.1). Fire safety regulations are a norm in many countries in work due to safety and environmental concerns. The definition may change; fundamentals are the same. "The Code addresses those construction, protection, and occupancy features necessary to minimize danger to life from fire, including smoke, fumes, or panic." (National Fire Protection Association (NFPA 101, 2000, p.23).

Definition expresses how fire safety is practically achieved. As explains in the Code of Practice for Fire Precautions in Buildings SCDF (2018), a code serves to establish the minimum required for fire safety provisions in every building. Function, Design, Operation, and Maintenance has taken as main aspects of code for securing life and property in the event of a fire (NFPA 101, 2015). With timely evaluation, fire safety definitions may undergo upgrades. NFPA 101 Life Safety Code (2015) definition has evolved in concern with other causes apart from fire identified in past years as threats for life such as heat, smoke, and toxic gases generated during a fire. (NFPA 101, 2015). There could also be seen in specific fire safety definitions. In the definition of the Confederation of Fire Protection Association in Europe (CFPA E, 2011), guidelines focus on providing a reasonably safe environment and safe evacuation for occupants in apartment buildings. NEW ZEALAND C1-Objectives of clauses C2 to C6 (protection from fire) depicts the objectives as to protect people from fatalities caused by fire, protect property from damages and enable firefighting and rescue procedures (Ministry of Business, Innovation, and Employment, New Zealand, 2019). In summary, all these definitions cover the following;

- Minimize danger to human life
- Minimize risk of property damage
- Support safe and effective firefighting

Each definition intends to communicate a set of procedures and guidelines against fire risks. In common, all countries share a similar set of objectives and goals. Adopting adequate measures incorporating prevention, early detection, and control measures are the basic form of these practices. Table 2.1 illustrates similar examples of underlying fire safety objectives in different contexts.

Table 2.1: Fire Safety Goals and Objectives in different contexts in the world

Country/ Regulation	**Goals**	**Objectives**
National Fire Protection Association (NFPA 101 Life Safety Code 2009), USA	"4.1.1 Fire. A goal of this Code is to provide an environment for the occupants that is reasonably safe from fire by the following means: (1)Protection of occupants not intimate with the initial fire development (2) Improvement of the survivability of occupants intimate with the initial fire development."	"Occupant Protection. A structure shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place."
	"4.1.2* Comparable Emergencies. An additional goal is to provide life safety during emergencies that can be mitigated using methods comparable to those used in case of fire."	"Structural Integrity. Structural integrity shall be maintained for the time needed to evacuate, relocate, or defend in place occupants who are not intimate with the initial fire development."
	"4.1.3 Crowd Movement. An additional goal is to provide for reasonably safe emergency crowd movement and where required, reasonable safe nonemergency crowd movement." (NFPA 101 Life Safety Code 2009).Code of Practice for Fire Safety in Buildings issued by the Buildings	"Systems Effectiveness. Systems utilized to achieve the goals of Section 4.1 shall be effective in mitigating the hazard or condition for which they are being used, shall be reliable, shall be maintained to the level at which they were designed to operate, and shall remain operational."

Country/ Regulation	Goals	Objectives
Code of Practice for Fire Safety in Building, Buildings Department of Hong Kong 2011	"To provide for the planning, design, and construction of buildings and associated works; to make provision for the rendering safe of dangerous buildings and land, and to make provision for matters connected therewith."	"Protection of life of building occupants
		Minimization of fire spread between fire compartments
		Prevention of building collapse as a result of a fire
		Minimization of fire spread between buildings and
		Facilitating of firefighting and rescue by fire service personnel."
CFPA_E 2011 Fire Safety in apartment buildings		"To advance the knowledge and the understanding of matters relating to fire science, fire prevention & protection, safety & security, and other associated risks.
		To encourage the exchange of information in relation to the protection of life and property.
		To facilitate co-operation between members for undertaking joint programs.
		To carry out or to commission research and studies. To act as spokesman.
		To promote the European perspective.
		To foster the development of fire protection organizations in new countries."
		(European Union (EU) Fire Safety Guide has staged 07 layers of fire safety) Prevention, Detection, Early Suppression, Evacuation, Compartmentation, Structural Safety, Firefighting
New Zealand Building Code (NZBC) Clauses C1-C6 Protection		"(a) safeguard people from an unacceptable risk of injury or illness caused by fire,
		(b) protect other property from damage caused by fire, and

Country/ Regulation	Goals	Objectives
from fire, Ministry of Business, Innovation,and Employment. (2019)		(c) facilitate firefighting and rescue operations.”
Code of Practice for Fire Precautions in Buildings, Singapore Civil Defense Force, Singapore 2018		“The Code of Practice for Fire Precautions in Buildings, hereinafter called "the Code" or "this Code" serves to establish the minimum requirements for fire safety provisions in all buildings. It takes into account the function, design, management, operation, and maintenance of buildings to secure the life safety of occupants and property safety in the event of a fire.”

These goals share the same insight of fire safety objectives; however, portray differently. They share common grounds of ensuring the safety of inhabitants and property in all three stages of buildings; design, construction, and use at the early stage of fire. These goals are determined to be achieved by the objectives of mainly 'Life Safety' and 'Property Protection'. Gerges, Mayouf, Rumley, and Moore (2017) states the primary aim of ensuring fire safety is to protect human life with secondary priority for the property, breaking down fire safety into two parts as; active and passive. The set of objectives usually prioritize in a comprehensive framework of Fire Safety Codes. The pyramided framework in figure 2.1 explains the hierarchy of composition of the fire safety practice in buildings.

Sri Lanka's fire safety regulations have begun performance in 1997. Both NFPA and British Standard Specifications (BSS) influence the system in delivering a practicable set of prescriptive norms. However, in the local context, there are no visible objectives or a level of safety underlying the fire safety practice, which has been followed over two decades. There could be classifications seen in terms of feasibility design, national planning laws, etc. in governing development of the physical environment.

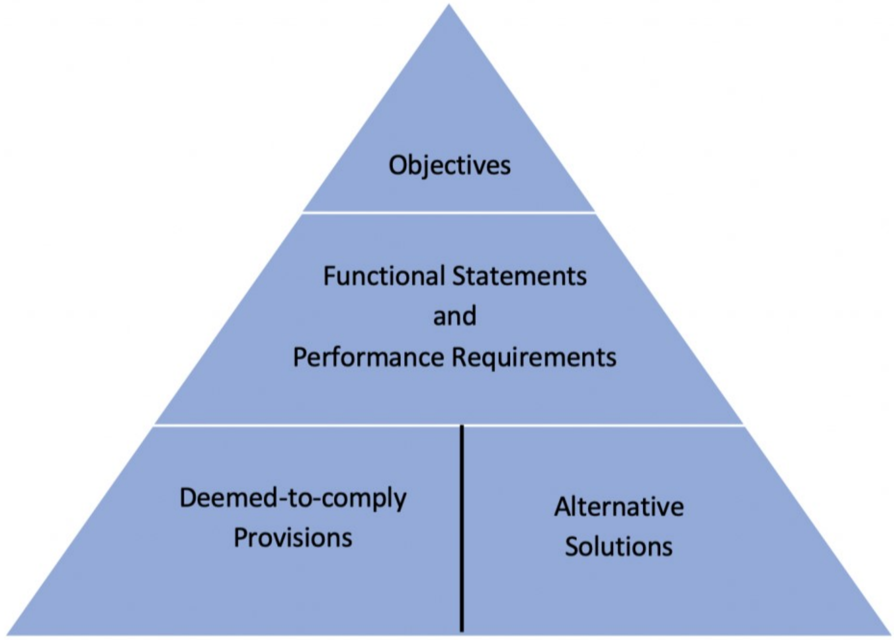


Figure 2.1: Composition for fire safety practices in building
Source: Code of Practice for Fire Safety in Building, Singapore (2011)

Fire regulations have a specific set of standards presented for buildings. For interpretation and application to not be intricate, there are several categorizations introduced for fire safety practices in terms of use, occupancy, height, and in some cases, construction.

2.3 Definitions for super high-rise buildings

It is evident that definitions for high-rises and super high-rises change with each country's fire safety regulation as shown in figure 2.2.

Table 2.2: Diversity of high-rise and super high-rise definitions around the world

Country/Region	Definition	Verticality
Russia	High-rises	>75m (Poliakova & Grigoriyan, 2018)
USA	High-rises	>75ft / 23m above the lowest level of fire department vehicle access (NFPA 101 Life Safety Code 2009)
New Zealand	High-rises	>25m
Hong Kong	Ultra High-rise	>40 levels (about 120m) (Chow, 2007)
China	Super High-rise	>100m (Chow, 2007)
Ireland	Super High-rise	>150m (Chow, 2007)
Canada	Super High-rise	>350m(Chow, 2007)
Singapore	Super High-rise	>40 levels (Code of Practice for Fire Precautions in Buildings, SCDF 2018)
Sri Lanka	High-rises	>30m <60m (CIDA Fire Regulation 2018)
	Super High-rise	>60m (CIDA Fire Regulation 2018)

Therefore the definition for super high-rise buildings in CIDA Fire Regulation (2018) is used for this study.

2.4 Evolution of 'Fire Safety'

Organized firefighting is first reported in ancient Egypt as per Spirkina (n.d). Aedile Marcus Egnatius Rufus has formed the first Roman fire brigade (Spirkina, n.d; Kolodko, 2012). A group of slaves were hired for the job. In AD 6, Augustus was inspired by Rufus and formed the Vigiles, which served as the police which patrolled the streets of Rome to watch for fires (Spirkina, n.d; Kolodko, 2012). To battle against fires, bucket brigades and pumps as well as poles, hooks, and in advance of flames, ballistae to tear down buildings were used (Kolodko, 2012). Firefighting was undeveloped in Europe until the 17^{th} century, as Spirkina (n.d) explains. In 1254 Paris, 'burgess watch' was created, allowing residents to prevent and stop crimes and fires. After several fires in the 16^{th} century, king's watch made as to the only one responsible for checking crimes and fires by King Charles IX. The great city of London, which suffered great fires in 798, 982, 989, and the greatest of all in 1666, 'The Great Fire of London' as illustrated in figure 2.2, felt the need for organized fire control (Healy, 1970). Prior to 1666, London did not have an organized fire protection system, and firefighting gained popularity with the property insurance companies seeing the potential of developing it as a profitable investment (Healy, 1970; Spirkina, n.d).The fire has begun on 2nd September 1666 and lasted just under five days, says Museum of London (2011). This tragedy has caused one-third of London to be destroyed and about 100,000 people their homes (Museum of London, 2011). Fire hazards were treated with basic equipment, and human effort, as the Museum of London (2011) describes. These fires were irresistible unless they pull down the house to make fire breaks. There was neither networked water supply in London nor water hose (Healy, 1970).

Figure 2.2: Painting of Great Fire of London
Source: 'Painting showing the Great Fire from Tower Wharf, 1666' Museum of London, (2011)

In the 17th century, the key revolution in firefighting was marked with success on first fire engines (Spirkina, n.d). In 1672 the fire hose was invented by Dutch inventor Jan Van Heyden. Boston's Governor John Winthrop forbade wooden chimneys and thatched roofs as a method of fire prevention in the year 1631 (Spirkina, n.d). New Amsterdam Governor Peter Stuyvesant appointed fire wardens in 1648. The four wardens were responsible for inspecting all chimneys and to fine any violators. Volunteered men, called 'Rattle watch' patrolled the street at night to search for fire. The first fire engine company started service in 1678, January 27th, with its Forman (Spirkina, n.d). As Pastukhov, (2020) explains, fire incidences happened during the Industrial Revolution in Great Britain in the 18th century and in the early 19th century in the Untitled States, were began to fall-off as combustible construction was replaced and public firefighting and protection measures were initiated. The Union Fire Company was established by Benjamin Franklin in Philadelphia in the year 1736. The United States did have amateur fire brigades paid by insurance companies, but professional firefighters in government fire departments came into being in the time around the American Civil War as per Spirkina (n.d). However, the current fire brigades were created in the early 18th century in France. Fire protection engineering was developed to address new fire hazards. During the time, an important innovation was made as the first automatic sprinkler was found by Henry S. Parmelee in 1874 (Pastukhov, 2020). The establishments of fire brigade and rules for fire preventing and firefighting were developed from time to time.

Fire protection has been promoted by insurance companies in the 19th century (Pastukhov, 2020; P.H. Robinson & Robinson, 2018). Initially, it was focused on industries, mainly for factories, and to prevent large-scale fires occurring in cities (Pastukhov, 2020; P.H. Robinson & Robinson, 2018). However, it was soon understood that fire could happen anytime, irrespective of the location, people, and social class, etc. with a mere reason of negligence. It could also be seen that many hazards happened due to the obliviousness of possible risks of actions. The movement began when 'Triangle Shirtwaist Factory' incident happened in New York City on 25th March 1911, which enabled the inclusion of new perspectives in legislation. It was a time when landlords jointly with architects started to build tall buildings with more than a dozen floors. But the law had not expected much for the buildings' and occupants' safety; hence industry owners could not be proven guilty for catastrophes. As a consequence, as shown in the figure 2.3 below, a fire in the 135 foot high building constructed in 1901, killed 146 garment workers within less than 20 minutes.

Figure 2.3: Image of victims of the 'Triangle Shirtwaist Factory' fire incident
Source: 'Bodies of victims collect on the sidewalk,' 1911. Kheel Center, Cornell University, photo by Brown Brothers

At the time with gaps in the law, legislation has been applied as per personal preferences. "The architect successfully argued that "the staircases are remote from each other and, as there is a fire escape in the court [yard], it practically makes three staircases, which in my opinion is sufficient." (P.H. Robinson & Robinson, 2018). Even though people witnessed the tremendous loss that happened, they were helpless due to height and restrictions of fire-fighting equipment. However under the law, owners have not done anything different from what other people do to be punished. "Nor are any officials found to have done wrong. The law's expectations for building safety are low." (P.H. Robinson & Robinson, 2018, p.9). Yet, people needed a new tragedy to move forward in safety measures. P.H. Robinson & Robinson (2018) further describe incidents that occurred afterward. A natural gas explosion has occurred at the New London School in Texas in March of 1937. The nature of natural gas at the time misled everyone inside the building and took 298 lives, mostly children. When the cause was identified, a legislation was passed requiring 'odorous mercaptans' to add to natural gas, and its reforms were quickly applied. However, some tragedies remain untouched, unheard, and distanced from public attention. P.H. Robinson & Robinson (2018) states another great fire in the mid-20th century. High combustibility of interior was preventing firefighters from entering into the building; hence the damage was doubled. “In 1942, a fire at the Cocoanut Grove nightclub kills 492 people.” (P.H. Robinson & Robinson, 2018, p12). More than 600 people lost their lives to a tragic fire that occurred in Iroquois Theater during a holiday show in 1903 but the incident remained private. It was not the 'Triangle Shirtwaist Factory' incident which marks the most tragic fire hazard occurring in that era, but social and political environments were different between two incidents (P.H. Robinson & Robinson,2018). In contrast to the theatre tragedy, the factory's incident was public, as no one could forget. This incident has made Ms. Frances Perkins, the executive secretary of the New York Consumers League at the time, to hold a presentation at the 1913 NFPA annual meeting which directed the formation of NFPA Technical Committee on Safety to Life and NFPA 101, the Life Safety Code(Gehandler, 2017, p.974). Due to the effort, New York City's Municipal building codes became more focused on safety. Gehandler (2017)states that “Standardization, regulation, politics, and media can or are being used to gain social legitimacy.″ The movement started by Ms. Perkins brought a notable change to fire prevention and public safety. “Systemic issues are also addressed, including the problems of evacuating large groups from high-rises and the storage of flammable materials in public buildings.” (P.H. Robinson & Robinson, 2018, p.10).

Whatever the achievements made by social force, enforcement was weak, allowing industry owners to slip through and make the same mistakes repeatedly. As P.H. Robinson & Robinson (2018) describe, New York City's safety conditions were brought to a high position but on papers only. Violation of such laws did not have serious consideration, and incidents involving fires were reportedly continued. Various causes exposed to awareness built-up of fire hazards. Nevertheless, the building’s fire safety was not in near-resolve with arduous problems.

> Throughout the United States, model building codes are developed by a wide range of organizations, including local government officials, insurance underwriters, private groups, union organizations, and the federal government, without much thought to uniformity or guiding principles. The United States has no national building code..."says P.H. Robinson & Robinson (2018, p.13)

Later, to formulate reasonable practice, the International Code Council (ICC) was formed in 1994 for the coordination of comprehensive codes for building construction safety and fire prevention. The International Building Code (IBC), the International Existing Building Code (IEBC) and the International Residential Code (IRC), are under the house of ICC(P.H. Robinson & Robinson, 2018). All European Union countries are superseding their own national safety codes with 'Eurocode.' Also constant improvements are being carried out for model codes. The whole United States is sharing some common ICC codes as to P.H. Robinson & Robinson (2018). Adhering to a Fire Code has significantly influenced reducing death risk.

> The numbers are compelling: the odds of dying on the job in 1911 were 1 in 1,800; the odds that a given worker will be killed this year are 1 in 69,000. As a point of comparison, it is more likely that today's worker will be killed crossing the street, a chance of 1 in 54,538." (P.H. Robinson & Robinson, 2018, p.13)

2.4.1 Evolution as a field of science

During the time codes and standards for fire safety were being improved, studies on fire protection engineering also grew (Pastukhov, 2020). The 'Fire Protection engineering' as a field of science, appeared majorly to resolve unexpected and devastating problems caused by fire with the upsurge of the industrial revolution.

Importance of understanding the nature of fire, fire hazards, and adopting preventive strategies recognized among many nations are being developed and carried out from time to time. However, some gaps can be seen in the implementation efforts put together for the benefit of society.

In the early 1900s, 'The British Fire Prevention Committee' was established in the United Kingdom with the mission to provide fire protective measures. In fact, fire protection engineering started to be practiced institutionally in the United States in 1903 in the 'Armor Institute of Technology' before famous fire hazards occurred in recent history. In the NFPA Annual meeting, in 1913, Ms. Perkins highlighted the lack of means of escape. A study carried out by NFPA technical committee on significant fires finally led the formation of the Building Exit Code in 1921. As Jennings (2013) states, research on residential fire scenarios was promoted with the publication of the 'America Burning' in 1973 by the National Commissions on Fire Prevention and Control in the United States, providing a broad overview of 'Fire Problem.' It is the creation of the 'Fire Research and Safety Act of 1968' with sparks mostly of social, economic circumstances the United States is going through. The panel that authored the report publicly recognized the absence of knowledge about at which point to design intrusions, further reducing fire hazards, explains Jennings (2013). “The passage of this Act was surely influenced by the surge in fires that occurred in the late-1960s associated with racial unrest, urban economic decline, and notable high-profile fires.” (Jennings, 2013, p.2). National Commission on Fire Prevention and Control (NFPCA) recommended public and government attention on the issue, in an attempt to understand the social, physical, and economic losses that come-along with fire, in the United States. Their report highlighted the need for a coordinated national fire research program (Jennings, 2013). As a result, following the legislation, the NFPCA was formed under the Department of Commerce in 1974. The government's fire laboratory led the development of a national system for collecting fire data from national fire departments and initiated an interdisciplinary research program. Later it was reorganized into US Fire Administration, narrowing down social research into residential fire problems.

The original research on the subject had been conducted on fluid mechanics, combustion, and fire safety in the Department of Mechanical Engineering at Harvard University, United States, by Professor Howard Wilson Emmons as Gehandler (2017) states. The early researches have recognized links between fire losses and the context of the built environment as it interacts with the multifaceted network of technical, organizational, economic, and human dynamics (Jennings, 2013). Early studies have indicated that fires are not foreseeable, but could be prevented. Also, fire incidences strongly vary depending on the social and economic characteristics and housing and neighborhood conditions. As Jennings (2013) indicates, Variations in the nature and severity of fire problems among urban areas have been recognized since fires were not uniformly or randomly distributed. He further states weaknesses in poverty, insufficient or overcrowded housing can lead to fires, ultimately to abandonment of properties.. Another important finding was income significantly affect people's attitude over fire-protective measures. Luxury or higher-middle income residents may generate demand overprotective measures than low-income residents. Early research laid the foundation for more advanced studies on residential fire problem in the next decade. Munson and Oates (1983) further explain, as cited by Jennings (2013), that there is a positive income elasticity of demand for investment for passive fire prevention methods. The higher the income is, the greater the probability of keeping safety equipment. The next decade research acquired great progress by adopting Geographic information systems (GIS). Also, the relationship between residential fires and social, economic characteristics of residents in the urban built environment grabbed the interest of researchers (Jennings, 2013). The most important step was developing a theoretical model to measure the risk, interpreting scale, and precise specification of risk.

The risk was founded by the decision theory with uncertain choices of humans, says Fischhoff and Kadvany (2011), as cited by (Gehandler, 2017). It was argued by Gehandler (2017) that 'Design' and 'Decision making' must not be separate and make use to establish a set of objectives to find solutions.

Decision making is fundamental to fire safety design; therefore, we should acknowledge that we are dealing with a decision problem. Then the tools from decision making can be used to structure the problem, to remove constraints and biases, to identify the basic objectives and potential solutions, to evaluate solutions, and to identify trade-offs." (Gehandler, 2017, p.978).

Passing through decades of numerous researches, fire safety has developed into a field of protection engineering to address the incessantly growing risk of fire. Henceit became a field of science as explains by Gehandler (2017). He suggests that the design should be problem-driven with a function-centered view; therefore, it is the responsibility of engineers to perform on a conclusive safety system, managing the risks with responding to human behavior. In fact, these risks origins with human decisions and confronting them lie on the human himself. In this regard, Gerges et al. (2017) state performance-based fire safety design are essential in ensuring safety from fire hazards as cited by (Oleszkiewics, 1991; Thomas, 1986; SFPE, 2012). Ultimately, studying fire resistance moved fire safety standards from detailed specifications to performance approach bound to occupancy classification and heights, and area limitations established by building codes (Pastukhov, 2020).

2.4.2 Evolution as a legislation

Regulations ought to exemplify public expectations on how buildings or built environments are expected to perform and such that represent public policy (Bukowski, 2003). In parallel, certain standards are developed as reference codes within almost all countries and have served as regulations, policies, and guidelines through a regulatory system.

There can be seen a slight diversity between standards followed by countries worldwide, influenced by their own economic, political, and social view towards the safety culture. This point of view is mainly as a result of technological, educational, and infrastructure development. The regulatory system of a country is governed by one or more of the three distinctive entities (P.H. Robinson & Robinson, 2018). Legislators, regulators, and stakeholders are the three participants acknowledged in the effect of writing codes and regulation, developing public policy (legislators) and enforcing the laws and regulations (regulators), finally, users of those regulations (stakeholders). Owners, operators, and building designers (architects and engineers) and fire protection engineers were recognized as Stakeholders by Richardson (1993) in this community.

Most of the countries follow the 'Traditional Approach' in which the legislators and regulators actively participate in the regulatory system, excluding the stakeholders. Stakeholders are considered as antagonists of legislators and regulators (Richardson, 1993). The traditional method where prescriptive requirements are presented consists of ‘deem-to-comply’ solutions known for easy-understand and application. Each building is checked for compliance to assess whether building elements are designed according to the given specification. Kurniawan et al., (2018) referred this as a prescriptive based evaluation method. “Prescriptive requirements induce safety factors by constraining design output to pre-established bounds”(Cowlard, Bittern, Abecassis-Empis & Torero, 2013, p.171). However, the drawback is public policies, and codes fall under the above does not address the question as to what extent fire safety is expected from such policies and rather specifies fire safety equipment and architectural designs. One other downside is that it only looks at local properties of buildings where its location is relative to other buildings and environment might play a major role as well. These common downsides of 'Traditional Method' further critiqued by Kurniawan et al.,(2018), stating that dissatisfaction lies for the prescriptive-based guidelines, is the incapability to use as a reference for evaluating building with complex designs and specific functions. It could also increase the cost by meeting overvalued safety levels set by deem-to-comply solutions. As Gehandler (2017) states, in the early stages, the traditional method was predominantly based on investigations done on fire incidents in history. It has been the leading method for building safety. Richardson (1993) affirms negative consequences cause with strictly adhering to prescriptive rules. In case of alteration or occupancy differ from accepted norms adhering to prescriptive codes would lead to safety risks. Also, it does not address how much safety is sufficient, where legislators are uncertain between public safety and economic reality (Richardson, 1993). The application of prescriptive approach could limit to non-complex, small scale building where addressing complex systems is not needed.

Interest in the prescriptive approach in fire safety regulations began shifting to the performance-based method over the past decades states Kurniawan et al. (2018). Performance-based design (PBD) rules considered being flexible, functional, cost-effective, and easily applicable compared to prescriptive rules. What is more appealing is that PBD lets building designers come up with innovative yet cost-effective, better designs for regulatory solutions (Kurniawan et al. 2018). The main disparity between the two approaches is that the prescriptive method focuses on standards and regulations, while the performance-based method focuses on goals, but specific solutions are not stressed (Kurniawan et al. 2018). According to Richardson (1993), Globalization has influenced and yet influencing countries to adopt transparent building and fire regulations without non-tariff trade barriers. This is another reason behind nations to have an interest in performance-based building codes.

It has been more than two decades since Richardson (1993) stated that New Zealand and the United States enacted PBD. For such regulations to be implemented, supporting structures, such as Fire Safety Engineering (FSE) methods, should be accepted (Richardson (1993). FSE method includes not only design tools for calculations regarding egress time, a response time of detectors and structural response but also comprehensive fire risk methodologies to address overall fire safety, says Richardson (1993). PBD regulations are the revolting aspect of FSE. "With performance-based codes and the new fire safety engineering methods, comes a significantly greater need for technically competent designers (users) and regulators."(Richardson, 1993, p.137). Gehandler (2017) affirms with FSE in regulations, and fire safety designs could be developed, adding performance options for prescriptive preferences. As shown in figure 2.4, NFPA 101 Life Safety Code adopted and developing the PBD approach from the latter part of the 20^{th} century to the present.

4.4 Life Safety Compliance Options **4.4.1 Options.** Life safety meeting the goals and objectives of sections 4.1 and 4.2 Shall be provided in accordance with either of the following: (1) Prescriptive-based provisions per 4.4.2 (2) Performance-based provisions per 4.4.3 **4.4.2 Prescriptive-Based Option** **4.4.2.1** A prescriptive-based life safety design shall be in accordance with Chapters 1 through 4, Chapters 6 through 11, Chapters 43, and the applicable occupancy chapter, Chapters 12 through 42. **4.4.2.2** Prescriptive-based designs meeting the requirements of Chapters 1 through 3, Sections 4.5 through 4.8, and Chapters 6 through 43 of this *Code* shall be deemed to satisfy the provisions of Sections 4.1 and 4.2. **4.4.2.3** Where specific requirements contained in Chapters 11 through 43 differ from general requirements contained in Chapters 1 through 4, and Chapters 6 through 10, the requirements of Chapters 11 through 43 shall govern. **4.4.3 Performance-Based Option**. A performance-based life safety design shall be in accordance with Chapters 1 through 5.

Figure 2.4: PBD option in NFPA 101 Life Safety Code (2009)
Source: NFPA 101 Life Safety Code (2009)

It permits the PBD option to apply for a life safety system to be prepared by a qualified professional adhering to the same goals and objectives. It is then to be review by an approved & independent third party appointed by Authority Having Jurisdiction (AHJ) followed with final evaluation by AHJ (NFPA 101, 2009). Besides, NFPA 101 Life Safety Code allows both the Prescriptive-based and Performance-based option to be used by consumers allowing an easier transition for public policymakers and code writers (NFPA 101, 2009). This dual approach could be seen in many other fire regulation guidelines; the European Union, the Americas, and Asia/Pacific. However, Sri Lanka still has not accepted the approach (CIDA Fire Regulations, 2018). Richardson (1993) states that, even though new regulations should focus on PBD goals, the prescriptive method could still prevail for simple designs. The public who intended to build small scale buildings does not have to strictly adhere to PBD and follow straightforward rules of 'deemed-to-satisfy' solutions.

In conclusion, present-day Fire regulation codes are rather a combination of traditional methods and fire engineering (NFPA, 2009; CFPA_E 2011). However, assessing the impact on the level of safety by any of these methods is an open research question since there is no obligation to maximize the fire safety inquiries by any of the AHJs, only an acceptable level. "Generally, there is no legislative or regulatory objective to maximize fire safety" (Gehandler, 2017, p.974). In some performance base-methods practice, there had been limitations as to maximize life-safety as they verified fire-safety to an 'acceptable level' only, explains Babrauskas, fleming, and Russel (2010) as cited by Gehandler (2017). To overcome what is lacking research being carrying out demanding alternative methods or concepts. Many researchers believe, with the regulation and education being two key cases, any change is possible in the practice since performance-based regulations specify outcomes rather than specific solutions (Bukowski, 2003). Researchers propose a conservative and traditional building industry to be inspired also influenced to embrace novel approaches, perceptions presenting spot-on examples. Netherlands practicing System Engineering (SE) for road tunnel fire safety design was an absolute example. “The Dutch infrastructure authority use SE as a working method to administrate their contracts. Consultants have no other option than to adapt and to speak the same language and use the required working methods.”(Gehandler, 2017, p.978). Subsequently, Gehandler (2017) propose fire safety to develop a vision to have no deaths with efficient strategies and concepts for fire safety, taking the 'Vision Zero' road network design philosophy as a model. Fire safety could be strengthened with multiple design perceptions by researchers, and shifting expectations could be addressed. The Regulatory requirements to be updated, persuading stakeholders to take the same path.

2.4.3 Influence of urbanization

More than natural causes, human-made physical environments generate more danger in trapped populated metropolises. Asgary, Ghaffari, and Levy, (2009) affirms a total of 53,589 fires, 304 fire deaths; 2547 fire injuries and billions in property losses in Canada in 2002. Littlewood, Alam, Goodhew & Davies (2017) say 76% of fire-related fatalities happened in dwellings in 2015/2016 in the UK. “Non-fatal casualties in dwelling fires were 76% while in other buildings it was 14%” (Littlewood et al. 2017, p.788). Gas or smoke has caused 40% of fire-related deaths, while 33% of fatalities happened due to burns and another 20% by both burns and gas or smoke during the 2014/21015 period in England, says Littlewood et al. (2017). Beasley, Holborn, Ingram, and Maidment, (2018) states 59% of fires involved refrigerators. “On average, 1,710 of these fires occurred each year, producing 02 fatalities, 56 injuries and $50 million in direct property damage per year.” (Beasley et al. 2018, p.2). The majority (66%) of these have started in the kitchen. The total cost of destructive fires is estimated to be $1 1.0 billion per year in the United States (Glass and Rubin, 1979). Around 12,000 persons have been killed in fires in the United States between 1923-1929 as per Glass and Rubin (1979). "The death rate attributed to fires on a per capita basis in the United States is twice that of Canada, four times that of the United Kingdom, and 6-1/2 times that of Japan” (Glass and Rubin, 1979, p.1). According to Kobes (2008), as cited by Kobes, Post, Helsloot, and de Vries (2008), in the Netherlands, major fires with more than 05 deaths per fire have occurred in residential and in public buildings.

> The major fires in public buildings have occurred in hotel accommodations (4 fires, 63 deaths), psychiatric institutions (3 fires, 31 deaths), homes for the elderly (2 fires, 14 deaths), a crowded pub (1 fire, 14 deaths), a night club (13 deaths) and a detention building (1 fire, 11 deaths).(Kobes et al. 2008, p.6)

Alongside social, technological, and economic drifts with urbanization, population streamed to key cities forming thickly squeezed built environment (Ma, Song, Tian, Lo & Liao, 2012). Kudarsamy (2015) states, the rapid development of the economy caused the cities to grow into major cities through urbanization, and the increased population resulted in limitation of land (Liu, Zhang and Zhu, 2012). In-aid of the situation construction industry boosted vertical building. “According to an annual report (CTBUH), it shows that in the year of 2015, 106 high-rise buildings with total height over 200m were completed in the world.” (Zhang, 2017, p.1). Moushtakim, Islam, and Rubieyat (2018) state, the obvious solution for the housing challenge for a growing urban population is vertical living. Ding, Yang, Weng, Fu, and Rao (2015) says rapid growth in high-rise buildings occurred in the past decades in order to address high demand in office and residential spaces in newly developed cities."In China, high-rise buildings over 200m have increased from 5 in 1990 to over 240 in 2012.”(Sun and Luo, 2014,p.1). Higher the density of buildings and population is, the higher the risk for fire.

High-rise buildings develop with concepts of modernism, maximization, and multifunction. Due to high floors, complex functions, and diversified devices, firefighting and evacuation become challenging than in ordinary construction (Liu et al. 2012). Simply put, urbanization has a great contribution to intensified fire risk. The reason behind fires does not belong to a single category though most of them are electrical. “With the rapid increase in economics and population in the Far East and the increasing number of non-accidental fires, fire ‘safety’ in dense urban areas (especially the development of big cities in China) has to be considered carefully.” (Chow, 2007, p.1). As a result, objectives of fire safety include mainly life safety, the safeguard of property and structures, continuation of day-to-day lives, business operation, health, and environmental protection, etc. Nonetheless, fire safety objectives may vary with the type of operation and occupancy a particular building contains. As an example, Qianli, and Guo (2012) see the following as common objectives of fire safety of a residential building.

- All occupants shall evacuate to outdoor safely within the required time.
- The fire shall be controlled within one unit
- Conditions inside the building shall be favorable enough for firefighters to do firefighting and rescue safely

➢ Fire prevention design can reduce hazards effectively and control property loss within the acceptable range

These objectives are mostly applied for vertical living scenarios. Due to challenges generated by the taller and peculiar architecture in these buildings, it would give new fire safety problems and stretch limits for Fire safety concerns (Poliakova & Grigoryan, 2018). Attention for fire safety in high-rise buildings was always brought-up by the general public and authorities Wong, Farag, and Luo (2006). Chow (2007), Poliakova and Grigoryan (2018), Moushtakim et al. (2018), Liu et al. (2012), Beasley et al. (2018) shows some incomplete statistics on the fires which occurred in the 20th century and 21st century approving the fact that high-rise fires are more intense. "Fire disasters in high-rise buildings were relatively severe during the 1980s to 1990s, then slightly mitigate in 1990s, but in recent years, it has presented upturn tendency since the rapid development of economic construction..." (Liu et al.2012). Table 2.3 shows a list of fire incidences that occurred in high-rise & super high-rise buildings around the world.

Table 2.3: List of fire incidences occurred in high-rise and super high-rise buildings

Date/Year	Location	Incident	Loss/Damage
28.07.1945	New York	Fire in a 102 story skyscraper 'Empire state building.'	Burned from 75th to 79th floor
1972	San Paulo (Brazil)	Fire in a 31 story Andraus Building	16 people were killed and more than 375 injured
01.02.1974	San Paulo (Brazil)	Fire in the 25 storey 'Joelma building.'	179 people were killed and 300 injured
05.05.1988	Los Angeles	Fire in the 62 storey Bank 'First Interstate Bank'	Fire engulfed five floors; one person was killed, more than 40-were injured
17.07.1990	New York	Fire in the skyscraper 'Empire state building.'	38 people were injured
25.02.1991	Philadelphia	Fire in a 38 story skyscraper	
March 1993	Moscow, Russia	Fire in a 25 story building on Marshal Zhukov Avenue	Five people were killed
17.01.1996	City of	Fire in a skyscraper on the	Evacuated around 500

Date/Year	Location	Incident	Loss/Damage
	London	45th floor	people
20.11.1996		Fire happened in an old high-rise building of about 50m height during the replacement of the lift.	
18.12.1997	Jakarta (Indonesia)	Fire in a 25 storey Bank	03 upper floors burned out completely, 15 people were killed
2000	Alexandria	Fire in a textile factor; It started in the middle of the storeroom of this building. This storage room situated in the lower portion of this building. And the fire spread out quickly. A few victims were escaped. After 9 hours, when the firefighters tried to control the fire, then the building collapsed	27 people were killed
11.09.2001	New York	As a result of terrorist attack fire in the world trade center	19 terrorists, 2977 people were killed, 24 were missing
2002	USA	The Santana Row fire, Under construction building with incomplete firefighting system. At first, the fire was seen in the roof, then it spread	Damage cost around 500 million dollars
February 2005	Madrid	Fire in the 106 meter Windsor tower in the business district	No victims
November 2005	Moscow	The fire burned down a 25story building on the Second Setun passage	Four people were killed, 15 were saved
May 2006	Astana, Kazakhstan	Fire in the 32storey 'Transpore tower.'	No injuries reported
16.01.2006	Vladivostok, Russia	Fire in a 9-story building	Nine people were killed, 17 were injured
23.02.2006.	Chittagong, Bangladesh	Fire at KTS Textile Industries, caused by a short circuit; there were between 400 and 500 people in the factory. The main gate had been blocked to prevent theft. There was no fire-fighting equipment, and no drills had ever been done	61 deaths, about 100 injured

Date/Year	Location	Incident	Loss/Damage
14.08.2007	Pudong New Area, Shanghai, China	A fire occurred in the 492m high101-level Shanghai World Financial Center while under construction	
February 2009	Beijing, China	CCTV/TVCC tower building fire	The fire spread 44 floors in around 15 minutes
17.04. 2009	Hubei Province, China	A fire took place in the office building of Wuhan government	
19.04.2009	Jiangsu Province, China	International Square Building of Nanjing	
15.11.2010	Jingan area in Shanghai	Fire at a high residence building	
14.12.2010	Dhaka, Bangladesh	Fire at Sportswear (Hameem Group) caused by a short circuit	29 dead and 11 serious injuries
24.11.2012	Dhaka, Bangladesh	Fire at Tazreen fashion factory, caused by a short circuit.	112 dead and 200 serious injuries
June 2017	London, UK	Fire in a high-rise residential tower, 'Grenfell Tower' block A fridge-freezer is also suspected to be a possible initial cause	Massive loss of life and catastrophic Structural damage

(Chow, 2007), (Poliakova and Grigoryan, 2018), (Moushtakim et al., 2018), (Liu et al., 2012), (Beasley et al., 2018), (Hu, Milke, and Merci (2017))

The above statistics reveals that fire-proofing is still a major difficulty in high-rise and super high-rise buildings around the world. Most of the cases did not end until it resulted in a catastrophic loss of human lives and properties. "11.15" Shanghai disastrous fire aroused profound consideration of the fire safety of high-rise residential buildings in China. This disaster was caused by the energy-saving project of the building, not because of the design of the high-rise building itself…"Qianli and Guo, 2012, p.685). Liu et el (2012) refer to three characteristics of high-rise buildings that encourage this difficulty.

1) Complicated Construction
2) Complicated Functions and high population density
3) Multiple combustibles and large fire load.

Increased height, number of floors, special architectural or engineering features, modern technological appearances, and many other reasons are behind high-rise buildings being contractually complex. These constructions are sometimes mixed-used buildings, including residential, hotel, retail, and offices, etc. And different functions require the use of various finishes with combustible materials, such as ceilings, partitions, wall covers, curtains, etc. whether decorative or not. These characteristics attract three major fire risks. Liu et al., (2012) and, Qianli and Guo (2012) state those as follows.

1) Rapid fire and smoke

   Fire and smoke can be spread easily to the upper floors of high-rise/ super high-rise buildings due to the 'chimney effect.' If the fire and smoke control measures are inadequate, fire spreads rapidly through staircases, elevator shafts, and ducts in a very short time (Qianli and Guo, 2012).

2) Difficult firefighting and rescue

   Height of high-rise/super high-rise buildings makes it difficult to extinguish fires from exterior and need to depend on inside fire apparatuses. Similarly, it is extremely difficult to extinguish fires that occur in high-rise buildings/ super high-rise due to strong thermal radiation, the speed of fire spreading and lack of fire and water, etc. as Liu et al., (2012) states.

3) The difficult safe evacuation of the occupants

   Liu et al., (2012) state three reasons for the above. Because of the height and many numbers of floors evacuation takes a long time. Concentrated population density is another reason. Once a fire occurs, fires and smoke could spread quickly as airflow is not controlled.

Wong et al., (2006)say challenges in ensuring fire safety in high-rise buildings could be summarized into six major areas.

1) Fire department accessibility,
2) Egress and people movement,
3) Stack effect,
4) Increase in occupant and fire load,
5) Combination of occupancies, and
6) Arrangement of internal utility services.

Many fire hazards that occurred in high-rise buildings have proved that the survival of occupants depends on the behavior of occupants (Pastukhov, 2020). The possibility of survival is determined by their fire response performance (Kobes et al., 2008). According to Kobes et al. (2008), 'Fire Response Performance is "..the ability of an individual to perceive and validate signals of danger and to make and carry out decisions that are effective relating to survive a fire situation with none or little health complications afterward". This is affected by the design of the building, the behavior of the surrounding people, and the effect of fire (Kobes et al., .2008). Kobes et al. (2008) presented three distinct strategies for survival. 1) Try to extinguish the fire, 2) Shelter, and to wait for rescue and 3) Evacuate. Considering the population density in high-rises/ super high-rise, it has always been a difficult challenge to evacuate all of them at the same time in case of an emergency (Soltanzadeh, Alaghmandan, and Soltanzadeh, 2018). Evacuation is explained as the process where people notice a fire in a building and move outside to a safer place by experiencing several mental processes and carry out several actions (Kobes et al., 2008). Due to the inborn risk, emergency evacuation is one of the most important issues in high-rise/super high-rise fire hazard cases. Soltanzadeh et al., (2018) present three Evacuation types; 1) Full evacuation, 2) Stage evacuation (Phased evacuation), and 3) Delayed evacuation. Safety with respect to 'evacuation' is measured in time.

> …the time required for all occupants to reach the outside of a building. The shorter this time, the safer the building is deemed to be. The height of many modern tall buildings, combined with the limited number of vertical escape

routes, extend travel times such that the stairwells must act as the outside. (Cowlard, Bittern, Abecassis-Empis & Torero, 2013, p.172).

The height of the building affects the time to evacuate occupants. (Torero, Quintiere and Steinhaus, 2002) As Cowlard et al., (2013) and Torero et al., (2002) explains, the higher the building is, the greater the risk for human life. Means of escape/egress are designed according to prescriptive codes or design guidance under functional regulations. In addition to traditional direct evacuation via stairs, approaches involving refuge areas and evacuation lifts are adopted as means of escape provisions in these regulations. As Boyce (2017) states, design decisions are based on engineering calculations in countries with functional regulations related to movement and evacuation models done using a computer. But nationally, only the prescriptive codes are available in aid of designing evacuation provisions (CIDA Fire regulations, 2018). The evolution of traditional standards is a timely necessity with the growing complexity in building construction and the thick nature of assorted population density due to urbanization. Adoption of assumptions regarding flows and suitable flow times for generalized prescriptive standards is a timely necessity (Boyce, 2017).

As a major component in the construction field, high-rise buildings need adequate methods to reduce the probability of fire and directly protect people from fire. "In order to meet the above requirement, plenty of relevant research studies have been carried out, and more and more building codes, such as NFPA 101 in the U.S. (NFPA, 2012), have incorporated changes to reflect the research advances."(Hu et al., 2017, p.1).

2.5 Causes of Fire hazards

Causes of fires in the super high-rise category of buildings are mainly accidental causes and incendiary causes (Lawal, Chandra, and Bichi, 2018). Accidental fires occur mainly due to electrical fires caused by arcing, sparking, and overheating

(Lawal et al., 2018). An incendiary fire outbreak is either malicious, deliberate or gross carelessness (Lawal et al., 2018). Fraud fires like arson fires could be named as the most destructive cause of fires under incendiary causes (Lawal et al., 2018). A few common patterns that triggered fire incidents can be identified based on past studies. Jennings (2013) states fires can start from internal (dwelling) sources or external, which has limited control. Internal means are controllable, which needs the full contribution of designers and stakeholders in the pre-construction phase. Lack of design comprehensiveness, adequate regulations, regulation practices, attention, education, and issues in fire safety management, can be seen as reasons in many research conclusions. The following are a few of the causes identified by various researchers and publications on the subject matter. However, causes that are outside control, such as terrorist attacks, are not discussed here.

2.5.1 Lack of comprehensive design

Glass and Rubin (1979) state due to complexity in adopted design features and technological approach make fire safety to be hardly-offered. Those will contribute to rapid heat build-up, the spread of fire, and, ultimately, smoke spread through air ducts. Sharry (1974) and Willey (1972) as cited by Glass and Rubin (1979) recognized absence of illuminated emergency exit signs, lack of emergency illuminations, absence of manual alarms and automatic detection or extinguishing system and absence of procedures to deal with fire emergencies as the prime factors contributing to a loss of life and injuries in fire hazards. Qianli, and Guo (2012)see the importance of comprehensive fire-safety design in support of a) secure the safe evacuation of occupants b) control early-stage fire and c) control smoke spreading. Glass and Rubin (1979) further indicate the insufficiency of solutions to compensate these risks. Koo, Kim, Kim, and Christensen (2013) highlight the importance of addressing heterogeneous population-sensory and mobility-impaired people-while designing the building structures, mainly evacuation. Occupants with mobility disabilities are likely to impede the evacuation route of other occupants due to slower speed, large space requirements and need for significant assistance (Koo et al., 2013). Therefore it is necessary to adopt a strategy in every super high-rise to evacuate people with special needs using elevators. This should be done without interrupting firefighting and using fire fighter's lifts. Enormous heights of super high-rises make the firefighting from outside fairly difficult. Hence the building design should be self-defensive and self-saving. If the overall design is not competent enough to fight fire hazards with passive strategies and active technology for indoor fire apparatuses, it would be difficult to put out fires, especially in low and mid standard buildings. Egress strategy and building performance are the two important aspects of a fire safety plan. A holistic fire safety strategy for every super high-rise is obligatory (Cowlard et al., 2013).

2.5.2 Inadequate fire resistance of materials used

Hu et al., (2017) discuss the issues of resistance for fire with commonly-used materials, further stating that "Complex building structures could also lead to specific fire evolution behavior." (Hu et al., 2017, p.2). The use of organic insulation materials based on exterior walls for energy-saving purposes can aid fire spread over the surfaces (Hu et al., 2017). Chow (2006) also debate on the use of fire-triggering characteristics of contemporary materials. In Sri Lanka, these are observable flaws (CIDA, Fire Regulation 2018). Usage of combustible materials and fire load is usually highest in super high-rises. A high amount of combustible materials used for decorations, wallpapers, curtains, plastics, and clothing could effortlessly quicken the spread of fire. On the other hand, architectural features such as using a high amount of glass may create issues with explosions exposing to extreme heat.

2.5.3 Issues in engineering designs

Pang and Chow (2011) identify problems related to engineering in super-tall buildings. Experiencing high pressure at lower levels to maintain required pressure levels at top floors, stack effect at vertical shafts, strong winds are observed as system failures in fire safety measure. All these relate to shortcomings in not only architectural & engineering fields but also socio-economic fields as well. The structures of all super high-rises need to transfer their loads while supporting complex building operations efficiently. A developed complex and highly optimized structure could efficiently redistribute the deformations and resultant loading caused by fire (Cowlard et al., 2013).

2.5.4 Inadequate construction methods

During the second phase, 'Physical-Construction', no special procurement method is followed for selecting contractors giving priority to stop fire-occurring and spreading. Standard construction methods are followed by a few categories of contractors; many other contractors do not use technology for a precise outcome, creating possibilities for fire hazards by practicing haphazard construction methods. This can happen with overlapping subcontractors' work. These construction defects occur due to several reasons, human errors in workmanship, non-standard construction site practices, incorrect fitting, and missing components such as insulation, temporary fixes, and damages to components during other installations by subcontractors or inadequate details submitted by the consultant (Littlewood et al., 2017). As Littlewood et al.,(2017) state, design approaches depend on carefully installed products for laboratory testing to meet the required standards. But during the construction, lack of knowledge of the operator and time or resource constraints may lead to construction defects in installation affecting the building's performance.

2.5.5 Lack of Fire Safety Management (FSM)

Sun and Luo (2014) state proper management is essential to lower the chance of fire occurrences and to lessen the consequences. Fire safety can be easily compromised by weak management. The growing complexity of buildings and fire safety systems stresses the management than it has been (Ebenehi et al.,2017). If the fire management system is not strict and the staff is not strongly responsible, fire casualties cannot be curtailed. When it comes to regularized fire prevention and protection strategies of a building, it’s an obligation of the top and middle management to fully support throughout the operation phase (Rezvani & Hudson, 2016). If the leadership cannot truly understand the relationship between long-term development and fire safety, then again, fire safety can be easily neglected (E& Zhou, 2016). FSM program should be based on sound fire safety concepts (Della-Giustina, 2014). FSM consists of eight elements; namely,

- Inspections
- Education and training
- Fire suppression
- Emergency services
- Evaluation of fire possibility
- Fire prevention
- Reports and record-keeping
- Communications, as stated by (Ebenehi et al. 2017).

Negligence in any of those will result in increased fire risk since all eight elements are in link with each other. However, it's a common scenario that practicality is in contrary with requisite.

Gerges et al., (2017) state there are a number of reasons for people to become personal victims and get seriously injured or may even lose lives in a fire situation. First and foremost cause Gerges et al., (2017) identifies is the uncertainty occupants face as to how to behave in a fire and secondly inability to escape to the ground floor within a safe period of time. Gerges et al., (2017) also state in research aimed at investigating the behavior of occupants under a fire situation, education, knowledge, and age, influence occupant's behavior in a fire risk situation. Cordeiro et al., (2014) stated as further cited by Gerges et al., (2017) in research conducted for the same, but in a different context, nearly 50% occupants are uncertain as to what action they should take during a building fire situation. These factors could also trigger the loss of life and injuries. (Della-Giustina, 2014) identifies, education and training is a significant element in FSM, and through those people are more likely to recognize fire safety hazards and less likely to fuel them.

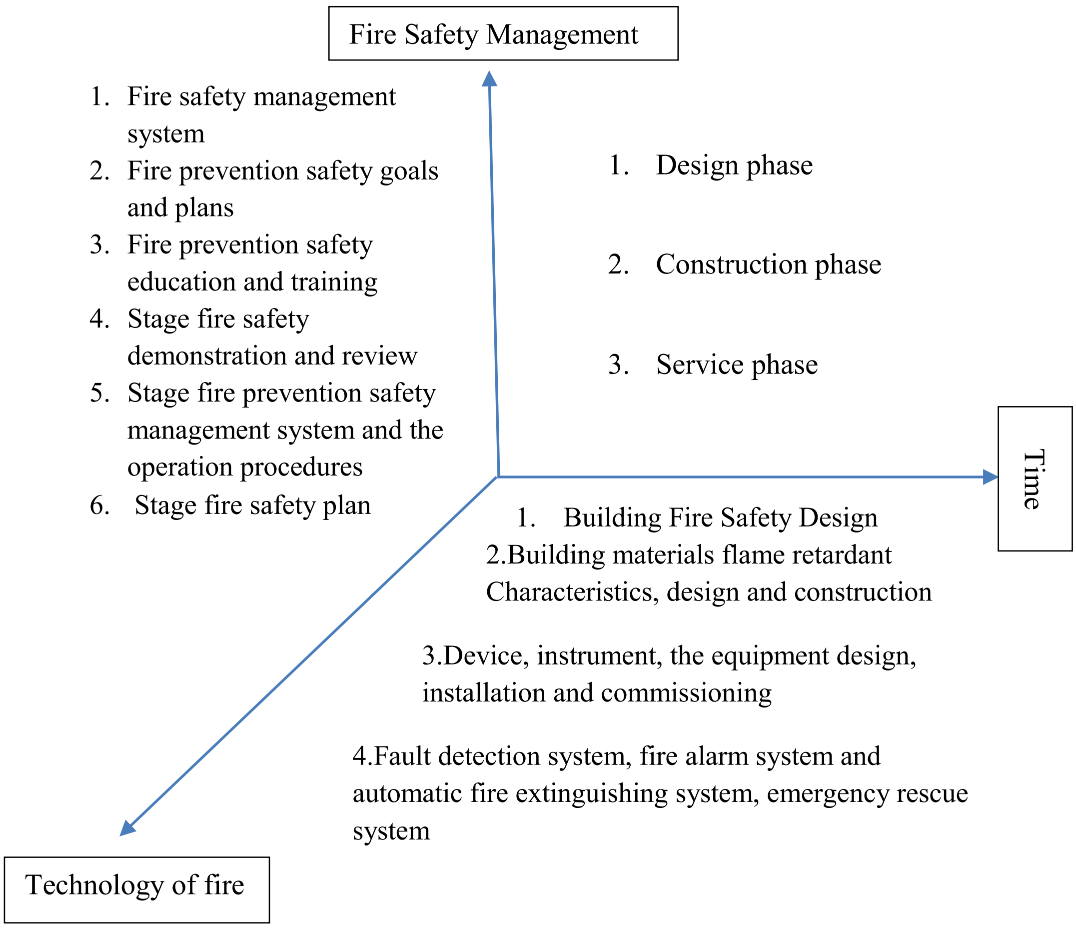


Figure 2.5: The composition of a high-rise building fire system

Source: Liu Et al., (2012)

Fire safety is divided into two distinctive areas, passive and active (Gerges et al., (2017). Passive refers to the primary building structure and elements. Means of escape are the prime focus in the passive fire protection system. Simultaneously fire safety requirement varies from residential and non-residential situations. Specifically, occupants in residential buildings are required to be familiar with the building environment and its escape routes (Hung and Chow, 2001). While it's critical not to obstruct the escape accesses in an emergency situation, buildings should be managed in a manner in which they are maintained in standby condition.

Walls (2001) says building occupants should always diligently monitor aspects pertaining to means of egress. He admits all occupants should know that they are always permitted to escape quickly and how to do so. Any smoke-filled escape route, locked doors, or obstructions in the escape way should not restrain or delaying occupants from evacuating. The working condition of many active protection and firefighting appliances does not undergo regular inspections and maintenance. This results in a high risk of failing to support rescue in an emergency. Littlewood et al, (2017) highlight the fatalities due to the dysfunction of active safety systems in a study done with fire safety professionals.

> In 2014-15, Fires, where a smoke alarm did not work or did not raise the alarm, accounted for 38% of all dwelling fire fatalities. A study showed that over 80% of the sleeping children (aged between 2 years to 13 years) tested did not respond to the sound of the industry-standard smoke detector. (Littlewood et al., 2017, p.790).

Laban, Milanko & Folic(2006) talks about low fire-resistant characteristics in case studies done in a group of late 20th century built residential towers, which has limited to no maintenance or testing in passive and active safety measures. Pang and Chow (2011) mention three key problems identified with management related to a survey done in existing super tall buildings. Obstructing staircases, decoration of hose reel cabinets, and blocking of fire service inlets have observed in the survey.

Fire Safety Management encompasses the whole life-cycle and includes day to day operations and changes in building, changes in use, according to Ebenehi et al., (2017). The management committee of the high-rise apartment building holds the responsibility for managing the dwellers' safety. To manage fire-hazards, a competent person in fire-safety should be appointed. However in most situations, the appointment of a building management officer isn't based on proper education & skills. His duties include total control of daily building safety management. But its practical execution is yet questionable. Except for built-in reasons for fire safety design, majority of the reasons for fire hazards are caused by defaults in management (Liu et al., 2012).

2.5.6 Lack of attention by occupants

Another perceived reason is the lack of attention by the occupants, as Sun and Luo (2014) state. Sun and Luo (2014) classify the fires occurred in high-rise buildings as categories I and II and identifies potential fire load and sources of fire ignition for each category. Category II fires are mostly caused by the ignorance/carelessness of occupants such as careless smoking, careless use of cooking utensils, improper operations, etc.

2.5.7 Lack of regulation

Inadequacies of regulation can also trigger fire damages. Adhering to a suitable approach being flexible for designers/developers to adopt, prescriptive, performance-based, or mixed-method, would make fire safety fully-approachable. However, in locally practiced fire regulations, the only method available is the prescriptive approach (CIDA, Fire Regulation 2018). Regulations should be updated to address imminent issues related to fire prevention and fire-fighting. As the occupancy class changes, the provided measures might be inadequate for firefighting, causing a higher level of damage. Walls (2001) mentions that even for a small renovation being carried out in a building, the authority could require upgrading means of escape properties in the whole building. In local regulations, Sri Lanka doesn’t have proper regulations to cover renovation or change of use (CIDA, Fire Regulation 2018).

Relatedly, during the second phase, 'Physical-Construction' no special procurement method followed for selecting contractors giving priority to lessen fire-occurring and spreading. Standard construction methods are followed by a few categories of contractors; many other contractors do not use technology for a precise outcome, creating possibilities for fire hazards by practicing haphazard construction methods. This can happen with overlapping subcontractors' work. These construction defects occur due to several reasons, human errors in workmanship, non-standard construction site practices, incorrect fitting or missing components such as insulation, temporary fixes, and damages to components during other installations by subcontractors or inadequate details submitted by the consultant (Littlewood et al., 2017).

Clauses specified in regulation for inspection and maintenance helps to maintain required fire safety measures in the operation phase. Littlewood et al., (2017) describe the insufficiency of regulations for proper evaluation of adopted safety measures. "…there are no approved construction details or a physical test method to determine the effectiveness of active and passive fire prevention measures and compliance with Approved Document B, of the England and Wales Building Regulations." (Littlewood et al., 2017, p.789). Chow (2011) says about 80% of fire cases in Hong Kong occur in domestic-use buildings, and possible reason is due to Fire Service Installations (FSI) required for high rise residential buildings are not as stringent as others in the local fire codes. Besides, the high-cost accompanying installations and annual inspections on FSI might be the other reason for missing the systems in residential buildings, states Chow (2011). Due to the provisions for practicing regulations is limited, results might mislead while testing and assessing fire risks. This could be generally seen in inspection procedures. Even if the detailed inspection is contractually permitted, defects cannot always be uncovered with available inspection methods. Littlewood et al., (2017) argue that the available visual inspection approach is inadequate to identify gaps and defects in compartmentalization construction and fire stopping details, particularly in concealed spaces. This is mainly due to construction details required to be hidden behind layers of materials and components. The downside of the scenario is that inadequacy in comprehensive regulations will not facilitate a good fire safety practice.

> regulators such as building control (new buildings) or fire and rescue authorities (existing buildings) are not always able to thoroughly check the installed performance of inbuilt fire safety measures, the assurance of achieving relevant regulation or standards is not known. (Littlewood et al., 2017, p.789).

Although a super high-rise building armed with carefully done design, without efficient management, it can easily be a victim of fire-hazards. In the third phase of project life-cycle, adhering to fire-safety measures in operation is also an important aspect, but to be the most neglected."…fire safety strategy for a specific building requires management policies and procedures for the strategy to function effectively"(Ebenehi et al., 2017, p.1). After designing and construction of a super high-rise building, the adopted fire-safety strategy should be continued throughout the rest of the life-cycle, such that active and passive fire-safety measures should be well checked and maintained. "the relationship between the personnel and the system of machine-environment in management should be coordinated" (Liu et al.,2012, p.644). If the fire-safety management failed to identify potential risks associated with and around the premises and carry out an effective assessment of adequate measures, countless harm might arise. Littlewood et al., (2017) states, in England during 2013-2014, 2.5 million or 11% of households either did not have a smoke alarm or it was not working, around 0.3 million households (1%) were not aware of the working condition of a smoke alarm. In the 2014-2015 periods, these fatalities accounted for 38% of all dwelling fire casualties (Littlewood et al. 2017) as such evidence proves that there is an urgent call for checking the in-build performance of both active and passive systems installed in buildings to verify their effectiveness in real scenarios. Periodic inspections and fire drills help to maintain a prepared pose for an emergency situation. However, nature and frequency of inspections are based on building fire-safety code requirements (Walls, 2001).

Hence the limitation on regulation practice is also seen as a major cause that supports fire damages. To take direct action against those who violate the regulation, having jurisdiction powers for national fire services is also an important factor. Cases where culprits were brought before the law directly by fire services, have been seen internationally but not locally. Littlewood et al.,(2017) affirm in the UK there were high court actions against a contractor, and a local council pleaded guilty against two fire hazard incidents respectively in 2015 and 2017 where loss of lives and injuries took place. In both cases, local fire services succeeded in the prosecution against lawbreakers (Littlewood et al., 2017). However, in Sri Lanka, the fire department hasn't been assigned such authority yet (CIDA, Fire Regulation 2018).

2.6 Provisions in regulation for evacuation

Gehandler (2017) also recognize fire safety as a combination of Fire prevention and Fire Protection with the concern of lessening the ways in which fire can start, prevent or minimize the fire spread and providing safe evacuation. Fire prevention is said to be the most important one out of the two. Fire protection involves in 'First-aid' fire appliances for extinguishing small scale fires to large-scale fires to perform by fire-brigade, and these two objectives are still in existence in some Regulatory requirements (Gehandler 2017). As Torero et al., (2002) explains, super high-rise possess greater risk with the increasing height of buildings. Due to complex design and operation in super high-rise buildings evacuation has become challenged than an ordinary. At any rate, comprehensive fire-safety design supporting evacuation is a necessity.

Provisions provided in regulations for supporting evacuation falls under means of escape/egress section. Both NFPA 101 Life Safety Code and CIDA fire regulations provided regulations under means of escape/egress.

2.6.1 Provisions in NFPA

NFPA 101 Life Safety Code elaborates on the clauses supporting emergency evacuation in Chapter 7, under 14 sections (figure 2.6).

Figure 2.6: Key sections listed under chapter 7; 'Means of Egress' in NFPA 101 Life Safety Code

Table 2.4 illustrates details of emergency evacuation practices under each key section in Chapter 7 of NFPA 101 Life Safety Code (2015). Further, Appendix A elaborates the focuses consigned under each key section demonstrating the comprehensiveness of international fire safety Code.

Table 2.4: 14 Key sections in the Chapter 7; Means of egress in NFPA 101 Life Safety Code

Key Sections in NFPA	**Section Title**	**Summary of code under key section**
Section 1:	General	Means of egress for both new and existing buildings have to be according to this chapter. A list of special terms and definitions discussed in the chapter. 11 numbers of related sections are provided under this key section.
Section 2:	Means of Egress components	Detailed conditions listed out for each important component of means of egress such as door openings, stairs, smoke-proof enclosures, horizontal exits, ramps, exit passageways, escalators and moving walks, fire escape stairs, fire escape ladders, slide escapes, alternating tread devices, areas of refuge, elevators in a tower. 13 numbers of related sections are provided under this key section.
Section 3:	Occupant load	Means of egress conditions to be fulfilled depending on the occupant load for each building are described here. 4 numbers of related sections are provided under this key section.
Section 4.	Number of means of egress	A number of means of egress discussed according to the occupant load, elevator landing, and lobby exit access and spaces about electrical equipment. 2 numbers of related sections are provided under this key section.
Section 5:	Arrangement of Means of Egress	Arrange means of egress in a way to easily access it during an emergency situation. 4 numbers of related sections are provided under this key section.
Section 6:	Measurement of Travel distance to exits	Conditions and limitation when designing the travel distance to exits is discussed
Section 7:	Discharge from exits	Exit termination in a public way or at an exterior exit discharge, exit discharge through internal building areas, and how to arrange and mark those exits are discussed here. 6 numbers of related sections are provided under this key section.

Key Sections in NFPA	Section Title	Summary of code under key section
Section 8:	Illumination of Means of egress	Conditions to fulfill when illuminating means of egress are motioned here, including the sources of illumination. 2 numbers of related sections are provided under this key section.
Section 9:	Emergency Lighting	Designing, performance requirements, and periodic testing of the emergency lighting system are discussed here. 3 numbers of related sections are provided under this key section.
Section 10:	Marking of means of egress	The requirement of marking the exits, conditions for exit signs, No exit signs and directional signs, illumination, power source, and testing of those signs are discussed. 9 numbers of related sections are provided under this key section.
Section 11:	Special provisions for occupancies with high hazard contents	Conditions and limitations for means of egress for high hazard areas are discussed here. 6 numbers of related sections are provided under this key section.
Section 12:	Mechanical equipment rooms, Boiler rooms, and furnace rooms	Designing of these areas and similar spaces in a way that is not limiting the common paths of travel is discussed here.
Section 13:	Normally unoccupied building service equipment support areas	The hazard of contents, egress doors, egress path, illumination requirements, and a number of required means of egress for these particular building areas are discussed here.
Section 14:	Occupant evacuation elevators	Requirements for designing and installing occupant evacuation elevators, including fire detection, alarms and communication systems, elevator machine room spaces, and elevator lobby sizes, are discussed here. 9 numbers of related sections are provided under this key section.

These 14 key sections can also be identified as prescriptive based and PBD based. Further, some of them are focused on design phase while others are on operational phase (refer table 2.5). However, key section 'Means of Egress Component' is related to both design and operation phases Means of egress components, emergency lighting, marking of means of egress, and occupant evacuation elevators were the four key sections recognized as focuses on the operational phase.

Table 2.5: Key sections related to design and operational phase, and prescriptive and performance-based.

	Prescriptive based	Performance Based
Design phase related	7.1 General	7.2 Means of Egress Components
	7.3 Capacity of Means of Egress	
	7.4 Number of Means of Egress	
	7.5 Arrangement of Means of Egress	
	7.6 Measurement of Travel Distance to exits	
	7.7 Discharge from Exits	
	7.8 Illumination of Means of Egress	
	7.11 Special Provisions for Occupancies with High Hazard Contents	
	7.12 Mechanical Equipment Rooms, Boiler Rooms, and Furnace Rooms	
	7.13 Normally Unoccupied Building Service Equipment Support Areas	
Operational Phase related	7.9 Emergency Lighting	7.2 Means of Egress Components
	7.10 Marking of Means of Egress	
	7.14 Occupant Evacuation Elevators	

The remaining ten key sections focuses solely on the design phase. Means of egress section has allowed PBD requirements only on key section 02 (7.2-means of egress components).

2.6.2 Provisions in CIDA Fire regulation

Local fire regulation published by Construction Industry development Authority (CIDA) (CIDA Fire Regulation, 2018), provides details of design, construction, protection, location, arrangement and maintenance of required exit facilities to provide safe means of escape from all new buildings and buildings altered or changes in occupancy (CIDA, Fire Regulation, 2018). Compared to international code CIDA Fire Regulation, 2018, does not display any key section or category under chapter 2; 'Means of Escape' (refer table 2.5). Instead it displays set of 'Expressions' and pertinent 'Definition' (CIDA, Fire Regulation, 2018). Table 2.6 indicates the relevant sections or for fire.

Table 2.6: CIDA Fire Regulation (2018) under Chapter 2; ‘Means of Escape’.

Reg. No	Expression	Reg. No	Expression
2(1)	General	2(29)	-ditto-
2(2)	Staircase identification	2(30)	-ditto-
2(3)	Definitions and General Requirements	2(31)	-ditto-
2(4)	Determination of Exit Requirements-General	2(32)	Fire Dampers
2(5)	Mixed Occupancy	2(33)	Air duct Access and Inspection
2(6)	Multiple Occupancy or Use	2(34)	Engineered Smoke Control System
2(7)	Non-simultaneous Occupancy	2(35)	Activation
2(8)	Exit Requirements-Capacity of Exits and Exit Facilities	2(36)	Shut down of Air-conditioning systems
2(9)	Minimum Widths	2(37)	Fire Dampers
2(10)	Maximum Widths	2(38)	Means of Escape Requirements
2(11)	Measurements of Width	2(39)	Exit Passageways
2(12)	Number of Exits from Rooms and Spaces	2(40)	Internal Exit Passageway
2(13)	Number of Staircases or Exits per Storey	2(41)	External exit Passageway
2(14)	-ditto-	2(42)	Internal Staircases
2(15)	-ditto-	2(43)	Handrails Balustrades etc.
2(16)	Exit Reduction	2(44)	Ventilation
2(17)	Location of Exits	2(45)	Facility for Re-entry
2(18)	Smoke-Free Approach Staircase	2(46)	External Staircases
2(19)	Smoke-free Lobby	2(47)	Scissor Exit Staircases
2(20)	Firefighting Lobby	2(48)	Hardwood Staircases
2(21)	Cross Ventilated Corridor	2(49)	Spiral Staircases
2(22)	Smoke-free Approach in basement	2(50)	Exit Ramps
2(23)	Pressurized Systems for Stairways	2(51)	Exit Doors
2(24)	Pressurization of Exit Stairways	2(52)	Area of Refuge
2(25)	Pressurization of Internal corridors in hotels	2(53)	Emergency Lighting
2(26)	Pressurization Level	2(54)	Exit and Directional Signs
2(27)	Exit Doors	2(55)	-ditto-
2(28)	Smoke Control System	2(56)	-ditto-

2.7 Chapter Summery

Across the centuries every country or great city has been wrecked by fire. During those many years, mankind learned fundamental principles of governing our plant and had earned remarkable cultural, educational and technological advancements, but had not learnt to control the elements of fire, faced numerous disastrous events as Healy (1970) said. And history repeats. During the 17th - 19th century, importance of fire protection was predominantly acknowledged and many of the advancements in fire protection engineering were ushered in by the influence of insurance companies in 20th century. Fire protection engineering is the application of science and engineering principles to protect life and environment of people from fire. During the 20th century fire safety standards and building codes were the primary means of applying fire protection engineering for life and property safety. Experiences distilled from facing catastrophic fires have been applied to revise the regulations. At the time, knowledge base for supporting fire protection engineering was influenced by other professions, in particular civil, mechanical, electrical and electronic engineering, architecture, and psychology and continued to grow. Refinement of fire regulations were backed by many of these research studies over decades.

Rapid development and urbanization contributed to the growth of many major cities. As a result large scale vertical buildings over 100-meters in height emerged as super high-rises. Due to inborn complexity these buildings possess a greater risk of fire. Proper carrying out of design and operational phases are vital and means of escape provisions in an emergency is crucial depending on the height and complexity. At the beginning of 21st century, computer based methods for evaluating fire protection continued to develop. PBD approach is being used for peculiar structures which cannot be adequately protected with prescriptive guidelines or traditional method. Dual approach is practiced worldwide. An adequate and up-to-date set of regulations to provide promising fire prevention and protection from hazards is a prevalent need in every country.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The intention of this research is to investigate the limitations in local fire safety code with relation to international code and limitations in the practice of existing local code and super high-rise buildings throughout the design and operational phases of super high-rise buildings. By identifying these limitations, it is open for discussions to find out measurements to ascertain and take actions to fill these limitations. Qualitative method research design was used to investigate the limitations in fire safety between the current and the required level of fire safety.

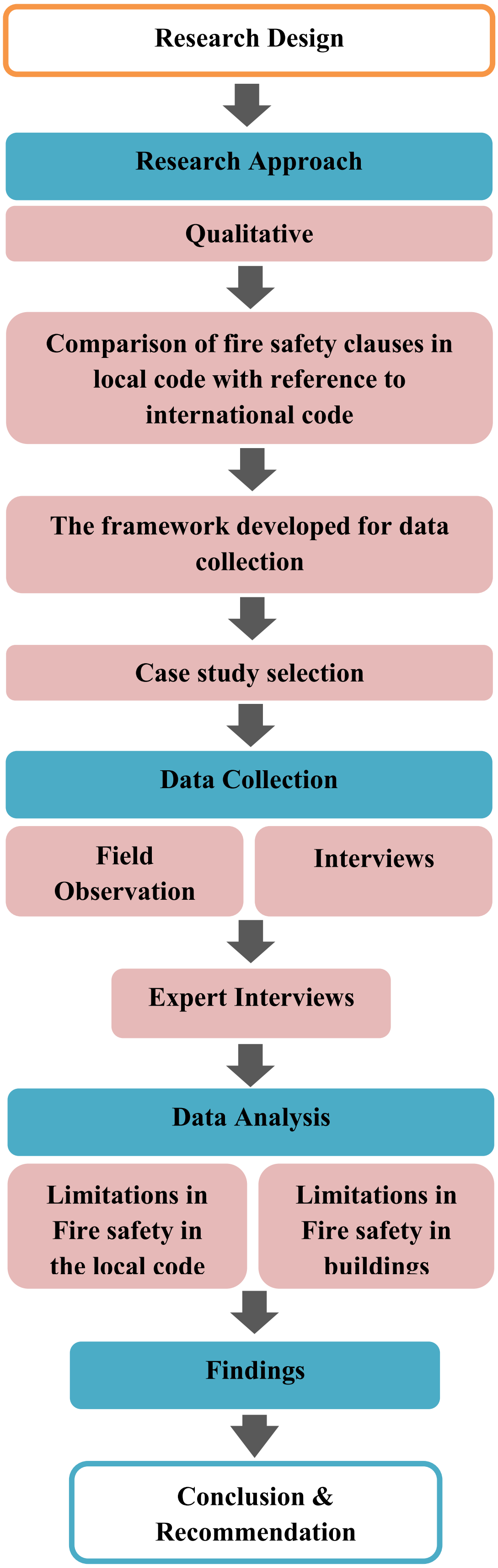
3.2 Research Design

Research design contains the process that inquires a plan to carry out the research successfully. Pandey and Pandey (2015, as cited by Zidhna, 2017) state, 'A research design is a plan or the overall framework used as a guide to collect, formulate and analyze the data needed for the research. Considering the nature of research and data to be collected in the field in purpose of the problem, the research method is established.

3.2.1 Research Approach

A qualitative method approach is used in this research as the research methodology. Figure 3.1 shows, in brief, the research approach for the study. As William (2007,as cited in Zidhna, 2017) states 'Quantitative research is a holistic approach which results in discoveries and cannot easily be reduced to numerical values (Leedy & Ormrod, 2010, as cited in Zidhna, 2017).

Figure 3.1 Research Design



The total list of clauses under 14 key sections in 'Means of Egress' component in the international code; NFPA 101 Life Safety Code (2015), were studied and relevant clauses of local code (CIDA Fire Regulations 3rd edition (2018) were identified. A framework prepared in comparison of the clauses of international code and local code accordingly classified under each key section. Limitations in local code were identified with respect to the international code. Appendix A indicates the Comparison between the two codes.

'Means of Egress' component of super-high-rise buildings are to be observed under the framework prepared with 14 key sections. The basis for the data collection of case studies is on active and passive approaches in buildings required to adopt to facilitate means of egress component according to the local code. Passive measures preferred during the design stage are integrated into the building structure from the pre-construction stage, and active measures are incorporated after completing the main structure. Hence design features and operational attributes were studied.

3.3 Selection of Case Studies

For the purpose of finding limitation in practice between the local fire safety code and buildings, studying selected sample cases were required. The basis for selecting case studies was the CIDA Fire Regulation 3rd Edition, June 2018, under the Ministry of Housing and Construction. This edition first provides a definition for Super High-rise building in Sri Lanka as 'any building greater than 60m in height, where the building height is measured from the lowest level of fire department vehicle access to the floor level of the highest occupy-able story' (CIDA, Fire Regulation 2018). In order to comply with the field observation requirements, either ongoing and post completion or near completion, above 60 m buildings were selected situated within Colombo Urban City. A list of Super High-rise buildings identified under the Fire Service Department were obtained for sample selection and contacted for gaining approvals for field observation. Only four responses were received. Two buildings were in near completion, and the other two buildings were already commissioned. Out of the four respondents, only three buildings permitted to be comprehensively observed due to security and safety concerns in which access was gained with the help of personal contacts. Two case studies out of three access-allowed Super High-rise buildings are already commissioned, and the other case study was in near completion stage.

Selected three case studies were among the number of super high-rise buildings that emerged in Sri Lanka after CIDA Fire Regulations first mentioned the term 'High-rise Buildings' in 2nd Edition (Revised) December 2006 under Ministry of Housing and Construction. Table 3.1 gives a brief introduction to each case study and indicates the purpose group each case study belongs to according to CIDA Fire Regulations' classification of purpose for which the building is intended to be used.

Table 3.1: Introduction to case studies

Case Study	**Description**	**Area**
01	The building belonged to purpose group classification 2 (b); Hotel under local fire regulations and owned by a worldwide hospitality chain. The building was designed by a foreign architectural company and developed by the foreign hospitality group.	72,433,092ft^2
02	The building belongs to purpose group classification under local fire regulations', 1 (a); Residential Apartments or flats. The design was done by a foreign architectural consultant and developed by an international hotels & resorts chain.	1,194,672.04ft^2
03	The building belongs to purpose group classification 2 (b); Hotel under local fire regulations. This property is designed by a local architectural company and is currently owned by the government of Sri Lanka.	1,110,000ft^2

3.4 Data collection methods

In order to investigate the limitations of adopting fire safety measures in local context, primary data was collected through field observations and interviews. To analyze the collected data, case study analysis method and manual content-analysis method were used respectively.

3.4.1 Field observations

Basic information was grabbed through field observations, pertaining to the clauses in local code and then tabularized under each key section of the framework. Passive measures and active measures adopted were explored with the help of professionals appointed for the maintenance and coordination of fire safety in each case study. Further details and technical data relating to observations were extracted through interviews with professionals appointed in each super high-rise building for maintenance and coordination of fire safety.

3.4.2 Expert Interviews

Burns (1997, as cited in Zidhna, 2017) states, an interview is a verbal interchange, often face to face, through the telephone may be used, in which interviewer tries to elicit information, belief, or opinion from another person.

Expert interviews were performed in two segments. The first type of data gathered pertaining to the check-list. Fire safety officer and MEP/ELV engineers of all three case studies were selected for this exercise (please see table 3.1). Active and passive fire safety measures were discussed during the interviews and took notes of the data required. A list of questions was presented to the respondents. In the second segment, data collected in the form of expert opinion regarding the limitations/gaps in the fire safety measures identified through field observations. Purpose of the second type of expert interviews is to discover the limitations of fire safety and understands the perception and opinion of interviewees. Two experts in addition to the experts selected for the 1st segment were selected. Those experts represent the relevant authorities. Table 3.1 provides details of those selected experts.

Professionals who were fire safety engineers and architects presumed to have knowledge in data within the limitation of collection during the field observations, selected for the first segment. Table 3.2 shows the details of interviewees.

Table 3.2: Details of professionals interviewed pertaining to field observations

Case Study	Respondent	No. of years in practice	Type of involvement in safety
Case study 01	Respondent 1	11 years	Architect
Case study 02	Respondent 2	12 years	Mechanical Engineer
	Respondent 3	15 years	Facility Services Engineer
Case study 03	Respondent 4	10 years	Mechanical Engineer
	Respondent 5	8 years	Mechanical Engineer

Due to the fact that time was limited and each interview cost a considerable amount of time, the number of interviews conducted was constrained for the second segment. Thus sample size for was seven. Table 3.3 shows the details of respondents in the second segment pertaining to the limitations of fire safety measures in case studies.

Table 3.3: Detail of selected respondents for the expert interviews

Respondent	No. of years in practice	Type of involvement in safety
Respondent 1	30 years	Fire Safety Officer (Retired)
Respondent 2	12 years	Mechanical Engineer
Respondent 3	8 years	Mechanical Engineer
Respondent 4	11 years	Architect
Respondent 5	15 years	Facility Services Engineer
Respondent 6	10 years	Mechanical Engineer
Respondent 7	26 years	Fire Safety Officer (Retired)

For conducting interviews, author approached one-on-one with all seven respondents who took part in field visits as well as dedicated interviews. These respondents are either experts in the field of fire safety or engaged in maintenance and coordination of fire safety parameters in sample case studies, which enables them to reflect a clear view on the limitations of fire safety.

3.5 Data Analysis

Qualitative research is to gain and develop understanding, discover meaning, and explaining the phenomena experienced by the participants (Zidhna, 2017). This study intends to find both the limitations in local code compared to international code and to measure the building's response to underlying local fire safety guidelines with response to the design and operational phases.

Causes for limitations or gaps in fire safety measures adopted in the existing super high-rise buildings were identified respectively with the expert interviews. Methods of analyzing the collected data complied under this section.

3.5.1 Descriptive Analysis

This analysis method was followed to identify the limitations between the existing local code with reference to the international code. Descriptive analysis conducted between the two codes to find the corresponding clauses in local code to the clauses of international code. Findings were placed in order pertaining to each key section. Clauses failed to be covered or not covered enough, and improvements needed being equally identified. In the same manner, which key sections were fully covered, partially covered, and not at all covered could be recognized.

3.5.2 Cross-case analysis

For the purpose of finding limitations in practice between the existing local fire safety code and super high-rise buildings, studying selected sample cases were required. Field observations were carried out according to the clauses in local code categorized under 14 key sections in the framework. From the field observations, raw data was collected and then tabularized under each key aection. Hence design features and operational characteristics were explored and compared with the local clauses. Compliance and non-compliances sections were taken notes of.

The framework used to collect data, built-up on the NFPA 101 Life Safety Code (2015) and CIDA Fire Regulations 3rd edition (2018) with regard to the 'Means of Egress' component. The 14 key sections identified under means of egress, display in Appendix B. Data collected through interviews with experts analyzed. Based on the data analysis through cross-case, limitations between the local code and case-studies as well as within local code itself have recognized. These limitations were further enhanced by the experts in the interviews.

3.5.3 Manual content analysis

The main purpose of expert interviews is to identify the causes behind the limitations/gaps in fire safety parameters. Hence contents of all seven interviews were analyzed to find design and operational related causes observable in 03 case studies. The causes found were further studied to find characteristics related to the existing local fire safety regulations.

After analysis, recommendations were introduced on minimizing the limitations/gaps based on the expert's suggestions. The presented recommendations were distinguished in two groups; to minimize gaps in local code and in the fire safety practice.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

The purpose of this chapter is to study and analyze the primary data gathered using primary data collection methods. Data produced by field observations and expert interviews were analyzed to investigate the fire safety gaps which arise between current and required levels of fire safety during the design and operational phases of super high-rise buildings.

4.2 Data Analysis

4.2.1 Limitations in the local code

Regulations identify in the NFPA 101 Life Safety Code (2015), and CIDA Fire Regulations 3rd edition (2018) were grouped under the 14 key sections of the framework. The elaborated comparison between the international code and local code illustrated in the appendix A with sub-sections compared with relevant clauses.

Appendix C indicates the summary of achieving the level of local code with reference to international code. Clauses were distinguished as fully covered, partially covered, and not covered with color codes. The summery in figure 4.1 gives an indication as to how much comprehensive local regulations are in achieving fire safety according to key sections.

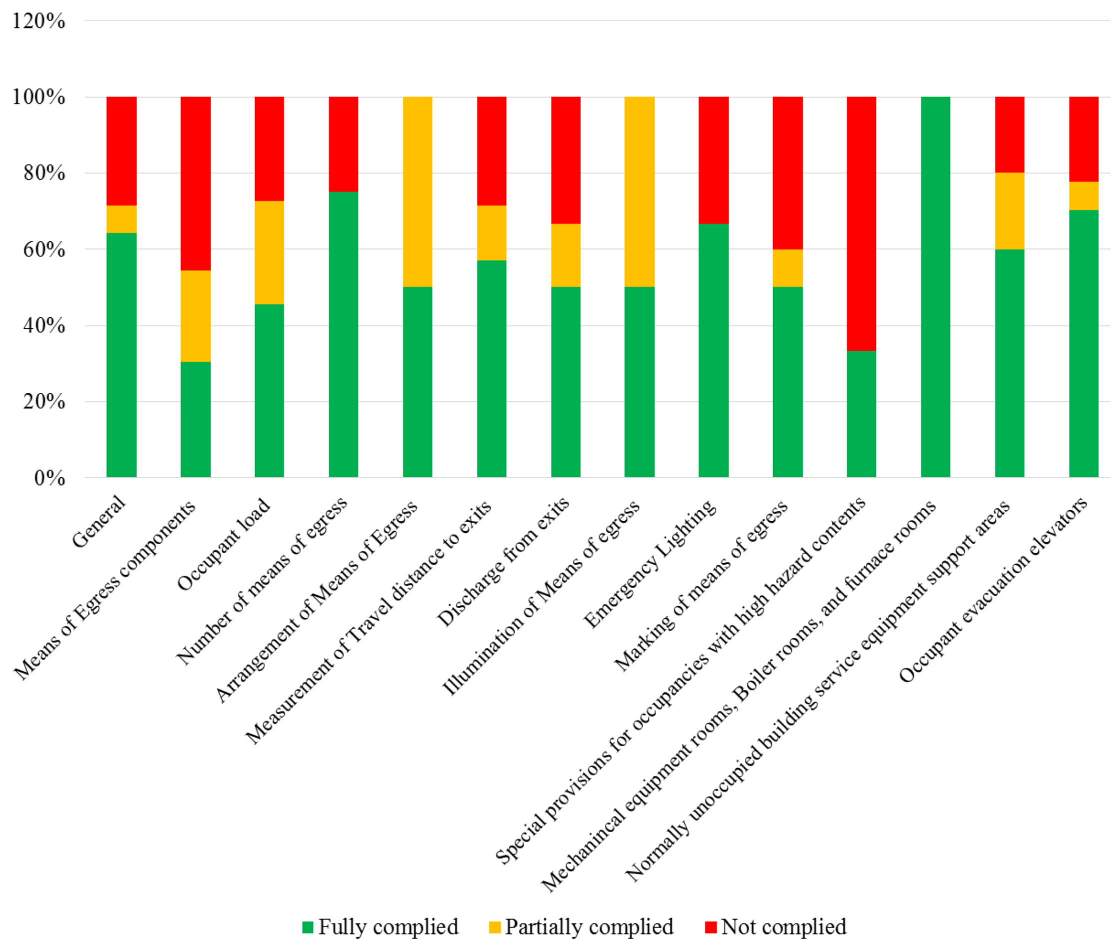


Figure 4.1: Achieved level of local fire safety code for each key section

As per the figure 4.1, key section 12-mechanical equipment rooms, boiler rooms, and furnace rooms was the only key section capable of adequately covering the international requirement. All other key sections have only been partially covered by the local code. Since this is the summary, details should be taken into account to get more insight to the subject. Referring to appendix C, Key section 01 (7.1-General), was adequately covered up to 63.63% by local regulation. 02 out of 11 sub-clauses could not be covered, and 02 were not adequately covered with the local regulation. Only 15.38% of key section 02 (7.2-Means of Egress components) could be covered by the local regulation. Out of the 13 subsections, only 02 were fully covered with key sections 02, and 07 were partially covered. 04 sub sections could not be covered with any of the local clauses, which represented 30.77% of sub-clauses. Local regulation was able to adequately address 50% of key section 03 (7.3-Capacity of Means of Egress). Out of 4, 02 subsections were partially covered by clauses in local code. 50 % of key section 04 (7.4-Number of Means of Egress) could be covered by local fire safety code. Out of the 02 sub sections presented, none of the local clauses were able to cover 01 sub section. Likewise in key section 02, key section 05 (7.5-arrangement of means of egress) also covered less than 50% by local regulation. It was 25% only supported with local fire safety regulation. 57.14% of key section 06 (7.6-Measurement of Travel Distance to exits) was adequately covered by the local code and 02 sub sections out of 07 were not at all addressed by it. Key section 07 (7.7-Discharge from Exits), key section 10 (7.10-Marking of Means of Egress) and key section 11 (7.11-Special Provisions for Occupancies with High Hazard Contents) were equally covered up to 33.33% with local fire safety guideline while 02 sub sections from key section 07, 02 subsections from key section 10 and 04 from key section 11 were failed to be covered by local guidelines. Key section 08 (7.8-Illumination of Means of Egress) was covered 50% out of the 02 clauses. Percentage coverage for key section 09 (7.9-Emergency Lighting), key section 13 (7.13-Normally Unoccupied Building Service Equipment Support Areas) were above 66.66% and 60% respectively. Percentages of coverage for key section 10 and 14 were also under 50%. Those were 33.33%. However local code was able to adequately address international requirement in key sections 12 with percentages of 100%. In 06 key sections out of the 14, existing local fire safety code shows below 50% coverage.

Several sub section of key sections did not comply by the local regulations at all. Apart from key section 05, 08 and 12 all other cases presented one or more sub sections that the local code failed to comply by any clause. Local regulation doesn't cover any fire safety guideline for existing buildings. As a summery, local fire safety code could fully cover only 7.14% of the means of egress component in international code which was the key section 12 (7.12-Mechanical Equipment Rooms, Boiler Rooms, and Furnace Rooms). Remaining 13 numbers of key sections were partially covered by the local code. Figure 4.2 shows the overall coverage of local fire safety code with reference to the international code.

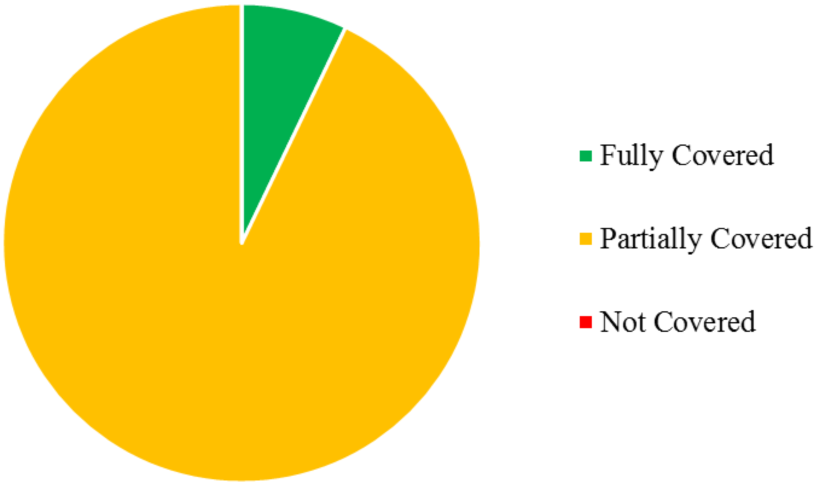


Figure 4.2: Percentage of coverage by local code

However there was no key section that was overlooked by the local code. Hence the balance 92.86% in local regulations needs to enhance the ability of addressing fire safety requirements.

4.2.2 Case study Analysis for fire safety gaps in practice

Data analyses study the level of compliance with each of the 14 key sections in all three case studies in response to the relevant regulations in local fire safety guidelines. Field observations were done using the framework prepared of local regulation. The framework investigates each case study for compliance only with local code. All three case studies are presented in a common table to comprehend the common characteristics of each case study. Annexure D provides a detailed insight to the compliance with local fire safety guidelines, under 14 key sections in each case study. Local fire safety codes comprise of prescriptive codes and there is no provision provided for PBD approach. Hence case studies were observed comparative to the prescriptive clauses only.

4.2.2.1 Case study 01

This case study represents a super high-rise building with a height of approximately 134m and 32 numbers of floors. Starting operation in late 2017, the building comprises of more than 500 rooms and has a capacity to accommodate up to 2000 conference guests at a time. Figure 4.3 shows the percentage of coverage under, fully covered, partially covered and not covered categories.

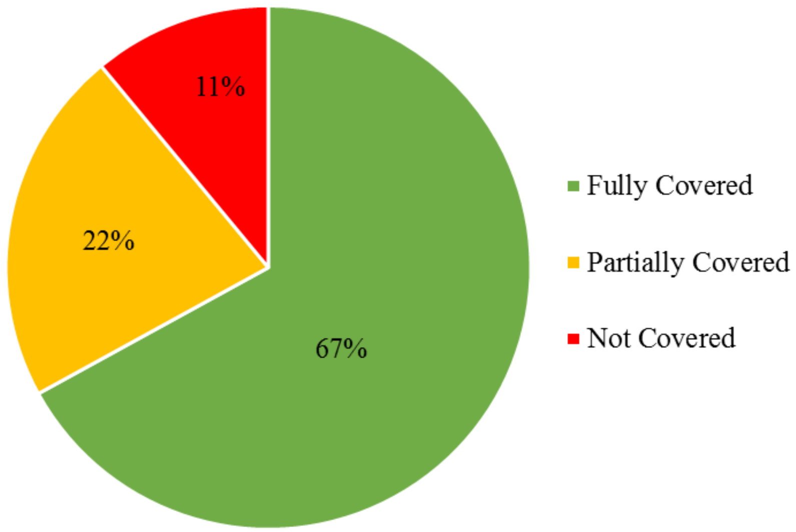


Figure 4.3: Distribution of case study 01

In case study 01, 67% of key sections were fully covered, 22% are partially covered and 11% are not at all covered. As the summery, case study 01 was able to adhere 50% of the requirement.

4.2.2.2 Case study 02

Correspond to 194m high super high-rise. The building was completed in 2018 and has been in operation since then. The towers consist of 51 floors and house 390 nos. of three types of apartment units.

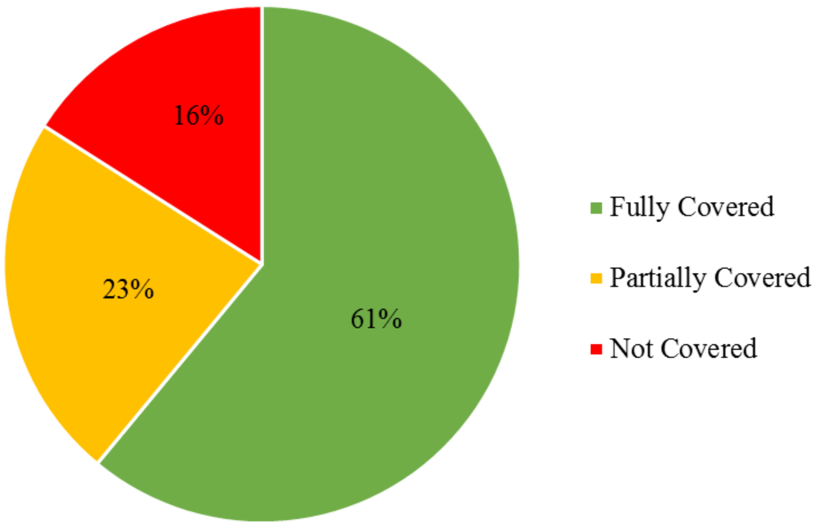


Figure 4.4: Distribution of case study 02

Whereas in case study 02, 16% of key sections are not completely covered by the provided fire safety measures and 61% of key sections are fully covered. Partially covered key sections represent by 23%.

4.2.2.3 Case study 03

Standing more than 229m in height, this super high-rise covers a total area of 1,110,000ft^2 with 47 nos. of floors above ground level. It comprises of 475 rooms and other amenities, and is nearing completion stage.

Case study 03, which is nearly at completion stage, has fully covered only 62% of the requirement. Out of remaining 38%, 24% allotted for partially covered key sections and rest 14% represents not covered key sections. In figure 4.5 pie chart, the percentage distribution has shown.

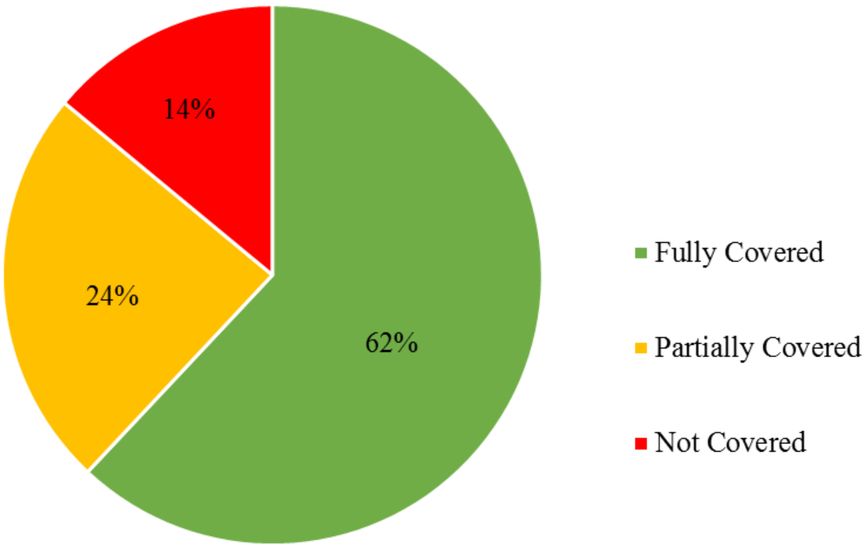


Figure 4.5: Distribution of case study 03

Figure 4.6 presents a summary of all 03 cases, illustrating the level of achievement for each key category. This bar chart helps to understand the most commonly covered key sections and to which extent they are covered, where the limitations lies.

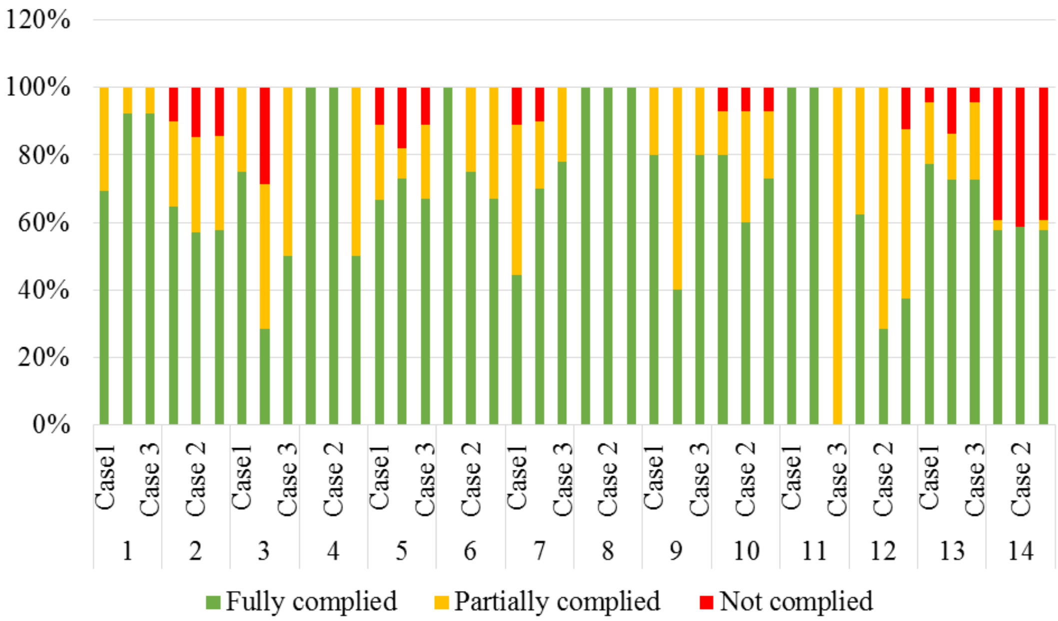


Figure 4.6: Summery of 03 case studies

Out of the partially covered key sections, which clauses make the key section partially covered? This question has the answer in appendix D. The detailed reproductions of chapter 7; means of egress in NFPA 101 Life Safety Code (2015) together with the pertinent chapter 2; means of escape in CIDA Fire Regulations (2018) clauses are portrayed. Table 4.1 shows fully achieved and not achieved percentages of case studies compared to local fire safety code. Partially covered percentage is not presented in the table.

Table 4.1: Percentage of fully achieved and not achieved in case studies

Section no	Key section	Case Study 1		Case Study 2		Case Study 3	
		Fully Complied	Not Complied	Fully Complied	Not Complied	Fully Complied	Not Complied
1	General	69%	-	92%	-	92%	-
2	Means of Egress components	65%	10%	57%	15%	58%	14%
3	Occupant load	75%	-	29%	29%	50%	-
4	Number of means of egress	100%	-	100%	-	50%	-
5	Arrangement of Means of Egress	67%	11%	73%	18%	67%	11%
6	Measurement of Travel distance to exits	100%	-	75%	-	67%	-
7	Discharge from exits	44%	11%	70%	10%	78%	-
8	Illumination of Means of egress	100%	-	100%	-	100%	-
9	Emergency Lighting	80%	-	40%	-	80%	-
10	Marking of means of egress	80%	7%	60%	7%	73%	7%
11	Special provisions for occupancies with high hazard contents	100%	-	100%	-	-	-
12	Mechanical equipment rooms, Boiler rooms, and furnace rooms	63%	-	29%	-	38%	13%
13	Normally unoccupied building service equipment support areas	77%	5%	73%	14%	73%	5%
14	Occupant evacuation elevators	58%	39%	59%	41%	58%	39%

In key section 01, 03 subsections were completely achieved by case study 01, 04 by case study 02 respectively and 03 subsections by case study 03.In key section 02, out of the 13 sub sections, 03 subsections were completely covered by case study 01, 02 by case study 02 and 02were fully complied by case study 03.In the key section 03out of all 04 subsections, case study 02 could not cover 01 subsection at all. In key section 04, full achievement could be observed in case studies 01 and 02 while it was only 50% by case study 03. In key section 05, none of the case studies could fully achieve all 04 subsections. Reason was none of the case studies have any external passageways requiring means of escape. And occupants have to use scissor staircases as the only means of escape in case study 02 which is not accepted as per CIDA regulations. All 03 case studies managed to achieve the key section 06, by more than 50%.In key section 07, both the case study 02 and 03 managed to achieve more than 70%, and case study 03 could cover only 44%. Key section 08, all 03 case studies could fully achieve the requirements. In key section 09 the requirements were covered up to 80% by both case 01 and 03. However case study 03 could only achieve 40%. In key section 10, none of the case studies covered all 07subsections due to the reason that those didn’t effectively responded to directional signs. Case study 02 was the lowest in achieving the related requirements. In key section 11, 02 case studies could fully adhere to local code and case study 03 could partially achieve. All 03 case studies could not effectively cover available requirements for key section 12. However key section 13 requirements, were fully achieved up to 73% by both case study 02 and 03, 77% by case study 01. Requirements in key section 14 were achieved just above the 50% by all 03 case studies.

Table 4.2 summarized which key sections were adequately covered, partly covered and critically covered by all 03 case studies, by examining the total achievement. The 06 critically covered areas, which include ‘not achieved’ subsections by 02 or all 03 case studies, include vital design aspects in means of egress; limitations in major structural components could be seen and also operational drawbacks. Partly covered key sections represent areas which include ‘not achieved’ subsections by only 01 case study. Adequately covered has no case studies with ‘not achieved’ subsections.

Table 4.2: Summary of complying key sections

Key Section	Adequately Covered	Partly covered	Critically covered
1. General	✓		
2. Means of Egress Components			o
3. Capacity of Means of Egress		×	
4. Number of Means of Egress	✓		
5. Arrangement of Means of Egress			o
6. Measurement of Travel Distance to Exits	✓		
7. Discharge from Exits			o
8. Illumination of Means of Egress	✓		
9. Emergency Lighting	✓		
10. Marking of Means of Egress			o
11. Special Provisions for Occupancies with High Hazard Contents	✓		
12. Mechanical Equipment Rooms, Boiler Rooms, and Furnace Rooms		×	
13. Normally Unoccupied Building Service Equipment Support Areas			o
14. Occupant Evacuation Elevators			o
Total	**06**	**02**	**06**

Clauses concerning communication, fire resistance, exit doors, protected shaft, combustibility of structures, means of escapes, illumination & emergency lighting, were commonly covered in all 03 case studies and there could be seen some disparities in complying with ‘re-entry’, panic-bar, ventilating and pressurizing internal exit passageways, compartmentalization, basements using solely for parking, providing external exits, evacuation lifts, firefighting lobby, refuge floors, directional signs, clauses. Case study 01 and case study 03 falls under same purpose group and portray some common characteristics.

Based on the findings, a number of limitations were identified and categorized as designed and operational level gaps. The underlying situations for these limitations to occur were explored by means of expert interviews of the field. Common limitations could be seen in case studies are listed in table 4.3.

Table 4.3: Limitations of fire safety practices in case studies

Phase	Gap/Limitation	Case study 01	Case study 02	Case study 03
Design	• Absence of occupant evacuation lifts	✓	✓	✓
	• Lack of compartmentation	✓	✓	✓
	• Omitted re-entry facility	✓	✓	✓
	• Lack of space allocation for fire-fighting/smoke free lobby	✓	✓	✓
	• Violation of capacity of exits and exit facilities	✓	✓	✓
	• Unaccepted exit staircase type		✓	–
	• Separate firefighting/protected shafts for Fireman lift and emergency exit staircase	–	–	✓
	• Absence of proper pressurization mechanism in internal corridors/ exit passageways	–	✓	✓
	• Lack of foam inlets facility	–	✓	✓
	• Lack of exit door accessories (panic bar, vision panel etc)	✓	✓	✓
	• Absence of vision panel in emergency exit doors	✓	✓	✓
	• Violation of conditions for refuge area/floor	✓	✓	✓
Operational	• Obstructed internal exit passageways	✓	–	–
	• Chemical storage in basement parking floors	✓	–	–
	• Lack of floor mounted directional signs	✓	✓	✓

4.2.3 Causes for the gaps

Author approached one-on-one to all seven respondents which took part in field visits as well as dedicated interviews. These respondents were a combination of experts in the field of fire safety and middle management engaged in maintenance and coordination of fire safety systems in sample studies. Numbers of points/potential causes for gaps distinguished from the interviews are enumerated as follows;

Table 4.4: Potential causes to appear fire safety gaps in case studies

No	Potential Cause
1)	These super high-rises are owned by world-wide hospitality chains and each has its own set of space design requirements and fire and life safety systems.
2)	These specific guidelines are based on international fire safety codes.
3)	The concept design and architectural designs were done by foreign architect and local architectural consultant was appointed at detail design stage.
4)	Fire safety design proposal for the architectural design was made by a foreign fire safety engineer/consultant.
5)	Local consultants failed to review initial architectural design to provide comprehensive passive fire safety design measures.
6)	Proposed fire safety strategies were based on PBD rather than prescriptive requirements to keep flexibility on aesthetics or architectural design. In active fire safety measures, design calculations were done based on actual figures, instead of adhering to sums mentioned in prescriptive CIDA clauses.
7)	Additions and alterations were carried out later for architectural design due to changes in the client's brief, reported during both design and operational stages.
8)	Cost concerns affected detailed passive fire safety design. Design alterations for elements of structure, doors, and other parts of building took place as a result.
9)	Local fire safety guidelines failed to provide state of the art fire safety guidelines to meet the international requirement.

No	Potential Cause
10)	Local fire regulations were not updated at the time of commencements to practical completion of projects. After the 2nd edition in 2006, CIDA fire regulations updated in the year 2018. Need of refuge area was not included in the 2nd edition. Therefore basic conditions of refuge areas required in 3rd edition were not attended by any of the case studies.
11)	Although some regulations were requested to provide, practical usage is yet questionable. In case study 01, foam inlet has provided but there was no foam creating device provided.
12)	Lack of up-to-date knowledge in fire officials to assess fire safety proposals. Parts of some active systems had been new experiences for local fire officials.
13)	For aesthetic purposes, essential details were omitted. Alterations were done under special request by the property owners to the fire service department.
14)	Active fire safety measures given priority than the passive measures in Fire safety designs. Excluded passive measures were tried to be compensated by providing active methods.
15)	Current operation was disturbed by emergency situations. Due to easter bombing happened in 21st April 2019, refurbishments were required inside the buildings and therefore internal exit passageways were obstructed.
16)	Building management has more advanced and comprehensive assessing systems than local fire safety guidelines required.

Table 4.5 displays which case study contains the above proposed potential causes to occur gaps in adopted fire safety measures.

Table 4.5: Case studies contain potential causes to occur gaps/limitations

Potential cause	Case study 01	Case study 02	Case study 03
Cause 01	✓	✓	✓
Cause 02	✓	✓	✓
Cause 03	✓	✓	_
Cause 04	✓	✓	✓
Cause 05	_	✓	✓
Cause 06	✓	✓	✓
Cause 07	_	_	✓

Potential cause	Case study 01	Case study 02	Case study 03
Cause 08	_	✓	✓
Cause 09	✓	✓	✓
Cause 10	✓	✓	✓
Cause 11	✓	_	_
Cause 12	✓	_	✓
Cause 13	✓	✓	_
Cause 14	✓	✓	✓
Cause 15	✓	_	_
Cause 16	✓	✓	✓
Total	**13**	**12**	**12**

50% of the above proposed potential causes noticed in every case study. 81% in case study 01 and 75% in other 02 case studies respectively. Out of the 16 proposed potential causes 75% are deign related. Remaining 25% operation related. It could be noticed that selected potential causes for limitations are common for all 03 case studies while others can be observed in 02 or only one case study oriented. Figure 4.7 shows this distribution.

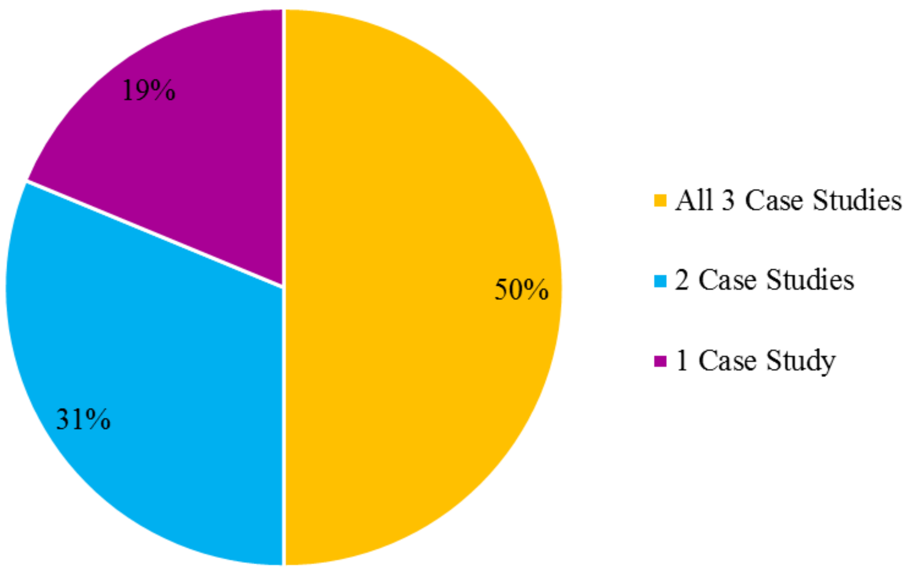


Figure 4.7: Distribution of potential causes among case studies

These identified potential causes ultimately directed the case studies to have gaps in fire safety system. It is worth checking whether these reasons are all regulation driven or not. It was found that these can be classified as,

- Direct regulations driven reasons,
- Indirect regulation driven reasons and
- Not regulations given reasons.

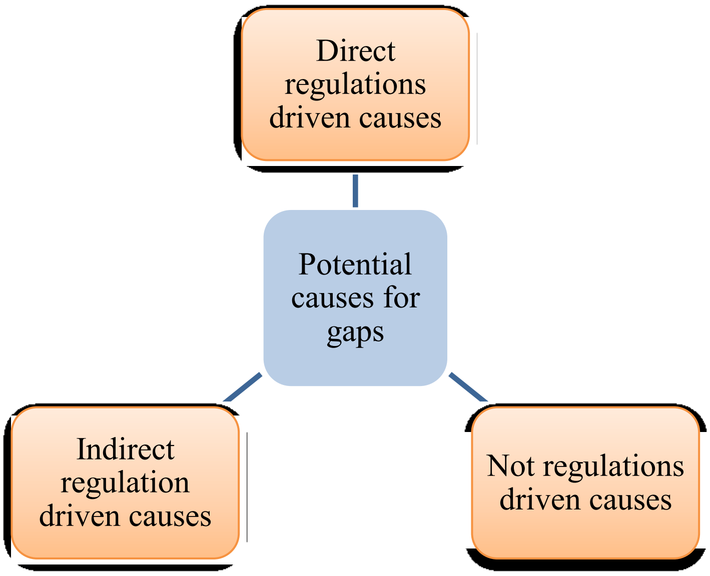


Figure 4.8: Three categories of potential causes

Shown below in the table 4.6 is the categorization of all potential causes into above mentioned 03 classes. The majority of reasons are direct regulation-driven reasons. 62.5% of the reasons comprised by them. Remaining 31.25% contains indirect regulation driven potential causes. Only 6.25% represents by not regulation related reasons.

Table 4.6- Categorization of potential causes

Type	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
Direct				✓	✓	✓		✓	✓	✓		✓	✓	✓		✓
Indirect	✓	✓	✓				✓				✓					
Not- related															✓	

Figure 4.9 shows percentage contribution of the 03 categories of potential causes to have limitations in all case studies. It shows that majority of reasons are regulation driven.

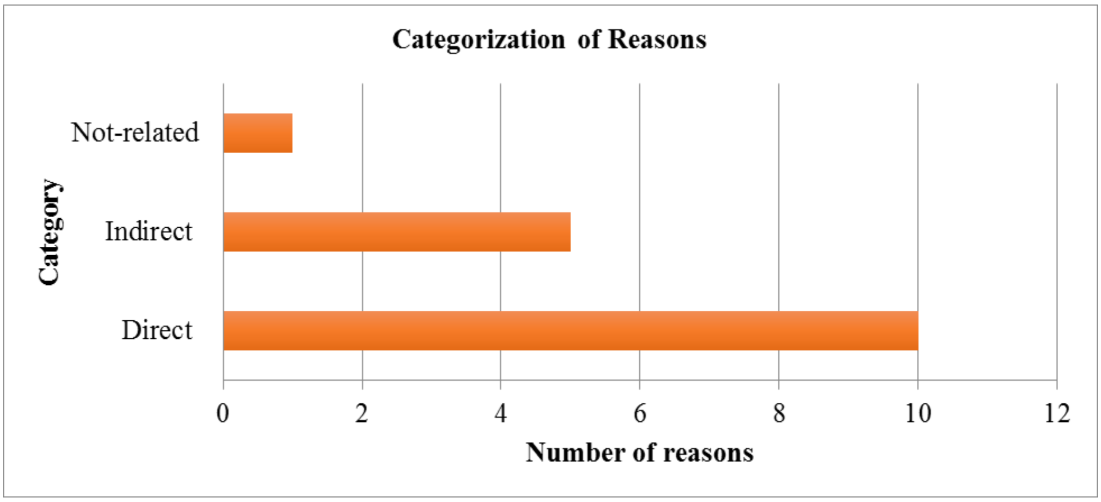


Figure 4.9: Contribution of the 03 categories of potential causes to have limitations

4.3 Recommendations for enhancing limitations

4.3.1 Enhancing limitations in local code

The international code provided detailed insights to address fire risks in buildings. Every detail has made an important stance to ensure or mitigate the risk of delaying safe egress. In comparison local guidelines could present limited number of clause. In order to have a more clear understanding, examination of clauses is required. Same clauses in local guidelines had to be repeated in several key sections as there were no specific detailed guidelines provided. Not only means of escape chapter in local CIDA (2018) guidelines, but also several other chapters contributed to cover the key sections of means of egress section in NFPA 101 Life Safety Code (2015). In order to cover all 14 key sections, compilation of several sections in local code (CIDA, 2018) was required.

- Chapter 2- means of egress,
- Chapter 3-structural fire precautions,
- Chapter 4-fire detection and alarm systems,
- Chapter 5-Fire extinguishing appliances, fixed fire protection and suppression system,
- Chapter 6-special uses, occupancies and structures,
- Chapter 8-inspection, maintenance and testing of active/ passive fire protection facilities, are the sections which compiled together to cover the clauses in key sections.

Through expert interviews recommendations presented to eliminate the above mentioned limitations.

1) Enhance means of escape

   Prescriptive requirements should be more detailed and elaborated for consultants to be more specific on implementation of design, construction and operational phases of a building. Comparing to the international regulations, local fire safety guidelines were not comprehensive or in a position to assess the fire safety strategy proposed for any of the cases.

2) Regular update

   Regulations need to be timely updated to minimize the gap between current and required level fire safety. Not only new constructions, but also other types of projects need a guideline for enhancing fire safety such as existing buildings, renovations. At the time of construction, local regulations were not updated and only CIDA fire regulations 2nd edition 2006 was in the practice. The term super high-rise was not included in the definitions at the time and many other clauses related to the term were not presented for reference. A comprehensive local code for fire safety assurance is vital in two ways. To provide all-inclusive fires safety guidelines and to assess alternative approaches. Local fire safety standards currently do not have the capacity to provide state-of-the-art design solution to address international requirements. This was also a reason for investors or developers to always consult external solution providers as in case studies. Continuous update is not regulated yet in Sri Lanka. Gap between editions are too high to embrace new advance or futuristic solutions. This was a major downfall and one of the main reasons to create discrepancies between provided and required level of safety in case studies.

3) Adopt PBD methods

   Not only prescriptive guidelines, but also performance based method should be allowed to implement a customized fire safety strategy for every complex building. All fire safety proposals for case studies were based on the PBD approach designed and tested by fire safety engineering consulted by the proprietor. As an example, minimum required pressurization in fire escape stairways found impractical by the consultant engineers as higher the number of floors are, higher the pressure in lowest floors. Therefore exact level of pressure has been calculated and applied for emergency exit staircase shafts.

4) Research and design

   Encourage the studies on fire safety and adopt findings on enhancing both active and passive fire safety strategies of buildings.

5) Up-to-date knowledge and training

   In-detail assessment of an advanced fire safety proposal by local fire safety officers, up-to-date knowledge and training is essential. Comprehensive assessment could not take place and missed segments could be available otherwise. On the other hand fire emergency situations are not pre-prepared and there will not be any excuses for surprises.

6) Enhance jurisdiction powers of the fire service department

   This was suggested in order to have control over culprits for fire safety hazards and risks. Since there is no proper jurisdiction power, lawbreakers could not be fined for the crimes and regulations are undermined.

4.3.2 Enhancing the limitations in fire safety practice

1) Appointment of local consultant at the preliminary stage of design

   The space planning, main structural elements and other details were decided through already setup requirements and fire and life safety systems of the hospitality chain. Involvement of local consultant at the design stage is crucial to follow a better design approach. Cost concerns are also a matter of fact here because design alterations could be encouraged.

2) Coordination with a local fire consultant

   Over-all proposal for fire safety was also done by a foreign fire consultant. Fulfilling basic minimum requirements within regulatory framework is a must. Obtaining recommendations may reduce the chance of breach of regulations. According to the local code, use of superior or equivalent standard systems complying with local regulations permitted. However AHJ has the authority in taking final decision regarding the use of any alternative. Review of any unconventional design by a local consultant is crucial and failing such may risk occupants and property safety causing unnecessary expenditures in future.

3) Comprehensive design and establishing a clear client's brief

   Safety must not be compromised by aesthetics. Aesthetics and safety could have been balanced more in the case studies. Minimum changes to the design brief may establish a clear fire safety strategy throughout the project cycle. Additions and alterations to client's brief make the fire safety design questionable as to occupancy loads, room areas subject to increase. Same situation was found in one case study. Percentage of active to passive measures in every fire safety solution differs according to set of requirements of owner. When the passive measures must moderate, it is required to adequately compensate by active measures. This is a popular scenario where maximizing lucrative area is a concern. Same scenario was visible through data from case studies. However basic minimum passive conditions required attaining as per CIDA (2018) was found lacking in case studies.

4) Overall safety strategy for the whole country

   All these scenarios were under intentional actions. But there could be situations where current fire safety system was disturbed, life and property become vulnerable for fire risks. The terror attacks in Colombo, Sri Lanka on April 21st 2018, is one example.

5) Establish good FSM system could help eliminating damages caused by fire hazards.

   Making arrangements mandatory to safeguard occupants is a prime responsibility of building (operations) management. Therefore sound FSM plan is a must in every functional building.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter concludes the findings of analysis. Based on the results recommendations are offered for immediate action.

5.2 Conclusions

5.2.1 Objective 1

The findings from data analysis limited to NFPA 101 Life safety code (2015)'s chapter 7; means of egress section only. Respective regulation in local code, CIDA Fire Regulation (2018) is chapter 2; means of escape. While identifying the pertinent regulation there was an important observation. By the time of commencement of construction of these super high-rises local fire safety guidelines, CIDA fire regulations was not been updated for more than 08 years, whereas world-wide practiced NFPA life safety code updates every year. It could be a main reason as to why local fire safety regulation could fully cover only 7.14% of international code. To enhance the ability of addressing fire safety requirement, remaining 92.86% should be advanced.

5.2.2 Objective 2

CIDA fire regulations 3rd editions came into being in 2018 after practical completion of every case study. Hence the term of super high-rises first appeared in fire regulation in CIDA 3rd edition (2018) only. That reflects how local regulations lag behind required level of update. On the other hand local regulations could not compete with any other international guidelines and it will discourage investors following any international fire safety codes. Ultimately the perception towards Sri

Lankan safety condition will developed into an unhealthy situation. Apart from three, all other key sections did have sub sections which could not cover by local code. Proper fire engineering approach need to be included in local guidelines to make path for internationally practice PBD approach. Adhering to local prescriptive only guidelines would not improve level of safety unless it is subjective. Therefore further improvements in the legislation to guarantee in-built performance of fire safety measures in super high-rise buildings are a necessity.

5.2.3 Objective 3

Main limitations between the current level of safety and required level of safety were due to not having specific clauses at the design phase for consultants to follow. Comparatively CIDA (2018) did not have enough guidelines corresponding to NFPA 101 (2015) clauses. If there were adequate clauses in CIDA (2018), case studies could have been evaluated more. And level of gaps could have been minimized. 11%-16% of local code was failed to cover by all 03 case studies. It was also observed that local guidelines were not comprehensive as to meet 22%-24% of detailed requirements in each case. Even if there are no particular local regulations, case studies could still have complied with NFPA 101 Life Safety Code (2015). Altogether, 08 key sections out of 14 have shown voids in compliance with local code. Hence design and operational level gaps could be seen in every case study. Half of the potential causes distinguished for these gaps were presented in each sample study. If the regulation had been focused more on design regulations 75% of causes would've been absent.

5.2.4 Objective 4

One major observation was all case studies did not provide provision for active evacuation. Hence in an emergency situation a disabled person may find difficult to evacuate as well as may disturb others evacuating. Using fireman lift for evacuation for disabled person is not a wise strategy since the act may disturb firefighting procedures. Hence it presents an absence of a strategy for disabled people evacuation. Where means of egress rules disregards, emergency exit staircase and firefighting lift are in two distinct places and do not share a protected lobby, feasibility of fire safety system in an actual emergency situation has major concerns. Granting a fire safety approval in above situations is alarming. In brief, approach towards providing refuge areas was not quite contented as either it was not designed on mandatory terms or operationally mistreated. Therefore including an effective test methodology to demonstrate compliance with both fire performance regulation and legislation will be beneficial for assuring life and property safety. This study did not examine any other active system and therefore could not comment on the workability of the fire safety system.

5.3 Recommendations

Where basic minimum fire safety guidelines misconduct AHJ need to be more firm on critical evaluation of any fire safety design proposal and granting approval. Local code for fire safety should be regularly updated to methodically serve the country along with the up-to-date knowledge of fire officers. At the same time a more detailed set of fire safety guidelines prerequisite to offer assuring and fathomable prescriptive guidelines. Also it is high time to adopt and practice suitable fire engineering and PBD approach. Evacuation of sensory and mobility impaired people should be of high concern than currently stipulated. A thorough testing and maintenance strategy should be implemented by AHJ rather than limiting to clauses and not relying on the advanced and comprehensive assessing systems of any local or international building management.

5.4 Further Research

Similar study on high-rise buildings can be studied. Limitations on the sample size may vary as there are considerable amount of high-rises exists. Current fire safety approach towards evacuation of disabled or differently abled people is suggested for exploration. Also in-detailed investigation on evacuation strategy of high-rises in urban areas can be done.

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	7.14.9	Occupant Evacuation Shaft System	7.14.9
		Elevator Lobby Size	7.14.9.2
		Access to the Exit Stair	7.14.9.3
		The Occupant evacuation shaft system	7.14.9.4
		Construction of occupant evacuation shaft system enclosures should provide min: of classification level 2	7.14.9.5
		Elevator lobbies should be waterproofed	7.14.9.6
		Occupant evacuation shaft system elevator lobby doors	7.14.9.7
		All elevator lobby doors	7.14.9.8
		Vision Panel	7.14.9.9

Key Section	NFPA	Requirement/Section No.	CIDA	Pertinent Reg. No
7.1	'General'		General	2.1
	A way out of a building or structure that does not conform to the strict		Areas which are designated as means of escape such as exit staircase, fire fighting	
	Separation of Means of Egress			
	Exit access corridor If occupant load >30, separate from other rooms of the building. Walls should have > one hour fire resistance rating.	7.1.3.1	2.3 (I) Exit passageway is a means of horizontal escape, leading to a place of safety, and is suitably fire rated.	2.3(l),
			2.4 Determination of Exit Requirements (a) Determination of exit requirements for a building should be based upon type of use or occupancy of the building, occupant load, floor area, travel distance to an exit, capacity of the exits as provided in Table 5 and herein. (b) Every building should be provided with exit facilities for its occupant load (c) Vertical exits (staircase or ramp) provided from any storey above ground level may serve simultaneously all storeys above ground level - vertical exits provided from any storey below ground level may serve all storeys below ground level, subject to the provisions of Regulations 6(42) which prohibits basement staircases being continuous with staircases serving upper storey.	2.4
	Exits Should be an exit separated from other parts of building. Should be a continuous path to discharge. Should not be blocked for any other purpose.	7.1.3.2	Exit – means of leaving from the interior of the building to an exterior space which is proved with, either singly or in combination, by the following: exterior door openings, protected staircases, exit passageways or exterior stairs.	2.3 (g)
	Interior Finish in Exit Enclosures Walls and ceiling should be in accordance with section 10.2 and materials shall be Class A or B. For the floor including stair treads and risers should not be less than	7.1.4	Class of Flame spread to be not Lower than Specified in Table Surface of a wall or ceiling in a room, circulation space or protected shat should be of a class not lower than specified in Table 12: Provided that- (a) Wall may've a surface of any class ≥Class 3 to extent permitted by Regulation 3(87) and 3(88) (b) Ceiling may've surface of any class ≥Class 3 to extent permitted by Regulation 3(88) (c) and (d)	3.86

		(c) Where automatic sprinkler is provided/installed according to Code of Practice in such rooms, circulation spaces or protected shafts, surface of walls/ceilings may be of 02 classes lower than as specified relevant in Table 12; (d) If timber is used for walls along side-gangways of auditorium or of a cinema, requirement may be relaxed only in respect of those parts of wall, above the height of 2.1m, area of such wall surfaces ≤50 % of the whole surface area of side walls of auditorium	
Headroom Means of egress headroom shall not be less than 7 ft 6 in. with projections from the ceiling not less than 6 ft 8 in. (2030 mm) with a tolerance of −3⁄4 in. (−19 mm), On Stairs, should not be less than 6 ft. 8 in measured vertically.	7.1.5	The minimum width and capacity of staircases should be as listed in Table 5 and such staircases should comply with the following: (a) Headroom : Clear headroom should be ≥2200	2.42 (a)
Walking Surfaces in the Means of Egress	7.1.6		
<u>General</u> Shall comply through 7.1.6.2 to	7.1.6.1		_
<u>Changes in Elevation</u> Shall not exceed ¼ inches. In cases it exceeds More than ¼ in less than ½ in – Bevelled with a slope of 1 in 2. More than ½ in – should consider a change in level and requirements of 7.1.7	7.1.6.2		_
<u>Level</u> Shall be nominally level. Slope in direction of travel should not exceed 1 in 20 Slope in perpendicular to the direction of travel should not exceed	7.1.6.3		_
<u>Slip Resistance</u> Walking surfaces should be slip resistant under foreseeable conditions	7.1.6.4		_
Change in Level in Means of Egress Shall be achieved method where the elevation difference exceeds 21 in (535 mm)	7.1.7.1		_
If not in excess of 21 in (535 mm), shall be achieved by ramp – complying to 7.2.5 stairs – complying to 7.2.2 7.1.7.2.1. where ramp is used it should be readily apparent	7.1.7.2	2.42 Internal Staircases i. Landings: except for circular or geometric stairs, all staircases should be in straight flights with landings provided at intervals of ≤16 risers and at every floor level. - changes in level along an exit stairway <2 risers should be a ramp	2.42 (ii)

	7.1.7.2.2. where stair is used tread depth should >12 in. (330 mm) 7.1.7.2.3. tread depth in industrial equipment areas 40.2.5.3 permitted 7.1.7.2.4. each step should clearly visible		2.40 Internal Exit Passageways c) Changes in level along an exit passageway less than two risers should be a ramp	2.40 (c)
	Guards Should be provided at open sides of means of egress that exceeds 30 in above the floor or finished ground level, unless specifically exempted.	7.1.8		_
	Impediments to Egress Any device installed to reduce improper use of means of egress should be designed and installed in a way it cannot prevent emergency use of means of egress in any situation.	7.1.9	(a) exit doors opening into exit staircases and exit passageways shouldn't impeded the egress of occupants when such doors are sung open	2.51 (c)
	Means of Egress Reliability	7.1.10		-
	<u>Maintenance</u> Should be continuously maintained and made sure there are no	7.1.10.1	2.17 Location of Exists All exits and access facilities should be located as follows: (a) Exists and access facilities should be clearly visible or their locations be clearly indicated with directional signs. - All exists must kept readily accessible and unobstructed at all times	2.17
			2.39 Exit Passageways All exit passages should be accessible and kept unobstructed at all times. Exit passageways that serve as means of escape of a building should have the requisite fire resistance as per Table 8.	2.39
	<u>Furnishing and Decorations in Means of Egress</u> 7.1.10.2.1. These should not obstruct the exit or access to exit. 7.1.10.2.2. Should not be separated in to sections by any means of railings, barriers of gates. 7.1.10.2.3. Mirrors shall not place on exit doors or adjacent to exits which confuse egress direction	7.1.10.2		_
	<u>Sprinkler System Installation</u> Should be installed in accordance with 9.7.1.1	7.1.11	Commencement of the Installation No person should commence work on the installation of the sprinkler system unless plans for such system required to be submitted in accordance with provisions of regulations 5(35) and 5(36) of this chapter, have been approved by AHJ	5.34
	'Means of Egress Components'	7.2	'Means of Escape'	
	Door Openings 7.2.1.1.1 According to section 7.1 & 7.2.1	7.2.1	2.51 Exit Doors Exit doors and doors providing access to exits should open to direction of escape and comply with relevant parts of	2.51

7.2.1.1.2 These should be designed in a way that the path of egress is obvious and direct. If windows can be mistaken for door openings, those should be made inaccessible.		(a) exit doors – should be openable simply by pushing open or by means of a panic bar (not applicable to buildings under purpose Group 1)	2.51 (a)
		(b) exit doors, which required to have FRR, should comply with relevant provisions for fire resisting doors	2.51 (b)
		(c) exit doors opening into exit staircases and exit passageways shouldn't impeded the egress of occupants when such doors are swung open	2.51 (c)
		3.71 Door to be Manually Openable Any door fitted in an opening which is provided as a means of escape in the event of fire or might be so used should be so constructed and installed that it can be readily opened manually.	3.71
		3.72 Direction of Opening Any door to which reference is made in Reg. 3(47) (a)(i) or 3(78) (b) should be either a single leaf door swinging in one direction only or a double leaf door, each leaf of which swings in opposite direction from the other leaf, where both open in direction of egress.	3.72
<u>Occupied Building</u> 7.2.1.1.3.1 Building shall be considered occupied if it is, 1. open for general occupancy 2. Open for public 3. Occupied by more than 10 7.2.1.1.3.2 Where egress doors are locked in un-occupied building, occupants should not be blocked beyond their control except for detention & correctional occupancies	7.2.1.1.3		–
<u>Door Leaf Width</u>	7.2.1.2	2.9 Minimum widths	
7.2.1.2.1 Measurement of clear width		a. min. clear width of an exit door opening should be ≥1100mm	2.9 (a)
7.2.1.2.2 Measurement of egress capacity width		b. the width of exit door serving a room with an occupant load of 2 persons ≥750mm clear	2.9 (b)
7.2.1.2.3 Minimum door leaf width		c. width of a single leaf swing door along the means of escape ≤1250mm	2.9 (c)
Should be considered. Regulations differ for swinging doors assemblies.		2.51 Exit Doors (f) Width and height of doors: The capacity of exit and corridor door openings should be listed in Table 5 (I) to (VIII). Door jambs or stops and the door thickness when the door opens should reduce ≥80mm. - Min. open width of the exit doors 1m, where corridor width is 1.2 m. - Min. clear height of door opening should be 2.1 m	2.51 (f)

Floor Level	7.2.1.3		–
7.2.1.3.1 difference in floor levels in both sides of the door ≤ ½ in 7.2.1.3.2 elevation of floor level on both sides of the door should be maintained for a distance ≥ width of the widest leaf 7.2.1.3.3 Thresholds at door openings ≤ ½ in (height) 7.2.1.3.4 Raised thresholds and floor level changes more than ¼ in to be bevelled with a slope not steeper than 1 in 2 7.2.1.3.5 In existing buildings, If door open outwards, floor level outside the door opening shall be one step lower than inside but ≤ 8 in 7.2.1.3.6 Door at top of a stair can be opened directly at a stair given that leaf doesn't swing over stairs and opening is for an occupant load ≤ 50 persons. 7.2.1.3.7 Doors for spaces which are not normally occupied – floor level can be lower than door opening but ≤			

Swing and Force to Open	7.2.1.4	2.51 Exit Doors	
7.2.1.4.1. Swinging type door assembly requirement		(d) door opening into exit path should close when pushed into direction of the movement	2.51 (d)
Any door shall be side hinged or pivoted swinging type. And shall be capable of swinging to the full required width of opening.		(e) any door located in path of travel should be hung & should be full width of exit path	2.51 (e)
Horizontal sliding and vertical rolling doors are permitted under conditions. Conditions:		(f) Width and height of doors: The capacity of exit and corridor door openings should be listed in Table 5 (I) to (VIII). Door jambs or stops and the door thickness when the door opens should reduce ≥80mm.	2.51 (f)
Those shall remain secured in fully open position when building is occupied		- Min. open width of the exit doors 1m, where corridor width is 1.2 m.	
Warning sign “THIS DOOR TO REMAIN OPEN WHEN THE SPACE IS OCCUPIED” should be there in letters > 1 in		- Min. clear height of door opening should be 2.1 m	
Should be open when occupied and easy to operate.		(g) Fire door protected staircase and smoke stop/Fire lift lobby should be with a vision panel.	2.51 (g)
Horizontal sliding door assemblies shall be permitted.		- Vision panel should have a clear view size of 100mm width x 600mm height and same FRR.	
In detention and correctional occupancies (Chapter 22 and 23)		(h) Provision of vision panel shouldn’t apply to exit doors of residential apartment or maisonette units.	2.51 (h)
For a room with occupant load < 10 persons is permitted if:		(i) All compartment doors on long exit paths should swing both ways and should be provided with a vision panel, as specified in above (c).	2.51 (i)
Particular area should not have high hazard contents		2.52 Area of Refuge	2.52
Easy to operate from both sides		- Doors providing access to an area of refuge should be kept unlocked at all times, when the floor area served by the area of refuge is occupied.	
Force to open the door is < 133N		- Doors providing access to an area of refuge should be kept unlocked at all times, when the floor area served by the area of refuge is occupied.	
Force to close the door or open to the minimum required width < 67 N		- Such doors should be swinging and self-closing with FRR of 1 ½ hours, except that doors in fire resistance rating	
Complied with any required fire protection rating		- They should swing in the direction of exit travel	
Corridor door assemblies have self-latching to keep it closed if forcefully closed		3.72 Direction of Opening	3.72

Private garages, business area, storage areas which have < 10 person occupancy can have vertical rolling doors.		Any door to which reference is made in Reg. 3(47) (a)(i) or 3(78) (b) should be either a single leaf door swinging in one direction only or a double leaf door, each leaf of which swings in opposite direction from the other leaf, where both open in direction of egress.	
7.2.1.4.2. Door leaf swing direction Side-hinged or pivoted-swinging type shall swing in the direction of egress travel Conditions: 1. Where room's occupant load >50, except a. Door leaves in horizontal exits and smoke barriers doesn't need to swing in the direction of egress travel 2. Door assembly is used in exit enclosure 3. Door opening to a high hazard content area 7.2.1.4.3. Door Leaf Encroachment 1. Door leaf should leave >1/2 of required width of aisle/ corridor/ passageway/ or landing during swing, unless a. Opening provide access to staircase b. Opening meets requirement of 7.2.1.4.3.2 2. Full open means of egress door leaf shouldn't project >7 in (180 mm) into required width of aisle/ corridor/ passageway/ or landing a. Occupied with self-closing device b. Not required to swing in egress direction 3. Surface-mounted latch release hardware on door leaf should except from including in the max. 7 in (180 mm) projection, if provide: a. Hardware mounted to side of door leaf when in open position b. Hardware mounted ≥34 in (865 in), and ≤48 in (1220 mm) above 7.2.1.4.4. Screen Door Assemblies and Storm Door Assemblies Above used in means of egress should be subject to requirement for swing direction that apply to other		2.27 Exit Doors Exit doors giving access to escape corridors should be so positioned that their swing should at no point encroach on the required minimum width of the escape corridor. - Door must be provided with a door closer.	2.27
Locks, Latches and Alarm Devices	7.2.1.5		_

7.2.1.5.1) Door leaves should arrange to readily open from egress side whenever building is occupied	7.2.1.5.1		
7.2.1.5.2) Above not apply to door leaves of listed fire door assemblies after exposure to elevated temperature in accordance with the listing, based on laboratory fire test	7.2.1.5.2		_
7.2.1.5.3) If Locks provided, shouldn't require a key/ tool/ special knowledge or effort to open	7.2.1.5.3		_
7.2.1.5.4) 1 and 3 shouldn't apply where otherwise provided in chap 18-23	7.2.1.5.4		_
7.2.1.5.5) <u>Key-Operated Locks</u> Exterior doors permit to have key-operated locks from egress side, if 1. Permitted in Chap 1143 for specific occupancy 2. Contrasting Sign in ≥1 in. letters located on or adjacent to door leaf that reads: "THIS DOOR TO REMAIN UNLOCKED WHEN THE BUILDING IS OCCUPIED" 3. Lock is Readily distinguishable as locked 4. Key is immediately available Above should permit to revoke by AHJ	7.2.1.5.5		_
7.2.1.5.6) <u>Electrically Controlled Egress Door Assemblies</u> Door assemblies permitted to be electrically locked if the hardware is listed & approved, if; 1. Hardware for occupant release of lock, is affixed to door leaf 2. Hardware has obvious operation method that is readily operated in egress direction 3. Hardware can be operated with one hand in egress direction 4. Hardware operation directly interrupts power supply to electric lock and unlock in egress direction 5. Loss of power to releasing hardware automatically unlocks door assembly in egress direction 6. Hardware in new installations is listed according to ANSI/UL 294	7.2.1.5.6		_
7.2.1.5.7) Key operation permitted if key cannot remove when door leaf is locked from side which egress is to be made	7.2.1.5.7		_

7.2.1.5.8) Every door assembly in stair enclosure in >4 stories, should meet at least one of; 1. Re-entry from stair enclosure to interior 2. Automatic release actuate with building fire alarm initiation, provide to unlock all stair enclosure door assemblies for re-entry 3. Selected re-entry provide according to (i) 7.2.1.5.8.1. Stair enclosures' door assemblies permit to have hardware that prevents re-entry to interior of the building. If; 1. Should be ≥02 levels where leaving stair enclosure is possible to access another exit 2. ≤04 stories intervening between stories where leaving stair enclosure is possible to access another exit 3. Re-entry possible on the top story or next-to-top story served by stair-enclosure, and such story allow access to another exit 4. Door assemblies allowing re-entry should be identified on stair side of door leaf 5. Door assemblies not allowing re-entry should be identified on stair side of door leaf & nearest re-entry opening 7.2.1.5.8.2. 7.2.1.5.8, not apply to, 1. Existing installations in not High-Rise buildings 2. Existing installations in High-Rises where occupants protected by approved, supervised automatic sprinkler system 3. Existing approved stairwell re-entry installations 4. Stair enclosures in a building permits to have single exit 5. Stair enclosures in healthcare occupancies 6. Stair enclosures in detention and correctional occupancies 7.2.1.5.8.3. When 7.2.1.5.8.2 used, signage on stair door leaves; 1. Identify Re-entry on stair side door leaf 2. No re-entry door assembly should identify nearest re-entry/ exit	7.2.1.5.8	2.45Facility for Re-entry Internal staircases where entry is restricted with fire doors, facility to re-enter the building should be provide at every 5th floor. Monitoring facilities should be provided for such doors to prevent unauthorized	2.45

7.2.1.5.9) If stair enclosure allows roof top access, door assembly should be kept locked or allow re-entry from roof	7.2.1.5.9		_
7.2.1.5.10) Latch/ other fastening device should provide with a releasing device with readily operated obvious method under all 7.2.1.5.10.1. Releasing mechanism of latch should locate: 1. ≥34 in (865 mm) above F.F.L other than existing installations 2. ≤48 in (1220 mm) above F.F.L 7.2.1.5.10.2. Releasing mechanism should open door leaf with ≤01 operation 7.2.1.5.10.3. Egress door assemblies from individual living units (residential occupancies) & guest rooms permit with automatic latching devices, that require ≤01 additional releasing operation, if operable from inside without key/ tool and is mounted on ≤48 in. (1220 7.2.1.5.10.4. Existing security devices permitted 7.2.1.5.10.3. permits with 02 additional operations 7.2.1.5.10.5. Existing security devices permitted 7.2.1.5.10.3. other than automatic latching devices, shall locate ≤60 in. (1525 mm) above 7.2.1.5.10.6. Existing hardware permit with 02 releasing operations on door leaf of an areas with ≤03 occupant load, if releasing doesn't need simultaneous operations	7.2.1.5.10		_
7.2.1.5.11) Where 02 door leaves in means of egress, 1. Each leaf should provide with releasing device that release doesn't depend on each other 2. Approved automatic flush bolts should use, if; (a) door leaf have no doorknob or surface-mounted hardware (b) unlatching of any leaf should require ≤01 operation	7.2.1.5.11		_
7.2.1.5.12) Devices should not install in connection with panic hardware or fire exit hardware required door assembly, where such device prevent free use of egress,	7.2.1.5.12		_

unless otherwise provided in 7.2.1.6			
<u>Special Locking Arrangements</u> 7.2.1.6.1) Delayed-Egress Locking Systems 7.2.1.6.1.1. Approved, listed, delayed-egress locking systems should permit on door assemblies in low & ordinary hazard contents in buildings protected by approved, supervised automatic fire detection system according to 9.6 or sprinkler system according to 9.7, if; 1. Door leaves should unlock in egress direction upon actuation of: (a) Approved, supervised automatic sprinkler system (b) ≤01 heat detector of an approved, supervised automatic fire detection system (c) ≤02 smoke detectors of an approved, supervised automatic fire detection system 2. Door leaves should unlock in egress direction upon power loss of controlling the lock or locking mechanism 3. Where approved by AHJ, irreversible process should release the lock within 15 sec or 30 sec in egress direction with a force to release required in 7.2.1.5.10 under: (a) Force shouldn't >15 lbf (67 N) (b) Not required for continuous application of Force for >3 sec. (c) Initiation of release process should activate an audible signal in door opening vicinity (d) Once the lock released by force relocking by manual means only 4. Locate readily visible/ durable 1 in. (25mm) high letters and ≥1/8 in. (3.2mm) in stroke width sign on contrasting background on door leaf adjacent to release device, reading: (a) PUSH UNTIL ALARM SOUNDS, DOOR CAN BE OPENED IN 15 SECONDS, for doors swing egress direction (b) PULL UNTIL ALARM SOUNDS, DOOR CAN BE OPENED IN 15 SECONDS, for doors swing against egress direction 5. Egress side of doors with delayed-egress locks should provide with emergency lighting according to 7.9	7.2.1.6		_

	7.2.1.6.1.2. Provisions of 7.2.1.6.2. for access-controlled egress door assemblies shouldn't apply to doors with delayed-egress locking systems			
	7.2.1.6.2) Access-Controlled Egress Door Assemblies Permits in means of egress to have electrical lock hardware that prevents egress, if: 1. Sensor provided on egress side, unlock in egress direction upon detection of approaching occupant 2. Automatically unlock door leaves in egress direction upon loss of power to sensor or part of its access control system 3. Door locks unlock in egress direction from manual release device complying with: (a) Located on egress side, 40 in. to 48 in. (1015 mm to 1220 mm) vertically above floor & within 60 in. (1525 mm) of secure door openings (b) Should readily accessible & clearly identified by PUSH TO EXIT (c) When operated, should directly interrupt power to the lock – independent of locking system electronics – and lock should remain unlocked for ≥30 sec. 4. Building fire-protective signaling system activation should automatically unlock door leaves in Remain unlocked until it is manually reset 5. Manual fire alarm boxes activation that activate building fire-protective signaling system shouldn't require to unlock door leaves 6. Automatic sprinkler or fire detection system activation should automatically unlock door leaves in egress direction, Remain unlocked until it is manually reset 7. Egress side of access-controlled egress doors, other than existing, should provide with emergency 7.2.1.6.3) Elevator Lobby Exit Access Door Assemblies Locking Door assemblies separating elevator lobby from exit access required by 7..4.1.6.1 should permit to electrically locked, if;		Notwithstanding Reg. 3(70) (a) a door which isn't fitted with a self-closing device may be installed in the structure which encloses a protected shaft containing exclusively a lift or lifts if (a) fire resistance of door is ≥1/2 hour and there's also installed to close the same opening which is fitted with an automatic self-closing device, held open by an automatic closing device activated by smoke detector or fire alarm and has fire resistance for a period ≥ prescribed by relevant provisions in Reg. 3(2) to 3(3) for the structure surrounding opening; (b) Unless the opening is in a compartment wall and is 01 of 02 openings provided at same level to allow access to a lift from different sides, then door should've fire resistance for a period ≥ prescribed by relevant provisions Reg. 3(24) to 3(30) for the structure	3.76

	1. Lock is listed according to ANSI/UL 294 2. Building is protected by fire alarm system 3. Building is protected by approved, supervised automatic 4. Water-flow in sprinkler system require by 7.2.1.6.3.(3) arranged to initiate building fire alarm system 5. Elevator lobby protected by approved, supervised smoke detection system 6. Smoke detection by detection system (7.2.1.6.3.5) to initiate building fire alarm system & notify 7. Building fire alarm system initiation by other than manual fire alarm boxes unlock elevator lobby 8. Loss of power to elevator lobby electric lock system unlock elevator lobby door 9. Once unlocked, elevator lobby door assemblies remain unlocked, until alarm system manually reset 10. After being unlocked, where elevator lobby door remain latched, releasing hardware is affixed to door leaves 11. Two-way communication system provide between elevator lobby & constantly staffed central control 12. Central control point staff is capable, trained and authorized to provide emergency assistance 13. (7.2.1.6.1) for delayed-egress locking systems aren't applied to elevator door assemblies 14. (7.2.1.6.2) for access-controlled egress door assemblies aren't applied to elevator lobby door			–
	Panic Hardware and Fire Exit Hardware 7.2.1.7.1) Where door assembly required panic or fire exit hardware, criteria should meet, 1. Should consist of a cross bar or push pad, actuation portion should be ≤1/2 of door leaf width 2. Mounted as follows: (a) New installations ≥34 in. (865 mm) & ≤48 in. (1220 mm), above floor	7.2.1.7	j) Door Hardware: any exit door which has to be kept shut and fastened whilst the building is occupied should be fitted with 'panic bar', appropriately shown "Push bar to Open" in ≥100mm high letters.	2.51 (j)

(b) Existing installations ≥30 in. (760 mm) & ≤48 in. (1220 mm), above floor 3. Constructed as to, Horizontal force ≤15 lbf (66 N) actuate cross bar/ push pad and latches 7.2.1.7.2) Only approved fire exit hardware should use on fire-protection-rated door assemblies. - New panic hardware & new fire exit hardware should comply with ANSI/UL 305, Standard for Safety Panic Hardware and ANSI/BHMA A156.3 Exit Devices 7.2.1.7.3) Required panic hardware and fire exit hardware should not use any locking device, set screw, or other arrangement prevents release of latch when pressure applied to releasing device, other than in detention & correctional occupancies 7.2.1.7.4) Latch hold devices in retracted positions should prohibited on fire exit hardware, unless listed and approved for such purpose			
<u>Self-Closing Devices</u> 7.2.1.15.1) Door leaf should be self-closing or automatic-closing according to 7.2.1.8.2 unless otherwise permitted in 7.2.1.8.3 7.2.1.15.2) Door leaves in low or ordinary hazard contents or where approved by AHJ, should permit to be automatic-closing, if: 1. Leaf becomes self-closing upon release of hold-open mechanism	7.2.1.8	2.51 Exit Doors k) An exception to this rule should be made for exit doors which kept locked back in fully open position during the whole time that the building is occupied. - All other exit doors should be fitted with self-closing devices other than rising butt hinges, and all exit doors should be hung on strong metal hinges and not on any combustible material. - The panic bolt should be ≤1m from the floor and should be capable of being operated by a horizontal thrust.	2.51 (k)
2. Release device is design to instantly release the leaf manually and upon release becomes self-closing, or leaf can be readily closed 3. Operation of approved smoke detectors installed according to NFPA 72, National Fire Alarm and Signaling Code, activates automatic release mechanism of door leaves 4. Hold-open mechanism is released and door leaf becomes self-closing upon loss of power to hold-open device		Fire revisiting Doors 3.69 Application of Regulation - Automatic self-closing devices doesn't include raising butt hinges except in 3(74) - Fire doors fitted with automatic devices to hold door open during normal operations should've devices to close door upon,	3.69

5. One door leaf in a stair enclosure release by smoke detection results closing of all door leaves serving stair 7.2.1.15.3) During Phase I Emergency Recall Operation, Elevator car doors & associated hoist-way enclosure doors at floor level designated to recall, should permit to		(a) Detection of smoke by an automatic smoke detector (b) Manual operation of a switch with overriding facility, fixed in suitable (c) Failure of electricity supply to device, apparatus or switch (d) If an evacuation alarm is activated through fire control panel for building	
		3.70 Provisions of Closing Devices and Non-Combustible Hinges (a) All fire Doors should be fitted with a positively self-closing devices capable of closing the door from any angle against any latch fitted to door (b) No holding of any such door open should be provided other than holding device that will release by activation of a smoke detector in vicinity	3.70. 3.70 (a) 3.70 (b)
<u>Powered Door Leaf Operation</u> 7.2.1.9.1) Power operated, upon approach of person or provided with power assisted manual operation, means of egress door leaves, should open manually to allow egress travel or close to safeguard the means of egress when necessary 7.2.1.9.1.1) Force required to manually open door leaves, specified in 7.2.1.9.1 shouldn't exceed 7.2.1.4.5, except force required to set door leaves in motion, ≤50lbf (222 N) 7.2.1.9.1.2) Door assembly should design & install to swing from any position to provide full use of required opening width in which its installed, when a force applied on the side where egress is made 7.2.1.9.1.3) Readily visible, durable sign in ≥1 in. (25 mm) high letters on a contrasting background that reads, IN EMEREGENCY PUSH TO OPEN locate on egress side of each door 7.2.1.9.1.4) In exit access with ≤50 occupant load, sliding, power-operated door assemblies manually open with forces ≤required in 7.2.1.4.5, in door leaf travel direction, not required to have swing-out feature as in 7.2.1.9.1.2. - sign in ≥1 in. (25mm) letters on contrasting background IN EMERGENCY SLIDE TO OPEN	7.2.1.9	(l) Power operated doors: may be used as exit or corridors provided they remain closed in case or power failure, but should be manually operable - No such doors should be credited as required exit unless it swings in direction of travel.	2.51 (l)

	7.2.1.9.1.5) door leaf in two-leaf opening in emergency breakdown mode, should exempt from min. 32 in. (810 mm) single-leaf requirement of 7.2.1.2.3.2 (1), if clear width of single leaf ≥30 in. (760 mm) 7.2.1.9.1.6) for biparting sliding door assembly, door leaf located within multiple leaf opening in emergency breakout mode, exempt from min. 32 in. (810 mm) requirement of 7.2.1.2.3.2 (1), if clear opening ≥32 in. (810 mm) provide by all leaves broken out 7.2.1.9.1.7) door assemblies complying 7.2.1.14 permit to use 7.2.1.9.1.8) requirements of 7.2.1.9.1 through 7.2.1.9.1.7 not apply to detention and correctional occupancies			
	7.2.1.9.2) <u>Self-Closing or Self-Latching Door Leaf Operations</u> Self-closing or self-latching and power operated upon approach of person, or power-assisted manual operated door leaves permitted in 1. Door leaves can be opened manually according to 7.2.1..9.1 for egress travel in power failure 2. New door leaves remain closed, unless actuated or manually opened 3. New door leaves remain open for ≤30 sec. where actuated 4. Door leaves held open for any period of time close / and power-assisted mechanism ceases to function, upon approved smoke detector, installed to detect smoke either side of door opening according to NFPA 72, National Fire Alarm and Signalling Code, operation 5. Door leaves Self-latching or become self-latching upon approved smoke detector, as per 7.2.1.9.2(4), operation 6. New power-assisted swinging door assemblies comply with BHMA/ANSI A156.19, American National Standard for Power Assist and Low Energy Power Operated Doors			
	<u>Revolving Door Assemblies</u>	7.2.1.10	(m) Revolving Doors: shouldn't be used as required exit s or as access doors to exits.	2.51 (m)
	7.2.1.10.1) Revolving door assemblies should comply:			

	1. wings should collapse into book-fold position, unless existing doors approved by AHJ 2. When revolving doors collapsed into book-fold, parallel egress paths should provide an aggregate width of 36 in. (915 mm), unless approved existing revolving doors 3. shouldn’t use within 10 ft (3050 mm) of foot or top of stairs/ 4. Dispersal area should locate between stairs/ escalators & revolving door assembly, accepted 5. should not exceed values in Table 7.2.1.10.1 for revolutions per minute (rpm) 6. revolving door should’ve conforming side-hinged swinging door assembly in same wall as revolving door within 10 ft (3050 mm) of same, unless one of (a) as required by 7.2.1.10.1.(6), in street floor elevator lobbies, if no stairway or door opening from other parts of building discharge through lobby and lobby has no occupancy other than as means of travel between elevators & street (b) 7.2.1.10.1(6) not apply to existing revolving door assemblies, where no. of revolving door assemblies doesn’t exceed no. of swinging door assemblies within 20 ft (6100 mm) of same			
	7.2.1.10.2) Revolving door assemblies permit as a component in means of egress, if: 1. Door openings shouldn’t for >50% egress capacity 2. Each door opening shouldn’t for >50 person capacity or if of >9 ft (2745 mm) dia. revolving door assembly should be permitted egress capacity based on clear opening width provided when book-fold 3. Revolving door wings capable of being collapsed into book-fold position when a force <130 lbf (580 N) is applied to wings within 3 in. (75 mm) of outer edge			

	7.2.1.10.3) Not use as means of egress component, should've collapsing force ≤180 lbf (800 N) apply at a point 3 in. (75 mm) from outer edge of outer wing stile and 40 in. (1015 mm) above floor			
	7.2.1.10.4) Above shouldn't apply to, if collapsing force reduced to ≤130 lbf (580 N) under all of 1. Power failure or power removal to device holding the wings 2. Automatic sprinkler system activation, where provided 3. Smoke detection system activation, installed to provide coverage in all areas within 75 ft (23m) of revolving door assemblies, inside building 4. Clearly identified manual control switch activation, in approved location that reduces holding force to ≤130 lbf (580 N)			
	<u>Turnstiles and Similar Devices</u> 7.2.1.11.1) Restrict to travel to one direction or are used to collect fares or admission charges shouldn't place to obstruct any required means of egress, unless specified in 7.2.1.11.1.1, 7.2.1.11.1.2 and 7.2.1.11.1.1) Approved freely turn in egress direction, ≤39 in. (990 mm) height turnstiles, permitted where revolving door assemblies permitted	7.2.1.11		_
	7.2.1.11.1.2) AHJ approved turnstiles should be for 50 person 1. They freewheel in egress direction when power lost - Freewheel in egress travel direction upon manual release by employee assigned 2. They aren't given credit for >50% of require egress width 3. Not >39 in. (990 mm) height & clear width ≥16 ½ in. (420 mm)			
	7.2.1.11.1.3) Security access turnstiles, impede travel in egress direction by physical barrier permit as egress component, if: 1. Building protected throughout by approved, supervised automatic sprinkler system			

	2. Each lane configuration has a >22 in. (560 mm) wide clear passage 3. Any, lane configuration provide <32 in. (810 mm) clear passage width should give egress capacity of 50 persons 4. Any, lane configuration provide 32 in. (810 mm) or more clear passage width should give egress capacity as per section 7.3 5. Each secure physical barrier should automatically retract or swing to unobstructed open position in egress direction, under: (a) Power loss to turnstile or any part of access control system that secures physical barrier (b) Readily accessible and clearly identified manual release device actuation, that directly interrupt power to secured physical barriers remain open for ≥30 sec. and i. Manual release device located on egress side of each security access turnstile lane ii. Manual release device located at approved location where it can be actuated by an employee (c) If provide, building fire—protective signaling system actuation, apply: i. Physical barrier remain open until fire-protective signalling system manually reset ii. Manual fire alarm boxes actuation, that actuate building fire-protective signalling not required to meet 7.2.1.11.1.3(5)(c) i. (d) Building automatic sprinkler or fire detection system activation and for which the physical barrier remain open until fire-protective signalling system manually reset 7.2.1.11.2) Turnstiles >39 in. (990 mm) height should meet revolving door assembly requirements in 7.2.1.10 or 7.2.1.11.1.3 for security access turnstiles			

7.2.1.11.3) Located in or furnishing access to, required exits should provide ≥16 ½ in. (420 mm) clear width at & <39 in. (990 mm) height and at least 22 in. (560 mm) clear width at heights above 39 in. (990 mm)			
<u>Door Openings in Folding Partitions</u> Permanently mounted folding or movable partitions divide a room, swinging door leaf or open doorway should provide as an exit access each space, unless otherwise specified in 7.2.1.12.1 & 7.2.1.12.2	7.2.1.12		–
7.2.1.12.1) Door leaf or opening in folding partition not required, if: 1. Subdivided space isn't use by >20 persons at any time 2. Use of space is under adult supervision 3. Partitions arranged to not extend across any aisle or corridor used as exit access to required exits from 4. Approved type of partitions, have simple release method, open quickly and easily by experienced person in an emergency			
7.2.1.12.2) Swinging door leaf in folding partitions in 7.2.1.12 not required and one means of egress permit with a horizontal-sliding door assembly comply with 7.2.1.14, where subdivide space provided with ≥02 means of egress			
<u>Balanced Door Assemblies</u> If panic hardware installed on balanced door leaves, should be push-pad type, & pad width not more than one-half width of door leaf, measured form latch stile	7.2.1.13	2.51 Exit Doors (a) exit doors – should be openable simply by pushing open or by means of a panic bar (not applicable to buildings under purpose Group 1)	2.51 (a)
<u>Special-Purpose Horizontally Sliding Accordion or Folding Door Assemblies</u> Special-purpose horizontally sliding accordion or folding door assemblies permit in means of egress, if: 1. door leaf readily operable from either side without special knowledge/effort 2. force applied to operating device required to operate door leaf ≤15 lbf (67 N)	7.2.1.14	(n) Sliding doors: Horizontal and vertical sliding or folding shouldn't be used as required exits or as access doors to exits in place of public resort, shopping centres and department stores.	2.51 (n)

	3. force required to operate door leaf in travel direction ≤30 lbf (133 N) and to close the leaf or open to minimum required width ≤15 lbf (67 4. force use to open door leaf ≤50 lbf (222 N) when 250 lbf (1100 N) force applied perpendicularly to leaf adjacent to operating device, - unless door opening is existing special purpose horizontally sliding accordion or folding exit access door assembly serving <50 occupant load area 5. Door assembly complies with fire protection rating, is self-closing or automatic closing by smoke detection according to 7.2.1.8 - Installed according to NFPA 80, Standard for Fire and Other Opening Protectives.			
	<u>Inspection of Door Openings</u>	7.2.1.15	2.51 Exit Doors (o) Clear opening size or doors	2.51 (o)
	7.2.1.15.1) Following door assemblies should inspect & test >annually according to 7.2.1.15.2 through 7.2.1.15.7 1. Door leaves with panic hardware or fire exit hardware according to 7.2.1.7 2. Door assemblies in exit 3. Electrically controlled egress 4. Door assemblies with special locking arrangements subject to 7.2.1.6		(i) in case of an exit door having single leaf door, opening should be measured between the edge of door jamb and the surface of the door when opened at an 90 degree angle, and (ii) in case of an exit door having 2-leaf and fitted with approved automatic door closer, clear openings should be measured between the surface of one leaf to the other leaf when opened at 90	
	7.2.1.15.2) Under written performance based programme, inspection & testing interval for fire-rated and nonrated door assemblies permit to exceed 12 months 7.2.1.15.2.1) Goals under performance-based programme should provide assurance that door assembly will perform intended function		(iii) If one of the door leaves is bolted to door frame and/or floor by a manually operated bolt, door shouldn't be considered for purpose of determining exit capacity of door. - Opening of door leaf should've a clear width ≥900mm measured between edge of the bolted door leaf and surface of other door leaf, when opened at an 90 degree angle	
	7.2.1.15.2.2) Technical justification for inspection, testing & maintenance intervals should documented 7.2.1.15.2.3) Performance-based option should include historical data		8.6 Frequency of Testing of Fire Systems Fire Door Assembly	8.6
	7.2.1.15.3) Written record of inspections & testing should signed and kept for AHJ's inspection		i. Fire door operating mechanisms and assemblies should be operated and tested and recorded monthly by the user.	

7.2.1.15.4) Functional testing of door assemblies should performed by who can demonstrate knowledge & understanding of operating components of door type		ii. Fire door operating mechanisms and assemblies should be operated and tested annually for functionality and a written record of the inspection should be signed and kept for inspection by the AHJ	
7.2.1.15.5) Door assemblies should visually inspected from both side to assess overall condition			
7.2.1.15.6) Following should verify: 1. Floor space clear of obstructions from both sides and door leaves open fully & close freely 2. Forces require to set motion & move to door leaves fully open position don't exceed 7.2.1.4.5		8.2 Inspection and Maintenance All systems should be subjected to routine inspection and maintenance, periodic maintenance by AHJ a) Routine inspection & maintenance – involves visual check of complete facility to ensure it is good operating condition	8.2
3. Latching & locking device comply 7.2.1.5 4. Releasing hardware devices installed according to 7.2.1.5.10.1 5. Paired opening door leaves installed to 7.2.1.5.11 6. Door closures adjusted properly to control closing speed of leaves according to accessibility requirements		2.26 Pressurization Level All fire escape stairways serving high-rise and super high-rise buildings should be provided with a pressurization system as follows: d) Force required to open any door against combined resistance of pressurized air and automatic door closing mechanism should ≤110 N at	2.26 (d)
7. Door leaves projection into egress path not exceed 7.2.1.4.3 8. Powered door openings operate according to 7.2.1.9 9. Signage required by 7.2.1.4.1(3), 7.2.1.5.5, 7.2.1.6 and 7.2.19 is intact and legible		2.51 Exit Doors l) Power operated doors: may be used as exit or corridors provided they remain closed in case or power failure, but should be manually operable - No such doors should be credited as required exit unless it swings in direction of travel.	2.51 (l)
10. Door openings with special locking arrangements function according to 7.2.1.6		3.70 Provisions of Closing Devices and Non-Combustible Hinges	3.70.
11. Security devices that impede egress aren't installed on openings, as required 7.2.1.5.12		(a) All fire Doors should be fitted with a positively self-closing devices capable of closing the door from any angle against any latch fitted to door	3.70 (a)
12. Door hardware marking is present & intact required by 7.2.2.5.5.7		(b) No holding of any such door open should be provided other than holding device that will release by activation of a smoke detector in vicinity	3.70 (b)
13. Emergency lighting on access-controlled egress doors & doors with delayed-egress locking systems is present & functional according to 7.9 7.2.1.15.7) Door openings not in proper operation should repair or replaced without delay		2.27 Exit Doors Exit doors giving access to escape corridors should be so positioned that their swing should at no point encroach on the required minimum width of the escape corridor. - Door must be provided with a door closer.	2.27

Stairs 7.2.2.1.1. Stairs used as means of egress component 7.2.2.1.2. Not apply to, 1. aisle stairs in assembly occupancies as in chapter 12 & 13 3. approved existing noncomplying stairs	7.2.2	Staircase Identification Every staircase forming a part of means of escape should be clearly identified and the floor levels should be clearly	2.2
7.2.2.2. <u>Dimensional Criteria</u> (1) New stairs – Table (7.2.2.2.1.1(a))	7.2.2.2	2.8 Exit Requirements – Capacity of Exits and Exit Facilities a. Capacity of exits, staircase and other facilities should be measured in units of width of ½ of a 1m & no. of persons per unit of width should be determined by type of occupancy and type of exit listed in Table 5 (I) to (VIII)	2.8 (a)
(2) Existing stairs – Table (7.2.2.2.1.1(b)) (3) a. Permit to remain in use as in table b. Approved existing stairs permit to rebuilt as per dimensional criteria in table		b. Fractions of a unit ≤250mm shouldn't be credited. - Where 250mm or more added to one or more full units, ½ of a unit of width should be credited	2.8 (b)
c. Other stair requirement 7.2.2 (4) New & existing stair requirement not apply to stairs located in industrial equipment access		2.9 Minimum Widths a. Width of staircase or other exit facilities shouldn't be less than min. as specified in Table 5 (I) to (VIII)	2.9 (a)
7.2.2.2.1.2. <u>Min. new stair width</u> A. Total occupant load of all stories served by stair ≤50, min. clear width each side at or below handrail height 36 in (915 mm), except ≤4 ½ in (114 mm) projections B. If occupant load exceed above, min. clear width as described above according to Table 7.2.2.2.1.2 (B) and required in C, D, E & F C. Total cumulative occupant load should be stair's prorated share of occupant load, calculated in proportion to stair width D. For downward egress travel, Stair Width based on total no. of occupants of above stories E. For upward egress travel, stair width based on total no. occupants of below stories F. Clear width of door opening discharging from stairway, min. 56 in (1420 mm)		2.10 Maximum Widths <u>Max. width of staircase shouldn't be more than 04 units of width</u>, unless divided by handrails into section of ≥02 units of width or ≥04 units of width. a. for determining exit capacity of a staircase wider than 4 units of width and forms part of the required means of escape from any storey of the building, the part of its width in excess of 4 units of width shouldn't be taken into account b. Max. width of single exit staircase should be ≤2000mm c. Where width exceeds 2000mm, handrails should be used to divide staircase into section of ≤1000mm width	2.10.

7.2.2.2.2. <u>Curved Stairs</u> 7.2.2.3.6.1. New stairs, permit as egress component, depth of tread at the 12 in (305 mm) point from narrower end is ≥11 in (280 mm) - Smallest radius ≥ twice the stair width 7.2.2.3.6.2. Existing stairs, as described above ≥10 in (255mm) 7.2.2.2.3 <u>Spiral Stairs</u> 7.2.2.2.3.1 Specifically permit for individual occupancies, 7.2.2.2.3.2 If only all following criteria are met:	2.11 Measurement Width Width of a staircase should be the clear width between: a. if the staircase is enclosed on both sides of walls, the finished surface of the b. finished surface of the wall and inner side of the balustrade or handrail, - if staircase has wall on one side and balustrade /handrail on the other Or c. the inner sides of balustrade or handrails if the staircase has balustrades or handrails on both sides	2.11
1. Riser height ≥7 in. (180 mm) 2. Tread depth ≥11 in. (280 mm) for a portion of stairway providing egress to occupant load according to 3. 10 ½ in (265 mm) provide at the outer edge for handrail, without including that to required egress capacity	2.15 Number of staircase or Exit per Storey Where scissor exit staircase is provided, each exit staircase should be separated from other by non-combustible construction having fire resistance not less than that required for the enclosure.	2.15
4. Handrail complying with 7.2.2.4 provide at both sides 5. Inner handrail located within 24 in. (610 mm), measured horizontally, where tread depth ≤11 in. (280 mm) 6. Turn of the stairway – outer handrail is at the right side of descending users 7.2.2.2.3.3 where occupant load ≤3, spiral stair should permitted, with all of following criteria are met 1. clear width of stair ≥>26 in. (660 mm) 2. height of risers ≤9 ½ in. (240 3. headroom ≥6 ft 6 in. (1980 mm) 4. tread depth ≥7 ½ in. (190 mm) at 12 in. (305) point from narrower edge 5. identical treads 6. handrail on both sides 7.2.2.2.3.4 Where occupant load ≤5, existing spiral stair shall permit, if only above are met.	2.47 Scissor Exit Staircase Where 02 separate internal exit staircases are contained within same enclosure, each exit staircase should be separated from each other by non-combustible construction having fire resistance for min. period required for the enclosure. (a) Such scissor exit staircases should comply with all applicable provision for exit staircase (b) Door opening into scissor exit staircases should be ≤7 m measured as travel distance between the two closer edges of the staircase doors. (c) Where there is only one pair of scissor exit staircase, the door opening into scissor exit staircases should be spaced at least 1/3 the diagonal dimension of the area to be served in a sprinkler protected building - ½ the diagonal dimension in a non-sprinkler protected building	2.47
7.2.2.2.4. <u>Winders</u>	<u>Exclusions</u> Scissor type staircase shouldn't accepted as alternative means of escape for super high-rise buildings	

7.2.2.2.4.1. Should permit in stairs, if following requirements are met: 7.2.2.2.4.2. new winders – tread depth ≥6 in. (150 mm) and tread depth ≥11in. (280 mm) at 12 in. (305 mm) point from narrowest edge 7.2.2.2.4.3. existing winders – tread depth ≥6 in (150mm) and tread depth ≥9 in. (230 mm) at 12 in. (305 mm) point from narrowest edge		2.49 Spiral Staircases May serve as required exists from mezzanine and balconies on any storey having an occupant load ≤25 persons, - When built externally as an enclosed staircase and also of non-combustible materials and having a tread length of ≥0.75m. - Such spiral staircases shouldn't be ≤10m height and shouldn't be used as an exit from public area. - Spiral staircases shouldn't be allowed as a fire exit for Purpose Group 2 (a).	2.49
<u>Stair Detail</u> 7.2.2.3.1. <u>Construction</u>	7.2.2.3	2.48 Hardwood Stairs Hardwood staircase should only be permitted as internal staircases in Purpose Group I buildings	2.48
7.2.2.3.1.1. All stairs serving means of egress – permanent fixed construction, unless serving seating designed to reposition 7.2.2.3.1.2. Each stair, platform, landing, not including handrail and existing stair in buildings to be of Type I or Type II construction, fully non-combustible material. 7.2.2.3.2 <u>Landings</u> 7.2.2.3.2.1 Should've landing at door openings 7.2.2.3.2.2 Stairs & intermediate landings should continue without decreasing the width along direction of travel 7.2.2.3.2.3 New buildings – every landing width = > stair width, measured along travel direction 7.2.2.3.2.4 If stair has straight run – no need to exceed 48 in. (1220 mm) landing in the travel direction 7.2.2.3.2.5 Existing buildings – door assembly at top of stair permit to open directly to stair if the door leaf doesn't swing over the stair & - Door opening area serves occupant load <50 persons		2.42 Internal Staircases Internal staircases serving as fire exists exceeding 03 stories in height should satisfy requirements as for protected staircases given in Regulation 2(3) (k) The minimum width and capacity of staircases should be as listed in Table 5 and such staircases should comply with the following: ii. Headroom : Clear headroom should be ≥2200 iii. Landings: except for circular or geometric stairs, all staircases should be in straight flights with landings provided at intervals of ≤16 risers and at every floor level. - changes in level along an exit stairway <2 risers should be a ramp iv. Minimum width of a landing should be not less than width of existing staircase v. Winders: shouldn't be permitted in any building other than residential buildings not exceeding 9 m and in such cases there should be ≤1 winder per 90	2.42
7.2.2.4.5.3 <u>Tread and Landing Surfaces</u> 7.2.2.3.3.1 Stair treads & landings – solid without perforations		3.45 Facility for Re-entry Internal staircases where entry is restricted with fire doors, facility to re-enter the building should be provide at every 5th floor.	3.45

	7.2.2.3.3.2 Stair treads & landings – free of projections or lips that could trip stair users 7.2.2.3.3.3 Stair treads & landings within same stairway should've consistent surface traction 7.2.2.3.3.4 Risers on new stairs permit to slope <30 degrees under the tread, from vertical, projection of the nosing shouldn't exceed 1 ½ in. (38 mm) 7.2.2.3.3.5 Requirement of 'i' shouldn't apply to non-combustible grated stair treads and landings in following occupancies; 1. Assembly occupancies (chapter 12) 2. Detention & correctional occupancies (chapter 22 & 23) 3. Industrial occupancies (chapter 40) 4. Storage occupancies (chapter 42) 7.2.2.4.5.4 <u>Tread and Landing</u> Slope < ¼ in./ ft (21 mm/m) (a slope of 1 in 48) 7.2.2.4.5.5 <u>Riser height and Tread Depth</u> a. Riser height measured between tread nosings, vertically b. Tread depth measured between vertical planes of primary projection of adjacent treads, horizontally. - At a right angle to tread's leading edge, but shouldn't include bevelled/rounded tread surfaces slope >20 degrees (a slope of 2 in - At tread nosings, such bevelling/rounding < ½ in. (13 mm) horizontally 7.2.2.4.5.6 Dimensional Uniformity 7.2.2.3.6.1 Variation >3/16 in. (4.8 mm) in adjacent tread depths or adjacent risers prohibited, unless permitted below in 'iii'. 7.2.2.3.6.2 Variation between largest & smallest riser / between largest & smallest tread depths < 3/8 in. (9.5 mm) in any flight		Monitoring facilities should be provided for such doors to prevent unauthorized entry.	

7.2.2.3.6.3 Where bottom or top riser adjoins public way, walk, driveway having established F.G.L and serves as landing, bottom or top riser permitted to have <1 in. variation in height in every 12 in. (25 mm in every 305 mm) of stairway 7.2.2.3.6.4 Size of variation mentioned in all above, based on nosing-to-nosing dimensions of tread depth & riser heights, consistent with measurement details in (5) (7.2.2.3.5) 7.2.2.3.6.5 All tread nosings should be marked. - portions of marking stripe at locations where riser height below the nosing is inconsistent by > 3/16 in. (4.8 mm), should be distinctively coloured or patterned, relative to other risers in the stair flight. – including safety Yellow, to warn descending users 7.2.2.3.6.6. variation in horizontal projections of all nosings, including landing, < 3/8 in. (9.5 mm) within each stair flight - For other than existing nosings, < 3/16 in. (4.8 mm) between adjacent nosings.			
<u>Guards and Handrails</u> 7.2.2.4.1 Handrails 7.2.2.4.1.1 stairs & ramps should've handrails on both side 7.2.2.4.1.2 following both provisions should apply, 1. new stairs – handrail provided within 30 in. (760 mm) of all portions of egress width 2. existing stairs – following should met (a) provided within 44 in. (1120 mm) of all portions of egress width (b) those shouldn't adjust egress capacity to higher occupant load than permitted in Table 7.3.3.1, if stair's clear width >60 in. (1525 mm) between handrails 7.2.2.4.1.3 where new intermediate handrails, min. clear width between handrails 20 in. (510 mm)	7.2.2.4	Handrails Balustrades etc. Every exit staircase should've walls, grillers or handrails on both sides, except where the width is <1250mm or less in width, can have a handrail one side only. Where the width of the exit staircase >2000mm, intermediate handrails should be provided.	2.43

	7.2.2.4.1.4 required egress width should provide along natural travel path 7.2.2.4.1.5 if a single step or ramp is part of a curb, that separates a sidewalk from vehicular bay, not required to have a handrail 7.2.2.4.1.6 Existing stairs, existing ramps, stairs within dwelling units, & guest rooms, and ramps within dwelling units & guest rooms permit to have handrail on one side only.			
	7.2.2.4.2 Continuity Required guards & handrails should continue for full length of stair - At turns of new stairs, inside handrails should continue between flights at landings			
	7.2.3.3 Projections Guards & handrail design and hardware for fixing handrail to guards, balustrades, and walls should prevent engaging loose clothing. - Opening in guards should designed to prevent loose clothing from becoming wedged in such			
	7.2.3.4 Directions Standard stairs – min. 01 handrail should be installed at a right angle to the leading edge of stair tread			
	7.2.3.5 Handrail Details 7.2.2.4.5.1 New handrails – 38 in. (965 mm) > 34 in. (865 mm) above tread surface, measure vertically to top of rail from leading edge of tread 7.2.2.4.5.2 Existing handrail – 38 in. (965 mm) >30 in. (760 mm) measured as above 7.2.2.4.5.3 Height of handrail – that form part of a guard, permit to 42 in. (1065 mm) >38 in. (965), measure as above 7.2.2.4.5.4 Additional handrails, that lower or higher than main handrail should permit 7.2.2.4.5.5 New handrails – installed to provide clearance >2 ½ in. (57 mm) between handrail & wall which its fastened 7.2.2.4.5.6 Handrail should include one of following; 1. Circular cross section with outside dia. 2 in. (51 mm) >1 ¼ in.			

	2. Shape – other than circular, with perimeter dimension 6 ½ in. (160 mm) >4 in. (100mm), and with largest cross-sectional dimension <2 - But graspable edges are rounded to provide >1/8 in. (3.2 mm) radius 7.2.2.4.5.7 New handrails – continuously graspable along entire length. 7.2.2.4.5.8 brackets or balustrades attached to the bottom surface of handrail, shouldn't considered as obstructions to grasp-ability, - if following criteria are met, 1. don't project beyond sides of handrail within 1 ½ in. (38 mm) horizontally of the bottom of handrail, - for each additional ½ in. (13 mm) of handrail perimeter dimension >4 in. (100 mm), vertical clearance dimension of 1 ½ in. (38 mm) is reduced by 1/8 in. (3.2 mm). 2. have edges with a radius of > 0.01 in (0.25 mm) 7.2.2.4.5.9 new handrail ends – return to the wall or floor or terminate at newel posts 7.2.2.4.5.10 In other than dwelling units, new handrail – that aren't continuous between flights, should extend horizontally, at required height >12 in. (305 mm) beyond top riser and continue to slope for a depth of 01 tread beyond the bottom 7.2.2.4.5.11 Within dwelling units – handrail should extend, at required height, to min. points that directly above the top & bottom risers			
	7.2.3.6 Guard Rails See 7.1.8 7.2.2.4.6.1 Height of guards – should measure vertically to top of guard from surface adjacent thereto. 7.2.2.4.6.2 Guards – should >42 in. (1065 mm), except as permitted in following: 1. Existing guards – within dwellings, permit to >36 in.(915 2. Above requirement not apply for assembly occupancies where otherwise provided (chapter 12 & 13) 3. Existing guards – on existing stairs, permit to > 30 in. (760 mm)			

	7.2.2.4.6.3 Open guards – other than approved existing, should've intermediate rails/ ornamental pattern that 4 in. (100mm) dia. Sphere isn't able pass through any opening up to 34in. (865 mm) height. - Following should apply. 1. Triangle opening formed by riser, tread and bottom element of guardrail at open side of a stair, should be sized that, 6 in. (150 mm) dia. Sphere cannot pass through the 2. In detention and correctional occupancies, industrial occupancies, storage occupancies the clear distance between intermediate rails, should <21 in. (535 mm) measured at right angle to the rails.			
	<u>Enclosure and Protection of Stairs</u> 7.2.2.5.1 Enclosure 7.2.2.5.1.1 All inside stairs or component serve as fire exit should be enclosed	7.2.2.5	2.15 Number of staircase or Exit per Storey Where scissor exit staircase is provided, each exit staircase should be separated from other by non-combustible construction having fire resistance not less than that required for the enclosure.	
	7.2.2.5.1.2 Other than above, all inside stairs to be protected 7.2.2.5.1.3 Existing buildings – where 2 story exit enclosure connects, story of exit discharge with adjacent story only on the exit discharge story permitted to be enclosed – if only ≤50% of number & capacity of exits o the story of discharge are independent of such		2.47 Scissor Exit Staircase Where 02 separate internal exit staircases are contained within same enclosure, each exit staircase should be separated from each other by non-combustible construction having fire resistance for min. period required for the enclosure.	2.47
	7.2.2.5.2 Exposure 7.2.2.5.2.1 When Nonrated walls / unprotected openings enclose exterior of a stairway, and walls / openings are exposed by other parts of building at ≤180 degree angle, building enclosure walls should be constructed within 10 ft. (3050 mm) horizontally of the nonrated wall / unprotected opening as required for stairway enclosures, including 7.2.2.5.2.2 From the F.G.L. to 10 ft. (3050 mm) height above the top most landing of stairs or to the roofline, whichever is lower, construction should be extended.		3.58 Enclosure Subject to the provisions of this regulation, any protected shaft should be completely enclosed by walls or floors having the necessary fire resistance rating under Reg.3(24) to 3(30)	3.58

7.2.2.5.2.3 FRR of separation extending 10 ft. (3050 mm) from the stairs, shouldn't be required to exceed 1-hour, if opening have min. ¾ hour Fire Protection rating. 7.2.2.5.3 Usable Space Enclosed, usable space including under the stairs within exit enclosures, should be prohibited, unless permitted below. 7.2.2.5.3.1 Opening space within exit enclosure shouldn't use for any purposes, due to potential interfere with egress 7.2.2.5.3.2 Enclosed, usable space should be permitted under stairs, if both following criteria met, 1. Space should be separated from stair enclosure with same FRR as exit enclosure 2. Entrance shouldn't be from within stair enclosure			
7.2.2.5.4 Stairway Identification 7.2.2.5.5.1 new enclosed stairs serving 03 or more stories and existing enclosed stairs, other than addressed in below (P) serving 05 or more stories should comply with (A) A. special signage within enclosure at each floor landing of stair B. floor level should indicate in the signage C. terminus of the top & bottom of the stair enclosure should indicate in signage D. identification of the stair enclosure should indicated in signage E. floor level of and the direction to exit discharge should indicate in the signage F. signage should located inside the stair enclosure G. Bottom of signage located min. of 48 in. (1220 mm) above the floor landing and top of the signage located a max. of 84 in. (2135 mm) above the floor landing H. Signage should be in a position visible when the door is open or closed	7.2.2.5.4	Number of Staircases or Exits per Storey Staircase serving all buildings (except purpose group I) should be provided with a signage ≥300mmX300mm and within stairwell at each storey landing with following information (a) the storey no. at least 100mm height (b) an identification of the staircase in alphabetical and/or numeric; at least 100mm height (c) letters and numbers on the sign can be of any colour that should contrast with background colour	2.14

	I. Signage should comply with 7.10.8.1 & 7.10.8.2 J. Floor level designation should be tactile in according to standards (mentioned) K. Signage should be painted or stencilled on the wall or separate signs securely attached to wall L. Stairway identification should be located at top of the sign in min. 1 in (25 mm) high lettering & should be according to 7.10.8.2 M. 'NO ROOF ACCESS' Signage should designate stairway that don't provide roof access. Lettering – min. 1 in. (25 mm) high & according to 7.10.8.2 N. Floor level no. should locate below the stairway identifier in min. 5 in. (125 mm) high numbers - Should be according to 7.10.8.2 - Mezzanine levels should've "M" or appropriate identification letter reefing floor no. - In basement levels should've letter "B" or appropriate identification letter referring floor O. Lower & upper terminus identification of stairway min. 1 in. (25 mm) high letters or numbers and according to 7.10..8.2 P. Previously approved, existing signage shouldn't require to comply with L – O 7.2.2.5.5.2 Where an enclosed stair requires traveling upward direction to reach the exit discharge level, special signs with directional indicators showing the direction should be provided at each floor landing from where it's required., - Unless otherwise provided below. 1. Such signage should comply with 7.10.8.1 & 7.10.8.2 2. Shall be visible when the door leaf is open or closed A. Above requirements not apply where "i" provided B. Requirement "ii" not apply to stairs extending not more than 01 story below the exit discharge level where exit discharge is clearly 7.2.2.5.5.3 Stairway Tread Marking			

	Where new contrasting marking is applies, such marking should comply with following, 1. Should include continuous strip as a coating on, or as a material integral with, to full width of leading edge of each tread 2. Same as above to landing nosing 3. Marking strip width should be consistent at all nosings , measured horizontally form the leading vertical edge of nosing 4. Marking strip should be 1 in. – 2 in. (25 mm – 50 mm) wide 7.2.2.5.5.4 Where new contrast marking done for stairway handrails, should be applied to upper surface of handrail, min. width ½ in. (13 mm) and extend the full length of each - After marking should comply with above "Handrail Details" - Where handrails or handrail extensions bend or turn corners, the strip should be permitted to have a <4 in. (100 mm) gap. 7.2.2.5.5 Exit Stair Path Markings Where exit stair path markings required in chapter 11, should installed according to details 7.2.2.5.1-7.2.2.5.5.11 7.2.2.5.5.1 Exit stair treads Incorporate marking stripe applied as paint/coating or material integral with nosing of steps A. installed along horizontal leading edge of step & extend to full width B. meet all following: 1. ≤1/2 in. (13 mm) from leading edge of step & not overlap leading edge of step by >1/2 in. (13 mm) down vertical face of step 2. Should've min. horizontal width 1 in (25mm) & max. 2 in (51mm) 3. Dimension & placement should uniform & consistent on each step 4. Shouldn't use Surface-applied adhesive-backed tapes 7.2.2.5.5.2 Exit Stair Landings			

	Leading edge should mark with solid and continuous marking stripe consistent with dimensions for stair treads & should be same length as stripes on steps 7.2.2.5.5.3 Exit Stair Handrails Handrails & handrail extensions marked with solid & continuous marking strip. - meet following: 1. Marking strip apply to handrail upper surface or be integral material with handrail upper surface for entire length, including extensions 2. Marking strips permit to have <4 in. (100 mm) gap at handrail/ handrail extensions bend or turn 3. Min. horizontal width of 1 in. (25 mm), not apply to outlining stripes listed in ANSI/UL 1994, Standard for Luminous Egress Path Marking System 4. Marking stripe Dimension and placement be uniform & consistent on each handrail throughout exit 7.2.2.5.5.4 Perimeter Demarcation Marking Stair landings, exit passageways and other parts within exit enclosure provide with solid and continuous perimeter demarcation marking stripe on floor/ on walls/ - also meet following: 1. Marking strip should've min. width of 1 in. (25 mm) and max. width of 2 in.(51 mm) with interruptions <4 in. (100 mm) 2. Min. width of 1 in. (25 mm) not apply to outlining stripes listed in ANSI/UL 1994, Standard for Luminous Egress Path Marking System 3. Marking stripe Dimension and placement be uniform & consistent on each handrail throughout exit 4. Shouldn't use Surface-applied adhesive-backed tapes A. Perimeter floor demarcation lines should comply with: 1. Place within 4 in. (100 mm) of wall and extend to within 2 in. (51 mm) of markings on leading edge of 2. Should continue across floor in front of doors			

3. Shouldn't extend in front of exit doors leading out of exit enclosure and through which occupants travel to complete egress path B. Perimeter wall demarcation lines should comply: 1. Should place on wall with stripe bottom edge <4 in. (100 mm) above finished floor 2. Should drop vertically to floor within 2 in. (51 mm) of step/ landing edge at top/ bottom of stairs 3. Should transition vertically to floor & extend across floor where, line on floor is only practical method of outlining path 4. Wall line broke by door, should continue across door face or transition to floor and extend across floor in front of such door 5. Should not extend in front of doors leading out of exit enclosure and through which occupants travel to complete egress path 6. wall mounted demarcation line transitions to a floor-mounted demarcation line/ vice versa, wall mounted line should drop vertically to floor to meet complementary extension of floor-mounted demarcation line, forming 7.2.2.5.5.5 Obstacles That are in exit enclosure at or below 6 ft 6 in. (1980 mm) height , and project >4 in. (100 mm) into egress path, should identified with >1 in. (25 mm) wide marking with alternating equal bands pattern of luminescent material and black; and with <2 in. (51 mm) wide bands and angled 45 degrees 7.2.2.5.5.6 Doors Serving Exit Enclosure Doors in exit enclosure swing out, in egress travel direction, should provide with marking stripe on top and sides of door(s) frame(s). - Should meet: 1. Min. width of marking strip, 1 in. (25mm) and max. width 2 in. (51			

	2. <1 in. (25 mm) Gaps permit in continuity of door frame markings, where line fitted into corner or bend, but should practicably small. 3. Where door mouldings not flat enough for marking stripes, should locate on wall surrounding frame 4. Dimensions and placement of marking stripes should uniform and consistent on all exit enclosure doors 7.2.2.5.5.7 Door Hardware Marking A. door hardware for Exit enclosure door that swing out of, in egress travel direction should provide with marking stripe B. marking strip should: 1. door hardware necessary to release latch should outlined with approved min. 1 in. (25 mm) wide marking stipe 2. where panic hardware is, following should meet: (a) marking trip width min. 1 in. (25 mm) and apply to entire actuating bar/ touch pad length (b) marking stripe placement shouldn't interfere with viewing any instructions on actuating bar/ touch 7.2.2.5.5.8 Emergency Exit Symbol With a luminescent background should apply on all exit enclosure doors that swing out from, in egress travel direction. - Emergency exit symbols should meet: 1. Requirements of NFPA 170, Standard for Fire Safety and Emergency Symbols 2. Symbols applied on door should min. 4 in. (100 mm) height and applied horizontally cantered, with symbol top <18 in. (455 mm) above 7.2.2.5.5.9 Uniformity Placement and dimension of marking stripe should consistent & uniform throughout same exit enclosure 7.2.2.5.5.10 Materials Exit stair path markings shall made of any material, including paint, provide that electrical charge not require to maintain required Such material include, not limited to, self-luminescence materials & photo luminescent materials.			

	Material should comply: 1. ASTM E 2072, Standard Specification for Photo luminescent(phosphorescent) Safety Markings with following: (a) Charging source 1 ft-candle (10.8 lux) of fluorescent illumination for 60 min. (b) Min. luminescent 5 millicandelas/m2 after 90 minutes 2. ANSI/UL 1994, Standard for Luminous Egress Path Marking System 7.2.2.5.5.11 Exit Stair Illumination Exit enclosures where photo luminescent materials installed should comply: 1. Exit enclosure should continuously illuminated for >60 minutes prior building is occupied 2. Illumination should remain when building occupied 3. Lighting control devices provide for illumination within exit enclosure should meet: (a) Based on occupancy, Devices automatically turn exit enclosures lighting on & off, permitted, - Provided, they turn on illumination for charging photo-luminescent materials for >60 minutes prior building is occupied (b) Motion sensors should not control lighting used to charge photo-luminescent materials (c) Unless provide min. illumination of 1 ft-candle (10.8 lux) within exit enclosure, measure at walking surface, lighting control devices that dim lighting levels shouldn't installed			
	<u>Special Provision for Outside Stairs</u> 7.2.2.6.1 Access Outside stairs permit to lead to roofs of other sections of building/ adjoining building where construction if fire resistive and a continuous and safe means of egress from roof, where approved by AHJ	7.2.2.6	2.3(j) External Staircases 'External exit staircase' means an exit staircase which reaches the ground floor and is located outside the building envelope.	2.3(j)
	7.2.2.6.2 Visual Protection Outside stair should arrange to avoid any impediments to use by persons having fear of high places.		2.46 External Staircases External staircases may be used as exits in lieu of internal staircases provide they comply with all of the requirements of Regulation 2.42 for internal staircases, except enclosures, and also comply with provisions of Regulation 2.3(j)	2.46

- Stairs >36 ft (11m) above F.G.L other than exiting approved stairs, provide with >48 in. (1220 mm) height opaque visual obstructions	3.66 Protected Shaft of Staircase	3.66
7.2.2.6.3 Separation and Protection of Outside Stairs	(a) A protected shaft which contains an exit staircase shouldn't contain any services except for:	
7.2.2.6.3.1 Outside stair should separate from building interior by fire resistance construction required for enclosed stairs with fixed/ self-closing opening protective, except:	i. Cut off sprinkler and pipe for that staircase ii. Rainwater down pipes serving the roof directly above the exit staircase iii. Rising mains	
1. Outside stair serving exterior exit access balcony that has 02 remote outside stairways/ ramps permit to be unprotected	(b) Protecting structure should be constructed of masonry or dry wall.	
2. Outside stairs serving 02 or fewer adjacent stories, including where exit discharges, permit to be unprotected, where there is remotely located second exit	- If dry wall construction is used, should be of non-combustible material.	
3. Existing outside stairs serving 03 or fewer adjacent stories, including where exit discharges, permit to be unprotected where remotely located second exit, in exiting building	- Wall should've fire resistance for less than relevant period specified in Table-8, having regard to the purpose group of building.	
4. FRR of a separation extending 10 ft. (3050 mm) from stair should nt require to exceed 1 hr where openings have min. ¾-hr fire		
5. Outside stairs in existing buildings protected by approved, supervised automatic sprinkler system according to 9.7 permit to be		
	'Staircases'	
7.2.2.6.3.2 Wall construction required above should extend as:	Non-Combustibility of Structure	3.77
1. From F.G.L to 10 ft (3050 mm) vertically, above topmost landing of stairs or to roofline, which is lower	Every Staircase (including any landing thereof) which forms part of a building should, whether internal or external, be constructed of non-combustible materials except-	
2. Horizontally ≥10 ft (3050 mm)	(a) an internal staircase which is situated- i. within a maisonette;	
7.2.2.6.3.3 Roof construction required by 7.2.2.6.3.1 should meet: 1. provide protection beneath stairs 2. extend horizontally to each side of stair for ≥10 ft (3050 mm)	ii. within a building of purpose group I or 2(b) which has ≤3 storeys iii. within the ground storey or an upper storey of part of a building, which part consists of flats or maisonettes if that is separated as described in Reg 3(28) (b) and has ≤3 storeys	
7.2.2.6.4 Protection of Openings		

	Openings below outside stair should protect with min. ¾-hr fire protection rated assembly as:		(b) External staircase of a building of purpose group I and such staircase is situated between the ground and a floor or flat roof level of which, at the lead of the staircase is not more than 6m above finished surface of the ground adjoining the foot of the staircase.	
	1. Where located in enclosed court, Smallest dimension of which doesn't exceed 1/3 its height 2. Where located in alcove having width doesn't exceed 1/3 its height and depth doesn't ¼ its height 7.2.2.6.5 Water Accumulation Outside stairs and landings, other than exiting, should designed to minimize water accumulation on 7.2.2.6.6 Openness Outside stairs, other than existing, should >50% open on one side. Outside stairs should arrange to restrict smoke accumulation		Special Requirements for Buildings for Purpose Group I exceeding 3 storeys In any building of purpose group I which exceed 9 m in height, any internal staircase(including any hall or landing associated herewith and any part of a floor which affords passage between flights of the staircase) should be separated from all other parts of the building by structure complying with (a) structure should've fire resistance for not less than the minimum period required by Reg. 3(24) to 3(30) for elements of structure forming part of the storey in which it is situated; (b) any opening in the structure which gives access to a habitable room, garage, or kitchen should be fitted with a door which has fire resistance of ≥1/2 hour and complies with requirements of Reg. 3(68) to 3(76)	3.78
	Smoke proof Enclosures 7.2.3.3 Unless approved existing, smoke proof enclosures comply with 7.2.3	7.2.3	2.19 Smoke free Lobby A lobby that is separated from adjoining areas of the building by a wall having fire resistance as per the building fire rating. (Table 8) The exit access door should've fire resistance of half that of the enclosure fitted with automatic self-closing device. The design of a smoke stop lobby should not impede the movement of occupants through the escape route. The floor area of a smoke stop lobby should be ≥3m^{2}. If a smoke stop lobby also serves as a fire fighting lobby, the floor area should be ≥6m^{2} and with no dimension <2m. The floor should be graded from the lift door towards the lobby door with a slope ≤1 in 200.	2.19
			1.22 Smoke free Approach in basement Smoke free approach to exit staircase in basement occupancy:	2.22

		(a) In a building with >4 basements, entry to exit staircase serving the basement storeys at every basement storey level should be through smoke stop lobbies, 01 of which should be designed as fire fighting lobby. - The exit staircase connecting to fire lobby should be pressurized. (b) In a building with 2,3 or 4 basements, entry at every basement storey level to at least 01 of the exit staircases serving the basement storeys should be through a smoke stop lobby and where only 01 smoke stop is provided, it should be required to serve as a fire fighting lobby.	
<u>Performance Design</u> To provide a system that meets, 'smoke proof enclosure' appropriate design method should use. Created using natural ventilation, mechanical ventilation incorporating a vestibule or by pressurizing stair enclosure.	7.2.3.2		_
<u>Enclosure</u> 7.2.3.3.1 Smoke proof enclosure should continuously enclosed by 2-hr FRR barriers, from highest point to exit discharge level, except as otherwise permitted in 7.2.3.3.3 7.2.3.3.2 A vestibule if used, considered as part of smoke proof enclosure, it should be within 2-hr-rated enclosure 7.2.3.3.3 Smoke proof enclosure serving floors below exit discharge level, comprised of enclosed stair separated from stairway enclosure at exit discharge level by 1-hour FRR, shall not require to comply 7.2.3.3..1	7.2.3.3	Smoke Free Approach Staircase Entry to an exit staircase at every storey level (including first storey) of any building of > 06 storey's above ground level should be through: a) An external passageway or external corridor. The openings for natural lighting and ventilation to the corridor should be so located that they face and i. The external space: or ii. A Street, service road or other public space which is open to sky. (b) An internal passageway complying with Regulation 2(40) (c) Changes in level along an exit passageway less than two risers should be a ramp (d) Any internal passageway connected to a pressurized exit passageway shall not be naturally ventilated and should also be pressurized.	2.18
<u>Vestibule</u> - Door to vestibule should be protected with approved Fire door assembly having >1 ½ hour rating, - Fire door assembly from vestibule to smoke proof enclosure should've >20 min. fire protection rating.	7.2.3.4		_

	- Door leaves should be designed to minimize air leakage & be self-closing or automatically closing by smoke detector activation within 10ft (3050 mm) of the vestibule door - New door assemblies should install according to NFPA 105			
	Discharge (a) Every smoke proof enclosure should discharge into public way/yard/court having direct access to a public way/exit passageway. - Such exit passageway should be without opening, other than entry to smoke proof enclosure/door to outside yard/court/public way - Exit passageway separate from remainder of building by 2-hour FRR (b) Smoke proof enclosure permitted to discharge through interior building areas, provided that, i. Building should be protected by approved, supervised automatic sprinkler system according to 9.7	7.2.3.5	2.19 Smoke free Lobby A lobby that is separated from adjoining areas of the building by a wall having fire resistance as per the building fire rating. (Table 8) Exit access door should've fire resistance of half that of the enclosure fitted with automatic self-closing device. The design of a smoke stop lobby should not impede the movement of occupants through the escape route. The floor area of a smoke stop lobby should be ≥3m2. If a smoke stop lobby also serves as a fire fighting lobby, the floor area should be ≥6m^2 and with no dimension <2m. The floor should be graded from the lift door towards the lobby door with a slope ≤1 in 200.	2.19
	ii. Discharge from smoke proof enclosure should lead to free & unobstructed way to an exterior exit, such way should be readily visible & identifiable from point of discharge iii. ≤50% of required number and capacity of exits comprised of smoke proof enclosures should discharge through interior building area according to 7.7.2		2.20 Fire Fighting Lobby A smoke free or fire fighting lobby which acts as buffer space for entry into the protected staircase and used by fire fighters during emergency, should be maintained as common property. (a) Permanent ventilation openings in an external wall to which lobby abuts, such openings being not less than 15% of the area of the lobby and located not more 9 m away from any part of the lobby; (b) Mechanical ventilation complying with Reg. 2(23) (c) Permanent ventilation openings of similar size as in Clause (a) above, opening to an open air well having a superficial plan area of not less than 10m^2 or 0.1m^2 for each 300 mm of height of the building whichever is the greater. Enclosure walls of such air well should be of a similar standard of fire resistant as that required for the enclosures of protected staircase and should be imperforate except for ventilation opening for the lobby or staircase.	2.20.
			2.40 Internal exit Passageways	2.40 (d)

		a) Any internal passageway connected to a pressurized exit passageway should not be naturally ventilated and should be pressurized.	
<u>Access</u> For smoke-proof enclosures other than consisting of a pressurized enclosure complying with 7.2.3.9, Access to smoke proof enclosure should be through vestibule or exterior balcony	7.2.3.6		_
Natural Ventilation Smoke-proof enclosures with natural ventilation; should comply with 7.2.3.3 and following: (1) Where access to enclosure through an open exterior balcony, door assembly should have ≥1 ½ hour Fire protection rating & should be self-closing or automatic closing by smoke detector activation (2) Openings adjacent to exterior balcony specified in 7.2.3.7(1) should be protected with 7.2.2.6.4 (3) Every vestibule should've net opening area ≥16 ft2 (1.5 m2) in an exterior wall facing exterior court/yard/public space ≥20 ft (6100mm) wide (4) Every vestibule should've min. dimension ≥required width of corridor leading to it, and dimension ≥6 ft (1830 mm) in travel direction	7.2.3.7	2.18 Smoke Free Approach Staircase Entry to an exit staircase at every storey level (including first storey) of any building of > 06 storey's above ground level should be through: a) An external passageway or external corridor. The openings for natural lighting and ventilation to the corridor should be so located that they face and open to : i. The external space: or ii. A Street, service road or other public space which is open to sky. b) An internal passageway complying with Regulation 2(40)	2.18
		2.20 Fire-fighting Lobby (a) Permanent ventilation openings in an external wall to which lobby abuts, such openings being not less than 15% of the area of the lobby and located not more 9 m away from any part of the lobby; (b) Permanent ventilation openings of similar size as in Clause (a) above, opening to an open air well having a superficial plan area of not less than $10m^2$ or $0.1m^2$ for each 300 mm of height of the building whichever is the greater.	2.20
		2.40 Internal exit Passageways Any internal passageway connected to a pressurized exit passageway should not be naturally ventilated and should be pressurized.	2.40
<u>Mechanical Ventilation</u> Smoke-proof enclosures using mechanical ventilation should comply with 7.2.3.3 and requirements of 7.2.3.8.1 through	7.2.3.8	2.23Pressurized system for Stairways All fire escape stairways serving high rise and super high-rise buildings should be provided with a pressurization system.	2.23
		2.29(A) General Requirements	2.29

	1. vestibule dimension ≥44 in. (1120 mm) wide and ≥6 ft (1830 mm_ in travel direction 2. Vestibules provide with ≥01 air change per minute, and exhaust should 150 % of the supply.		The "smoke control system" should consist of the following: a) A "Smoke Purging System" which is independent of all other systems serving other parts of the building, and which will provide an extraction rate of ≥ 8 air changes per hour.	
	- Supply air should enter and exhaust air should discharge from vestibule through separate tightly constructed ducts used for such - Supply air enter vestibule within 6 in. (150 mm) of Floor level.		i. "Automatic Activation" The smoke purging system should be automatically activated by the building fire alarm system. ii. "Manual Control" A manual control system should be provided at the Fire Control Centre, or at the main Fire Control Panel, which will override the automatic control system. Visual indication of the operation status of the smoke control system should be provided with the remote control facility.	
	- Top of exhaust register locate <6 in. (150 mm) below top of trap and entirely within smoke trap area.		b) "Supply Air" for the smoke control system should be drawn directly from the exterior, and the intakes should be ≥5m from any exhaust discharge openings.	
	- Door leaves, in open position, should not obstruct duct openings. - Controlling dampers permit in duct openings if need to meet the design requirements.		c) The exhaust fan should be capable of operating efficiently at 250 centigrade for 2 hours and supplied from a secondary source of power.	
			2.30(B) Additional Requirement Basement Smoke Extraction Systems – Basement smoke extraction systems where required by the "AHJ" should be provided in addition to the stipulations of the "general requirements "above and should comply with the following i. "Smoke Purging Rate" should be ≥10 air changes per hour for fire conditions. The extract points should be arranged so that 50% are at high level and 50% at low level. ii. "Ducts" Where ducts are used for the smoke extraction system they should comply with the requirements for mechanical ventilation systems in buildings. The ducting should be manufactured with metal sheets of suitable thickness of suitable standards in compliance with ANSI standards. iii. "Melting Point" All components of the smoke extraction system must have a minimum melting point of 800 ^{o}C. iv. Smoke control system should be activated by the building fire alarm	2.3

			2.33 Air duct Access and Inspection A service opening should be provided in air ducts adjacent to each fire damper a) Service opening should be identified with lettering having a minimum height of 12.5mm to indicate the location of the fire protection devices within b) Service opening should be located at 6m intervals along the length of the duct and at the base of each vertical riser.	2.33
			2.34 Engineered Smoke Control System Engineered Smoke Control Systems where required by the AHJ should be provided in addition to the stipulations of the "general requirements" above and should comply with the following a) The capacity of an engineered smoke control system should be capable of handling the largest demand for smoke exhaust. b) The design smoke layer base should be above the heads of people escaping beneath it. The minimum height should be 2.5 m c) Smoke reservoirs to prevent the lateral spread of smoke, and to collect smoke for removal should be of non-combustible construction capable of withstanding smoke temperatures d) The smoke reservoir size for a smoke ventilation system should not exceed: i. 2000m^2 for natural smoke ventilation ii. 2600m^2 for mechanical smoke ventilation e) The minimum length of the smoke reservoir should ≤ 60m. The smoke ventilation system should be provided with secondary source of power.	2.34
			2.37 Fire Dampers Should not be installed in the engineered smoke ventilation system.	2.37
	<u>Enclosure Pressurization</u>	7.2.3.9	2.23Pressurized system for Stairways	2.23

	7.2.3.9.1 Pressurized smoke proof enclosure, should use approved engineered system with design pressure difference across the barrier $\geq$0.05 in. water column (12.5 N/m^2) in sprinklered buildings, or 0.10 in. water column (25 N/m^2) in nonsprinklered buildings, and should capable of maintaining same under likely conditions of stack effect or - Pressure differences across door openings should not exceed that allows door leaves to begin to open by 30 lbf (133 N) force according to 7.2.1.4.5		All fire escape stairways serving high rise and super high-rise buildings should be provided with a pressurization system.	
	7.2.3.9.2 Equipment & ductwork should locate as follows: 1. Exterior to building and connected directly to non-combustible ductwork enclosure 2. Within enclosure with intake, exhaust air directly to vented outside, or through ductwork enclosed by 2 hour-fire-resistive rating 3. Within building under following: (a) Where equipment & ductwork separated from building, including other mechanical equipment, by a 2-hour fire-resistive rating		2.24Pressurization of Exit stairways a) In any building which the habitable height exceeds 30m, any internal staircases without adequate provision for natural ventilation should be pressurized b) Where the upper part of the staircase is naturally ventilated, its lower part can be provided with mechanical ventilation pressurization whichever is appropriate c) In a building comprising more than 4 basements, exit staircase connected to fire fighting lobby in basement stories should be pressurized.	2.24
	(b) Where building & enclosure protected by approved, supervised automatic sprinkler system installed according to 9.7, and equipment & ductwork separated from building, including other mechanical equipment, by a 1-hour fire-resistive		2.25Pressurization of Internal corridors in hotels Where internal corridors are required to be pressurized in compliance with Reg. 2(26) the pressure within internal exit staircases > pressure within such corridors > guest rooms. The pressure gradient should $\geq$50Pa for each of the pressurized zone.	2.25
	7.2.3.9.3 In cases specified in 7.2.3.9.2(1)-(3), openings to fire-rated construction should limit to maintenance and operation and should protect by self-closing fire protection-rated devices according to 8.3.4		2.26 Pressurization Level <u>All fire escape stairways serving high-rise and super high-rise buildings should be provided with a pressurization system as follows:</u> a) Minimum pressurization level of 50 Pa should be achieved with all doors closed and all pressure relief systems	2.26

			b) In operation, pressurization system should maintain a pressure differential of ≥50 Pa between pressurized staircase and adjacent area when all doors are closed c) Where a smoke-free lobby is also pressurized, the pressure at the exit staircase should always be > the smoke free lobby d) Force required to open any door against combined resistance of pressurized air and automatic door closing mechanism should ≤110 N at e) In operation, fan capacity should be enough to maintain minimum average egress velocity through doorways of 0.75 m/s with any 03 single leaf entry doors (01 on each of 03 levels) and the largest exit door open, plus leakage allowance for all other doors. f) In operation, system should maintain an air flow of sufficient pressure when 03 nos of doors open simultaneously to stairway to prevent smoke from entering into the pressurizes area g) Minimum FRR for enclosure of pressurization plant should be the same as of the staircase served h) Number and distribution of injection points for supplying of pressurization air to exit staircase should ensure an even pressure profile. Multiple injection system with air supplies at ≤12m apart to i) Emergency power supply should be provided for all equipment serving staircase pressurization, bypassing the main distribution panel. - Power supply for pressurization equipment must be fed directly, bypassing Main Distribution Board and emergency power supply must be directly from generator output. - Above required an Auto Transfer Switch panel at pressurization equipment room. j) All wiring, cables, electrical equipment, starters, relays, etc., including building primary & secondary sources of supply should be suitable for continuous operation at 250˚C ambient for a time period as per the rating given for building	

			k) All cables feeding pressurization fan located outside fire protected ducts should be fire resistant and should've adequate mechanical protection. l) Pressurization system should be automatically activated by building fire alarm system. - A remote manual start/stop switch should be made available for firemen at fire command centre. - Visual indication of operation status of the pressurization system should be provided m) Supply air for pressurization system should be drawn directly from outside and its intake should be ≥5 m from any exhaust discharge openings n) Pressurization system should not be controlled by any Building Management System o) Measures should be provided to ensure that no excessive pressure build-up occurs to negate the pressure gradient specified	
			3.65 Ventilation of Protected shaft a) A protected shaft used for passage of people, should be ventilated complying with relevant provisions. - Where staircase is pressurized the differential pressure between the staircase and any adjoining area to which openings are provided from the staircase should be ≥50Pa. b) Protected shaft containing pipe conveying combustible gas should be adequately ventilated directly to the outside, both at top and bottom.	3.65
	Activation of Mechanical Ventilation and Pressurized Enclosure Systems 1. Activation of the system shall be initiated by a smoke detector installed in approved location within 10 ft (3050mm) of each entrance to smoke proof enclosure	7.2.3.10	2.26 Pressurization Level (l) Pressurization system should be automatically activated by building fire alarm system. - A remote manual start/stop switch should be made available for firemen at fire command centre.	2.26 (I)

2. Required mechanical system should operate upon activation of smoke detectors specified in 7.2.3.10.1 and by manual controls accessible to fire department. - Required system also should initiate by following, if provided: i. Waterflow signal from a complete automatic sprinkler system ii. General evacuation alarm signal (see 9.6.3.6)		- Visual indication of operation status of the pressurization system should be provided	
		2.29(A) General Requirements The "smoke control system" should consist of the following: a) A "Smoke Purging System" which is independent of all other systems serving other parts of the building, and which will provide an extraction rate of ≥ 8 air changes per hour. i. "Automatic Activation" The smoke purging system should be automatically activated by the building ii. "Manual Control" A manual control system should be provided at the Fire Control Centre, or at the main Fire Control Panel, which will override the automatic control system. Visual indication of the operation status of the smoke control system should be provided with the remote control facility.	2.29 (a)
		2.35 Activation The engineered smoke ventilation system should be activated by smoke detectors located in the "smoke control zone"	2.35
		2.36 Shut down of Air-conditioning systems Air conditioning systems within the area served by the engineered smoke ventilation system should be shut down automatically upon the activation of the smoke ventilation system.	2.36
<u>Door Leaf Closures</u> Activation of an automatic closing device on any door leaf in smoke-proof enclosure should activate all other automatic-closing devices on door leaves in smoke-proof enclosure.	7.2.3.11		–
<u>Emergency Power Supply System(EPSS)</u> Power should be as follows: (1) Type 60, Class 2, Level 2 EPSS for new mechanical ventilation equipment should provide according to NFPA 110	7.2.3.12	2.26 Pressurization Level <u>All fire escape stairways serving high-rise and super high-rise buildings should be provided with a pressurization system as follows:</u>	2.26 (i) 2.26 (j) 2.26 (k)

	(2) Previously approved existing standby power generator install with a fuel supply adequate to operate the equipment for 2 hours, permit in lieu of 7.2.3.12 (1) (3) Generator locate in a room separate from remainder of building by fire barriers having min. 1hour		i) Emergency power supply should be provided for all equipment serving staircase pressurization, bypassing the main distribution panel. - Power supply for pressurization equipment must be fed directly, bypassing Main Distribution Board and emergency power supply must be directly from generator output. - Above required an Auto Transfer Switch panel at pressurization equipment room. j) All wiring, cables, electrical equipment, starters, relays, etc., including building primary & secondary sources of supply should be suitable for continuous operation at 250˚C ambient for a time period as per the rating given for building k) All cables feeding pressurization fan located outside fire protected ducts should be fire resistant and should've adequate mechanical protection.	
			3.14 Areas of Special Hazard (a) Boiler Rooms, Transformer Rooms, Generator Rooms, Storage Areas of highly flammable/combustible materials to be separated from compartment walls and floors having fire resistance of not less than 2 hours. - if building is provided with an automatic fire suppression system, fire resistance should be a min. of 1 hour	3.14(a)
			6.67 Fuel Storage a) For boiler rooms or generator rooms use flammable liquid as fuel, amount allowed to be stored within the same compartments should ≤8 hour requirement operation and such storage should be provided with a secondary containment tank having a volume of ≥110% of the storage capacity. Any excess fuel should be stored in separate compartments according to Reg. 6(67), and if its "Petroleum" under the provisions of the Petroleum Act, storage compartments should also confirm to the requirements of the Petroleum Ordinance Regulations, or if not "Petroleum" the storage compartment should conform to the requirements of Reg. 6(72)	6.67

		b) Generators and associated fuel supplies located in buildings other than basement or ground floor level should be protected by an automatic fire suppression system.	
<u>Testing</u> Before mechanical equipment is accepted by AHJ, should be tested to confirm operation in compliance with the requirements of 7.2.3 All operating parts of system should be tested semi-manually by approved personnel; a log should keep of the results.	7.2.3.13	8.5 Testing of Active Fire Systems (a) All active fire Systems stated in Reg. 8 (1) should be tested for its functionality and ensure that they perform their intended purpose (b) Testing has to be carried out by a trained competent person (c) Testing methodology should be in accordance with manufacturer's recommendations and to comply with stipulated fire regulations	8.5
		8.2 Inspection and Maintenance All systems should be subjected to routine inspection and maintenance, periodic maintenance by AHJ a) Routine inspection & maintenance – involves visual check of complete facility to ensure it is good operating condition b) Periodic inspection & maintenance – systematic and periodic functional and operational checks and tests to ensure facility is in reliable and efficient operation condition. - Should be carried out by qualified persons having access to necessary special tooling & equipment and trained & certified in same use, required for. c) Inspection by AHJ – All buildings falling under all Purpose Groups except, 1(b) and 1(c) should be subjected to an annual inspection and issuance of a certificate	8.2
		8.10 Documentation Routine inspection and maintenance activities should record and be available for inspection by AHJ on request A certificate of compliance should be issued by certified inspector on successful completion of periodic inspection. Owner/ occupier should retain certificate for inspection by AHJ when	8.1
Horizontal Exits	7.2.4	Provision of Compartment Walls and Compartment Floors	
<u>Fire Compartments</u>	7.2.4.2	3.5 Excess floor area and cubicle extent	3.5

	7.2.4.2.1 Every fire compartment for which credit is permitted in connection with horizontal exit(s) should have >01 additional exit, but ≥50% of required number & capacity of exits, that's not a horizontal exit, unless otherwise provided in 7.2.4.2.1.2		Any building other than a building of Purpose Group I which has,	
	7.2.4.2.1.1 Any fire compartment not having an exit leading outside considered as part of an adjoining compartment with exit leading		(a) Any storey of the floor area of which exceeds specified as relevant to a building of that area in column (2) of Table 6 or	
	7.2.4.2.1.2 (7.2.4.2.1) not apply to:		(b) A cubicle capacity which exceed specified as so relevant in column 3 of Table 6, should be so divided into compartmentation by means of compartment walls/floors or both that-	
	1. Healthcare occupancies as otherwise in Chap: 18 & 19		i. No compartment has any storey with exceeding floor area specified in column 2 of the Table, and	
	2. Detention & correctional occupancies as otherwise in Chap: 22 & 23		ii. No such compartment has a cubic capacity which exceed that specified as so relevant in column 3 of the Table	
	7.2.4.2.2 Every horizontal exit for which credit is permitted should be arranged so that there are continuously available travel paths leading from each side of exit to stairways/ other means of egress leading to outside of building		3.6 Compartmentation by height	3.6
	7.2.4.2.3 Either side of horizontal exit is occupied, door leaves used in horizontal exits should unlock from egress side, unless otherwise permitted in:		(a) In any compartment up to habitable floor 30m, no compartment should comprise >03 stories, except for atrium spaces.	
	1. Healthcare occupancies as in Chap 18 & 19			
	2. Detention and correctional occupancies as in Chap: 22 &23		(b) Buildings under purpose group I may consist of >03 stories if they are occupied by a single household dwelling	
	7.2.4.2.4 Floor area on either side of horizontal exit should sufficient to hold occupants of both floor areas with ≥3 ft^2 (0.28 m^2) per person clear, unless otherwise permitted for :		3.7 Building Authority may Consent to Greater sizes	3.7
	1. Healthcare occupancies as in Chap: 18 &19		where AHJ is satisfied that additional floor area and cubicle extent can be allowed any such building or compartment thereof, AHJ may consent to such additional floor area and cubicle	
	2. Detention and correctional occupancies as in Chap: 22 & 23			

			(a) such building/compartment thereof is fitted throughout with an automatic sprinkler system which complies with relevant requirement of an accepted code of practice (b) there is adequate accessibility to Fire Brigade appliances of site as required in Regulations (Chapter 7) (c) all other measures have been or will be taken and maintained for so far and is reasonable practicable any danger from Such consent should continue in force only when such buildings or compartment is actually used for the purpose in respect of which such consent	
			3.8 Excess Height In any building which exceeds 18 m in height, any floor which separates one storey from another storey, other than a floor which is- (a) Within a self-contained living accommodation (maisonette) or (b) Within a compartment which is permitted by the provisions of Table 6 or Regulation 3(7) of this chapter to comprise 02 or more storeys; should be constructed as a compartment floor.	3.8
			3.9 Other Cases requiring Compartment walls and Compartment Floors Following should be constructed as compartment walls or floors- (b) Any wall or floor separating a flat or maisonette from any other part of building (d) Any floor immediately over a basement storey if such storey- i. forms part of a building of purpose group I which has 3 or more storeys or a building or compartment of purpose group 2(b), 2(c), 2(d) or 4; and ii. has an area exceeding $100m^2$ (e) In any space below pavement level, no compartment should comprise more than 01 storey. Exception: basement used solely for parking	3.9 3.9 (b) 3.9 (d) 3.9 (e)

			No part of basement should use for bulk storage of highly flammable liquids or substances of an explosive nature	
			(f) The fire command centre should be separated from other parts of the same building by compartment walls and floors having fire resistance of ≥2 hours	3.9 (f)
			(g) Kitchen Fire separation (i) in any kitchen and/or 'open flame' cooking appliances are used, kitchen should be separated from other parts of the same building by compartment walls and floor having Fire Resistance of ≥1 (ii) Opening in the compartment wall and floor should comply with relevant provisions for protection of openings (Fire Stopping) Doors should've fire resistance of 30 minutes and should be fitted with automatic self-closing devices. Sizes limitations of buildings and Compartmentation	3.9 (g)
			3.10 Compartmentation The spread of fire within a building should be restricted by sub-dividing it into compartments separated from one another by walls and/or floors of fire resisting construction.	3.10.
			(a) Size Limitations Size limitation for Building & Compartments, except for Purpose Group I(b) and (c), should comply with the criterion given in Table 6	3.11 (a)
			(b) Cubicle extent for Compartment exceeding 4m in height 2. Where 02 buildings are connected by external open sided or covered link-bridge, the buildings are considered as separate buildings under following conditions: (i) Within covered/link-bridge there are no commercial activities or other usage that would pose a fire risk. (ii) Length of the covered way should <5m measured from eave to eave	3.11 (b)(2)
			3.12 High Hazard Occupancy (a) The compartment shouldn't exceed ½ of the sizes given in Table 6 and 7, and each compartment should be limited to 01 storey only.	3.12

			(b) If habitable floor ≥18 m, an Automatic Fire Sprinkler System should	
			3.14 Areas of Special Hazard	3.14
			(a) Boiler Rooms, Transformer Rooms, Generator Rooms, Storage Areas of highly flammable/combustible materials to be separated from compartment walls and floors having fire resistance of not less than 2 hours. - if building is provided with an automatic fire suppression system, fire resistance should be a min. of 1 hour	3.14 (a)
			(b) Rooms having transformer containing flammable liquid and generator rooms should've easy access for Fire Brigade/Fire Service Department	3.14 (b)
			(d) Kitchen Separation i. In an eating establishment where kitchen is required for preparation of food and 'open flame cooking' appliances are used, location should be separated from other parts of building by a fire separation/compartmentation having fire resistance of ≥1 hour. ii. Opening in the compartment wall and floor comply with relevant provisions for fire protection of openings. iii. Doors should've fire resistance of 30 minutes with automatic self-closing iv. Where flue or exhaust duct passes through the compartment wall or floor, penetration should be sealed with fire resistance material having the same fire rating. v. If automatic fire suppression system is provided to the cooking range, no fire compartmentation is required	3.14 (d)
			(e) A theatre, cinema or concert hall should be separated from other parts of the building, which is of a different purpose group, by compartment walls and floors having a fire resistance of minimum 01 hour. - If the building is protected by an automatic sprinkler system, fire resistance can be ½ hour.	3.14 (e)

			- Where openings provided for access between theatre, cinema or concert hall and any other part of same building of a different purpose group, such opening should be protected by fire doors or provided with a smoke free lobby approach.	
			3.17 Atrium Spaces AHJ consent to modify requirements for compartment size, floor area, cubic extent and compartment height for design of 'Atrium Spaces' in a building provided following conditions are complied with; (a) minimum plan area of the atrium void is ≥90m^2 and horizontal dimension between opposite edges of floor opening is >6 m wide; (b) occupancy within floor space meets low or ordinary hazard content; (c) atrium is open and unobstructed; (d) building is fitted throughout with an automatic sprinkler system (e) building is fitted with an engineered smoke control system	3.17
			3.51 Use of Fire Shutters and Curtains Automatic fire shutters and curtains with identical fire rating as the compartment wall should be permitted except for fire compartment of FCC and Means of Escape	3.51
	<u>Fire Barriers</u> 7.2.4.3.1 separating building or areas, horizontal exits in between, should meet following: 1. barriers shall have min. 2-hourr FRR, unless in 7.2.4.4.1 2. barrier should provide separation continuous to finished ground level, unless in 7.2.4.3.2 7.2.4.3.2 separation required by 7.2.4.3.1(2) not required to extend below lowest level with exterior discharge, where following are met: 1. stories below lowest level with exterior discharge don't have a horizontal exit 2. and are separated from the level by min. 2-hour FRR construction 7.2.4.3.3 fire barrier with horizontal exit in any story of a building, not required on other stories, provided that:	7.2.4.3		_

	1. stories on which fire barrier omitted, separated from story with horizontal exit by construction with FRR equal to horizontal exit fire barrier 2. vertical openings between story with horizontal exit and open fire area story are enclosed with construction as above 3. all required exits other than horizontal, discharge directly to outside 7.2.4.3.4 other than existing, fire barriers serving horizontal exits, terminate at outside walls and walls are at an ≥180 degree angle for 10 ft (3050 mm) distance on each side of horizontal exit, outside walls should protected by one of following: 1. should've min. 1-hour FRR, with 3/4-hour fire protection rated opening protective, for a 10 ft (3050 mm) distance on each side of 2. one should've 2-hour FRR with min. 1 ½ -hour fire protection rated opening protectives, for 10 ft (3050 mm) distance from intersection with horizontal exit 7.2.4.3.5 fire barriers forming horizontal exits, shouldn't penetrate by ducts, unless one of following met: 1. ducts are existing, protected by approved & listed fire dampers 2. building is protected by approved, supervised automatic sprinkler system according to 9.7 3. ducts permitted in detention and correctional occupancies, otherwise in chap: 22 & 23, are protected by combination fire dampers/ smoke leakage-rated dampers that meet actuation requirements 8.55 7.2.4.3.6 opening in fire barriers specified in 7.2.4.3.5 should protected as in 8.3.4 7.2.4.3.7 door assemblies in horizontal exits should comply 7.2.1.4 unless are sliding door assemblies in industrial or storage occupancies as otherwise in Chap:			

	7.2.4.3.8 swinging fire door assemblies permit in horizontal exits, provided that criteria in both 7.2.4.3.8(1) & (2) or 7.2.4.3.8(1) & (3) are met as follows: 1. door leaves swing in egress travel direction 2. in detention and correctional occupancies, in other than sleeping room areas with horizontal exit serve both sides of fire barrier, provide adjacent openings with swinging door leaves open opposite directions, - signs on each side of fire barrier identifying door leaf that swing with travel - door assemblies of any other approved arrangement, door leaves always swing with possible egress travel 7.2.4.3.8.1 (7.2.4.3.8) not apply to horizontal exit door leaf swing as in Chap: 19 & 23 7.2.4.3.8.2 (7.2.4.3.8) not apply to horizontal exit door assemblies in ≤6 ft (1830 mm) wide corridors in existing buildings 7.2.4.3.9 Door leaves in horizontal exits designed & installed to minimize air leakage. - New door assemblies in horizontal exits install according to NFPA 105, Standard for Smoke Door Assembles and Other Opening 7.2.4.3.10 All fire door assemblies in horizontal exits be self-closing or automatic-closing according to 7.2.4.3.11 Horizontal exit door assemblies located across a corridor, other than approved existing, be automatic closing according to 7.2.1.8.2			
	<u>Bridges Serving Horizontal Exits Between Buildings</u> Apply to, between buildings and to the associated horizontal exit fire barrier. 7.2.4.4.1 Min. 2-hour FRR barrier required by 7.2.4.3.1 extend as:	7.2.4.4		_

	1. Vertically from Ground to 10 ft (3050 mm) point above bridge or to roofline, whichever is lower 2. Horizontally, for ≥10 ft (3050 mm) to each side of bridge 7.2.4.4.2 Openings in fire barrier addressed in 7.2.4.4.1 be protected with ¾ hour Fire protection rating fire door assemblies/ fixed fire window assemblies, unless otherwise in 7.2.4.4.3 7.2.4.4.3 Requirement 7.2.4.4.2 not apply to approved existing bridges 7.2.4.4.4 Where bridge serve as horizontal exit in one direction, the door leaf be swing only in egress travel direction, unless complies with swing requirements in: 1. Existing healthcare occupancies in Chap: 19 2. Existing detention and correctional occupancies in Chap: 23 7.2.4.4.5 Where bridge serve as horizontal exit in both directions, door leaves should be in pairs swing in opposite direction, - Only door leaf swinging in egress travel direction includes in determining egress capacity, unless in 7.2.4.4.5.1 – 7.2.4.4.5.2 7.2.4.4.5.1 Approved existing door assemblies on both ends of bridge, permit to swing out from building 7.2.4.4.5.2 (7.2.4.45) not apply to existing building bridges, if fire barrier has sufficient floor area to accommodate occupant load of either connected building or fire areas based on 3 ft^2 (0.28 m^2) per person 7.2.4.4.5.3 (7.2.4.4.5) not apply to horizontal exit door leaf swing as in: 1. Existing healthcare occupancies, Chap: 19 2. Existing detention and correctional occupancies, Chap: 23 7.2.4.4.6 Every bridge be ≥width of door opening and [redacted]4 in. (1120 mm) wide for new construction			

7.2.4.4.7 In Snow and ice accumulation climates, bridge should protect to prevent accumulation 7.2.4.4.8 In existing building, one step ≤8 in. (205 mm) permitted below inside floor level.			
Ramps Apply for means of egress components only	7.2.5	Exit Ramps Internal and external ramps may be used as exists in lieu of internal and external staircases, and also as a "means of escape" for disabled persons, provided their exit capacities are as listed in Table 5 and except where otherwise provided, they comply with the applicable requirements of Regulations 2(42) and 2(46) and with the following.	2.5
Vehicle Ramps If not an accessible means of egress exempt from below	7.2.5.2		_
Dimensional Criteria (1) New ramps Min clear width 41 in (1120 mm) Max. slope 1 in 12 Max. cross slope 1 in 48 Max. rise for single ramp run 30 in (760 mm) - Not apply for industrial equipment access - Max. slope not apply in assembly occupancies - Max. rise not apply for vehicle access, vessels, mobile structures, aircraft (2) Existing ramps Min width 30 in (760 mm) Max. slope 1 in 8 Max. height between landings 12 ft (3660 mm) - Not apply for industrial equipment access - Max. height not apply for vehicle access, vessels, mobile structures, aircraft - Approved existing <1 in 6 slope permit to remain - Existing <1 in 10 not required landings	7.2.5.3	(a) Maximum slope: 1 in 8, - in factory buildings and go downs steep should be ≤1 in 12 except provided in other Regulations	2.50 (a)

<u>Ramp Details</u> 7.2.5.4.1 Construction a. Permanent fixed construction b. Type I & Type II construction be any combination of no-combustible or limited-combustible material or fire-retardant treated wood. c. fire-retardant treated wood Constructed ramp height <30 in (760 mm) - <3000 ft2 (277 m2) area - Shouldn't occupy <50% of room area d. Solid Ramp floor & landing without perforations 7.2.5.4.2 Landings a. located at the top, bottom, at door leaves opening to of ramp b. slope of landing <1 in 48 c. same as ramp width d. length >60 in (1525 mm) in the travel direction, unless approved landing e. if straight run ramp isn't part of accessible route, landing <48 in (1525 mm) in the direction of travel f. travel direction change at landing only, unless exiting ramp g. width shouldn't decrease in ramp & intermediate landings along direction of egress 7.2.5.4.3 Drop-offs - Ramps & landing with drop-offs should've curbs, walls, railings, projecting surfaces to prevent people from traveling off the edge - Curbs, barriers height <4 in (100 mm)	7.2.5.4	(b) changes in directions: Should be straight with changes in directions are at level platforms or - except ramp slope ≤1 in 12 at any place be curved (c) length: sloping portion of ramps should be 12.5m > 1m long between platforms or landings (d) Platforms: Level Platforms or landings at least as wide as the ramp should be provided at the bottom, intermediate levels where required and at the top of all ramps. - Level platforms should be provided at each door opening into or from a ramp having a min. length in the direction of exit travel of 1m.	2.50 (b) 2.50 (c) 2.50 (d)
<u>Guards and Handrails</u>	7.2.5.5	(a) Guards and Handrails: Guards and railings of ramps should comply with Regulation 4(2) (d) except that only ramps having a slope steeper ≤1 in 10 needs to comply with the requirements of handrails and intermediate handrails should not be	2.50 (e)

7.2.5.5.1 Guards - Comply with 7.2.2.4, Unless otherwise in below 4 7.2.5.5.2 Handrails – Comply with 7.2.2.4 both side or ramps with riser >6 in (150 mm) unless in below 4 7.2.5.5.3 Handrail & guards height – measured to top of guard rail 7.2.5.5.4 Above Not apply for ramped aisles in assembly occupancies as otherwise provided in chapter 12 & 13			
<u>Enclosure and Protection of Ramps</u> Ramps in means of egress, should be enclosed as in 7.2.2.5 & 7.2.2.6	7.2.5.6	(b) Surface: All ramps should be provided with non-slip surfaces. - Ramps serving as means of escape to only one basement storey need not be protected by enclosure walls.	2.50 (f)
<u>Special Provisions for Outside Ramps</u> 7.2.5.7.1 Outside ramps above >36 ft (11m) F.G.L should provide with >48 in (1220 mm) height opaque visual obstruction. 7.2.5.7.2 Designed to minimize water accumulation	7.2.5.7	(g) Exit ramps if enclosed should be ventilated to comply with the requirements for ventilation of exit (h) Exit ramps serving as means of escape to only one basement storey need not be protected by enclosure walls.	2.50 (g) 2.50 (h)
Exit Passageways Comply with general requirement of 7.1 & special requirements with 7.2.6	7.2.6	Exit Passageways All exit passages should be accessible and kept unobstructed at all times. - Exit passageways that serve as means of escape of a building should've the requisite fire resistance as per Table 8.	2.39
<u>Enclosure</u> Separate from other parts of the building, as specified in 7.1.3.2, - Following alternatives permit (1) In buildings with automatic sprinkler system, Fire windows permitted (according to 8.3.3) And (2) Existing fixed wired glass panels in steel sash permitted	7.2.6.2	Internal exit Passageways An internal exit passageway serving as a part of required exit should be enclosed with fire resistant construction complying with the provision of Table 8. a) Exit doors opening in to the exit passageway should've fire rating as required for exit doors opening in to exit staircases fitted with automatic self-closing devices b) Minimum width and capacity of exit passageways should comply with requirements given Table 5 (I) to (VIII). c) Changes in level along an exit passageway less than two risers should be a ramp d) Any internal passageway connected to a pressurized exit passageway should not be naturally ventilated and should be pressurized.	2.4

Stair Discharge If serves as above, not less than same FRR & opening protective fire protection required for enclosure	7.2.6.3		_
Width 7.2.6.4.1 Exit passageway sized to accommodate all exit capacity discharge through it, unless, a. It Serves occupants of the exit discharge level & other stories b. Exit passageway in mall buildings – permit to accommodate occupant load independently 7.2.6.4.2 in new construction, horizontal transfer within exit stair system, - min. width >2/3 of width of exit stair - With egress capacity according to 7.3.3.2, width should size to accommodate same capacity as stair (table 7.3.3.1)	7.2.6.4		_
Floor Solid without perforations	7.2.6.5		_
Escalators and Moving Walks Shouldn't constitute part of required means of egress, unless previously approved	7.2.7		_
Fire Escape Stairs 7.2.8.1.1 Should comply unless approved existing stairs 7.2.8.1.2 Shouldn't constitute any required means of egress unless otherwise provided in 7.2.8.1.2.1 & 7.2.8.1.2.2 7.2.8.1.2.1 Permit on existing buildings as in chapter 11, but shouldn't constitute <50% of required means of egress 7.2.8.1.2.2 New fire escape stair to erect on existing buildings Permit by AHJ, if determined that outside stair is impractical 7.2.8.1.2.3 Regardless of occupancy classification/occupancy load, new fire escape stairs permit above, shouldn't incorporate ladders or access windows,	7.2.8		_

	7.2.8.1.3 Fire-escape ladders of return-platform type with superimposed runs / straight-run type with platform that continues in the same direction, permits. - Either parallel to or at right angle to buildings, - Either attached or erected independently			
	<u>Protection of Openings</u> Exposed to minimum no. of windows & door openings - Each opening should be protected with approved fire door/fire window assemblies - Location as follows; 1. Horizontally – within 15 ft (4570 mm) of any balcony/platform/stairway 2. Below – within 03 stories / 36 ft (11m) of any balcony/platform/walkway/stairway ~ component of fire-escape stair Or - within 02 stories/ 24 ft (7320 mm) of a platform/walkway leading from any story to the escape stair 3. Above – within 10 ft (3050 mm) of any balcony/platform/walkway, measure vertically Or - Within 10 ft (3050 mm) of any stair tread surface, measure vertically 4. Facing a court – served by fire-escape stair, - Min.dimension of court – <1/3 of topmost fire escape stair platform height from F.G.L 5. Facing an alcove – served by fire-escape stair - Min.width of alcove – <1/3 of topmost platform of fire escape stair from FGL	7.2.8.2	External exit Passageway External wall between the exit passageway and rest of the floor space may provide ventilation openings of non-combustible construction, fixed above a level of 1.8 m from the F.F.L of the - such ventilation openings should be located ≥3m from any opening of an exit staircase; (a) May be roofed over provided the depth of the roofed over portion shouldn't exceed 3 m to avoid smoke logging. (b) May be enclosed on the open side only, by a parapet wall of ≥1100mm or more than 1200 mm in height. Exit doors opening into an external exit passageway should've fire resistance for at least 30 minutes and fitted with automatic self-closing device.	2.41

	- Min.depth of alcove - <1/4 of topmost platform of fire escape stair from FGL 7.2.8.2.1 above not apply to openings on top storey where stair doesn't lead to roof 7.2.8.2.2 above requirements permit to modify by AHJ, where provided automatic sprinkler protection, low-hazard content occupancy & special conditions exits 7.2.8.2.3 Above requirements for window opening protection not apply where such window openings need to access existing fire escape stairs			
	Access 7.2.8.3.1 Should be according to 7.2.8.4 & 7.5.1.1.1 – 7.5.1.2.2 7.2.8.3.2 Where permitted by way of windows, windows to be arranged to easily opened - Screening or storm windows restricting free access is prohibited 7.2.8.3.3 Should extend to roof, where roof is subject to occupancy, area of safe refuge 7.2.8.3.4 Where roof pitch is 6>1, fire escape ladders (according to 7.2.9) or alternating tread device (according to 7.2.11) permitted to access roof 7.2.8.3.5 Access to fire escape stair should be directly to a balcony, landing, platform - shouldn't exceed floor or window sill level - and shouldn't >8 in (205 mm) below the floor level / 18 in. (455 mm) below window sill level	7.2.8.3		_
	Stair Details Comply with table 7.2.8.4(a) Replacement of stairs comply with 7.2.8.4(b)	7.2.8.4		Table 5(V), 5(VI) 5(VII)
	Guards, Handrails and Visual Enclosures 7.2.8.5.1 All escape stairs should've walls or guards & handrails on both sides	7.2.8.5	Handrails Balustrades Every exit staircase should've walls, grilles or handrails on both sides, except where the width is ≤1250mm. or less in width, can have a handrail one side only	2.43

7.2.8.5.2 Replacing fire escape stairs; - Stairs more than 36 ft (11 m) above finished ground level) F.G.L should've opaque visual obstruction >48 in (1220 mm) height.		Where the width of the exit staircase exceeds 2000mm, intermediate handrails should be provided.	
<u>Material and Strength</u> 7.2.8.6.1 Non-combustible materials should use for all fire escape stair construction 7.2.8.6.2 AHJ permit to approve any existing fire escape stair	7.2.8.6	Non-combustibility of structure Every staircase (including any landing thereof) which forms part of a building should, whether the staircase is internal or external, be constructed of non-combustible materials except- a) An internal staircase which is situated- i. Within a maisonette; or ii. Within a building of purpose group 1 or 2(b) which has not more than 3 iii. Within the ground storey or an upper storey of part of a building, which part consists of flats or maisonettes if that part is separated as described in Reg. 3 (28) (b) and has not more than three storeys; or b) An external staircase of a building of purpose group 1 and such staircase is situated between the ground and a floor or flat roof the level of which, at the head of the staircase, is not more than 6 m above the finished surface of the ground adjoining the foot of the staircase.	3.77
<u>Swinging Stairs</u> 7.2.8.7.1 Fire escape stairs terminate with Single swinging stair section should be permit over sidewalks, alleys, driveways where it's impractical to terminate with fire-escape stairs. 7.2.8.7.2 This section shouldn't locate over doors, path of travel from other exit or locations may have obstructions. 7.2.8.7.3 Width should >fire escape stairs above. 7.2.8.7.4 Pitch shouldn't <pitch of the fire escape stairs above 7.2.8.7.5 Guards & handrails similar to instruction in 7.2.2.4 - height & construction similar to fire escape stairs	7.2.8.7		_

	- Guards & handrails designed to prevent injury where stairs swing downward - Gap between moving section & other portion of stair shouldn't >4 in. (100mm) 7.2.8.7.6 If lowest platform to finished ground level is >12 ft (3660 mm), intermediate balcony > 12 ft (3660 mm) from the finished ground level and clear underneath of >7 ft (2135 mm) should provide. - Width not less than stair width - Length >48 in (1220 mm) 7.2.8.7.7 Should be counterbalanced about a pivot - Shouldn't use Cables - 150 lb (68 kg) Weight located at ¼ length of stair from pivot should cause the stair swing down 7.2.8.7.8 Pivot should corrosion-resistant assembly - Should've clearance to prevent sticking due to corrosion 7.2.8.7.9 Shouldn't lock in the up position			
	<u>Intervening Spaces</u> 7.2.8.8.1 Approved by AHJ, fire escape stairs should permit to lead to adjoining roof, crossed before continuing downward travel. Clearly mark direction of travel, walkways with guards & handrails complying with 7.2.2.4 7.2.8.8.2 Approved by AHJ, sire escape stairs should permit to use combination with inside or outside stairs complying with 7.2.2 continuing & maintaining safe path	7.2.8.8		_
	Fire Escape Ladders 7.2.9.1 Permitted to use in the means of egress only Provide one of the following, 1. access to unoccupied roof space as permitted in 7.2.8.3.4 2. 2^{nd} means of egress from storage elevators as permitted in chapter 42	7.2.9		_

3. Means of egress from towers & elevated platforms around machinery/similar spaces subject to occupancy <3 persons all capable of using ladder 4. 2nd means of egress from boiler rooms or similar spaces subject to occupancy <3 persons all capable of using ladder 5. Access to Finished ground level from lowest balcony/landing of a fire escape stair for small buildings as permitted in 7.2.8.4 (where approved by AHJ)			
<u>Construction and Installation</u> 7.2.9.2.1 Fire escape ladders should comply with (mentioned) standards, unless, (1) approved existing ladder comply with current standards (2) industrial stairs comply with minimum requirements for fixed - should be permitted where fire escape ladders are allowed according to chapter 40. 7.2.9.2.2 Installed with a pitch >75 degree	7.2.9.2		_
<u>Access</u> Lowest rung of any ladder <12 in. (305 mm) above the surface level below	7.2.9.3		_
Slide Escapes 7.2.10.1.1 Should be permitted as a component in a means of egress where permitted in chapter 11 7.2.10.1.2 Should be an approved type	7.2.10		_
<u>Capacity</u> 7.2.10.2.1 Should be rated at a capacity of 60 persons 7.2.10.2.2 Shouldn't constitute >25% of egress capacity unless otherwise provided for industrial occupancies (chapter 40)	7.2.10.2		_
Alternating Tread Devices 7.2.11.1 Permits only in the means of egress, providing one of following,	7.2.11		_

	1. Access to unoccupied roof spaces as permitted in 7.2.8.3.4 2. 2nd means of egress from storage elevators as permitted in chapter 42 3. Means of egress from towers & elevated platforms around machinery/similar spaces subject to occupancy <3 persons all capable of using tread device 4. 2nd means of egress from boiler rooms or similar spaces subject to occupancy <3 persons all capable of using tread device 7.2.11.2 should comply with following, 1. handrail should provide on both side 2. clear width between handrails 24 in (610mm)>17 in (430mm) 3. headroom >6 ft. 8 in(2030 mm) 4. angle if the device 50 degrees – 68 degrees horizontal 5. height of the riser <9 ½ in (240 mm) 6. Treads should've a projected tread depth >5 2/3 in (145mm) measured according to 7.2.2. with each tread providing 9 ½ in (240 mm) of depth, including tread 7. Between the alternating tread device handrail & any other object distance should be >6 in (150 mm) 8. Initial tread should begin at same elevation as platform, landing or floor surface 9. Initial tread shouldn't be laterally separated by >2 in (51mm) 10. Occupant load shouldn't >3			
	Area of Refuge 7.2.12.1.1 Part of an accessible means of egress according to 7.5.4	7.2.12	2.16 Exit Reduction	2.16

	- Consist of story in a building protected by an approved, supervised automatic sprinkler system according to section 9.7		When a floor area has access to areas of refuge confirming to the provisions of regulation 2.53 the number of persons for whom vertical exits are to be provided may be reduced to 50 % of the occupant load of the floor area when one area of refuge is provided and may be reduced to 33 1/3 of the floor area when two areas of refuge are provided	
	- One or more stories above or below a story of exit discharge		2.52 Area of Refuge	2.52 (a)
			(b) An area adequately separated from the rest of the building by fire resisting construction and evacuees from the rest of the building enter the area of refuge using external corridor that links this area to the rest of the building	2.52 (b)
	- Should meet following criteria; 1) each elevator landing should've two-way communication system for between elevator landing & fire command center/ central control point (approved by AHJ)		(c) An area of refuge may also be an area in an adjoining building which is separated from the building under consideration by fire resisting construction and evacuees similarly enter this area of refuge using an external	
	2) adjacent to two-way communication system, - direction for use - instruction for summoning assistance - written identification of the should be posted 3) both audible & visible signals should include in two-way communication system 7.2.12.1.2 in other than buildings with automatic sprinkler systems as above, should meet criteria 1. area of refuge' should meet general requirement of 7.1 2. should meet requirements of 7.2.12.2 & 7.2.12.3		4.25 Two-way telephone communication system with Fire Command Centre(FCC) Should be provided for all buildings categorized as High-Rise and Super High-Rise and any other building as requested by AHJ. Should be provided between FCC and following areas or any area specified by AHJ. i. Every fire fighting lobby ii. In basements, where number of basements exceed 2 iii. Fire fighting related mechanical iv. Fire service lifts v. Rooms having smoke control equipment vi. Each area of refuge (a) Monitoring of the integrity of two-way telephone communications circuit should be provided	4.25

			(b) Two-way telephone communications service should be capable or permitting the simultaneous operation of any 05 telephone stations in a common talk (c) A notification signal at the control equipment, distinctive from any other alarm, supervisory, or trouble signal, should indicate the off-hook condition of a calling telephone circuit (d) In high rise and super high rise buildings equipped with a fire pump(s), a telephone station or jack should be provided in each fire pump room (e) If telephone jacks are provided, at least 05 handsets should be stored at fire command centre (f) All circuit necessary for the operation of two-way telephone communication systems should be installed using 01 of the following methods. i. Cables of 3-hour fire rated circuit integrity at 950 ˚C. Cat CWZ ii. Cables installed inside 2-hour fire rated enclosure	
	<u>Accessibility</u> 7.2.12.2.1 from the serving area 'area of refuge' should access by an accessible means of egress	7.2.12.2	2.9 Minimum Widths d) Min. width required for wheel chair access ≥950 mm	2.9 (d)
	7.2.12.2.2 should've access to public way via exit or an elevator		2.52 Area of Refuge	2.52
	- without returning back to building spaces came in from 7.2.12.2.3 egress through stair to public way from area of refuge		c) An area of refuge should always be accessible	2.52 (c)
	- clear width of landings & stair flights between handrails & at all points below handrail heights >48 in (1220 mm) unless,		d) Should be adequately in size to hold the occupant load it receives from the floor area it serves in addition to its own occupant load on the basis of 0.5 m^2 per person and should be provide with at least 01 protected staircase and exit facilities of adequate width discharging at ground level directly to an exterior open	2.52 (d)
	1. min. 48 in (1220mm) not required where area of refuge is separated from remainder of story by horizontal exit according to 7.2.4		e) Doors providing access to an area of refuge should be kept unlocked at all times, when the floor area served by the area of refuge is occupied. - Such doors should be swinging and self-closing with FRR of 1 ½ hours, except that doors in fire resistance rating of 3 hours.	2.52 (e)

	2. Existing stairs & landings provide clear width of >37 in (940mm) measures at and below 7.2.12.2.4 Where elevator provide access to public way from area of refuge according to 7.2.12.2.2, - all of following should met 1. elevator should be approved for Fire fighters' emergency operations 2. power supply should protected against interruption from fire outside refuge area within the building 3. elevator should locate in a shaft system with smoke proof enclosure according to 7.2.3 7.2.12.2.4.1. smoke-proof enclosure specified above, not required for >1000 ft^2 (93 m^2) areas of refuge & that are created by horizontal exits as required in 7.2.4 7.2.12.2.4.2. smoke-proof enclosures specified in 7.2.12.2.4(3) not required for elevators complying 7.2.13 7.2.12.2.5 Area of refuge should provide with two-way communication system between area of refuge & central control point. - stair enclosure door /elevator door & associated portion of the area of refuge should identify by signage 7.2.12.2.6 adjacent to two-way communication system, - instruction for summoning assistance		- They should swing in the direction of exit travel	
			2.26 Pressurization Level All fire escape stairways serving high-rise and super high-rise buildings should be provided with a pressurization system as follows: a) Minimum pressurization level of 50 Pa should be achieved with all doors closed and all pressure relief systems b) In operation, pressurization system should maintain a pressure differential of ≥50 Pa between pressurized staircase and adjacent area when all doors are closed c) Where a smoke-free lobby is also pressurized, the pressure at the exit staircase should always be > the smoke free lobby d) Force required to open any door against combined resistance of pressurized air and automatic door closing mechanism should ≤110 N at door handle e) In operation, fan capacity should be enough to maintain minimum average egress velocity through doorways of 0.75 m/s with any 03 single leaf entry doors (01 on each of 03 levels) and the largest exit door open, plus leakage allowance for all other doors. f) in operation, system should maintain an air flow of sufficient pressure when 03 nos of doors open simultaneously to stairway to prevent smoke from entering into the pressurizes area g) minimum FRR for enclosure of pressurization plant should be the same as of the staircase served h) Number and distribution of injection points for supplying of pressurization air to exit staircase should ensure an even pressure profile. Multiple injection system with air supplies at ≤12m apart to	2.26

	- written identification of the area of refuge location should be posted		i) Emergency power supply should be provided for all equipment serving staircase pressurization, bypassing the main distribution panel. - Power supply for pressurization equipment must be fed directly, bypassing Main Distribution Board and emergency power supply must be directly from generator output. - Above required an Auto Transfer Switch panel at pressurization equipment room. j) All wiring, cables, electrical equipment, starters, relays, etc., including building primary & secondary sources of supply should be suitable for continuous operation at 250˚C ambient for a time period as per the rating given for building k) All cables feeding pressurization fan located outside fire protected ducts should be fire resistant and should've adequate mechanical protection. l) Pressurization system should be automatically activated by building fire alarm system. - A remote manual start/stop switch should be made available for firemen at fire command centre. - Visual indication of operation status of the pressurization system should be provided m) Supply air for pressurization system should be drawn directly from outside and its intake should be ≥5 m from any exhaust discharge openings n) Pressurization system should not be controlled by any Building Management System o) Measures should be provided to ensure that no excessive pressure build-up occurs to negate the pressure gradient specified	
			2.28 Smoke Control System	2.28

			A "smoke control system" which is a "mechanical ventilation" system, shall be provided for high rise buildings and other buildings where required by the AHJ and shall comply with the following	
			2.29(A) General Requirements The "smoke control system" should consist of the following: c) A "Smoke Purging System" which is independent of all other systems serving other parts of the building, and which will provide an extraction rate of ≥ 8 air changes per hour. iii. "Automatic Activation" The smoke purging system should be automatically activated by the building iv. "Manual Control" A manual control system should be provided at the Fire Control Centre, or at the main Fire Control Panel, which will override the automatic control system. Visual indication of the operation status of the smoke control system should be provided with the remote control facility. d) "Supply Air" for the smoke control system should be drawn directly from the exterior, and the intakes should be ≥5m from any exhaust discharge openings. e) The exhaust fan should be capable of operating efficiently at 250 centigrade for 2 hours and supplied from a secondary source of power.	2.29
			2.30(B) Additional Requirement Basement Smoke Extraction Systems – Basement smoke extraction systems where required by the "AHJ" should be provided in addition to the stipulations of the "general requirements "above and should comply with the following stipulations: i. "Smoke Purging Rate" should be ≥10 air changes per hour for fire conditions. The extract points should be arranged so that 50% are at high level and 50% at low level. ii. "Ducts" Where ducts are used for the smoke extraction system, should comply with the requirements for mechanical ventilation systems in - The ducting should be manufactured with metal sheets of suitable thickness of suitable standards in compliance with ANSI standards.	2.30.

			iii. "Melting Point" All components of the smoke extraction system must have a minimum melting point of 800 ^{o}C. iv. Smoke control system should be activated by the building fire alarm	
			2.31 (C) Ductless Jet Fan system in basement Car park i. The space should be divided into smoke control zones ≤2000m^2 (excluding plant rooms & circulation spaces) ii. Each smoke control zone should've its own jet fan system (Fresh air fans, exhaust air fans and jet fans) iii. The jet fans system should be activated by the fire detection system/ sprinkler system serving the basement car park level or a manual call point. A fireman over-ride switch should be provided at the Fire Command centre. iv. The air velocity within the escape routes should ≤ 5m/s. The mechanized air supply fans, smoke exhaust fans, jet fans, duct works and wiring should be capable of operating effectively at 250 degrees Celsius for 2 hours.	2.31
			2.32 Fire Dampers Listed fire dampers should be provided where air ducts penetrate or terminate at openings in walls or partitions required having the same fire rating as the compartment wall. a) Fire dampers used for protection of openings in walls, partitions or floors with FRR of ≥3h should have a minimum of 1.5h fire protection rating. Where the fire resistance rating is 3h or more, the damper should've a minimum of 3h fire protection rating. b) All fire dampers should close automatically using either a fusible link or a closing device activated by a heat c) Fusible links should've a temperature rating of 15^{0}C above the normal operating temperature.	2.32

			d) Dampers should close against the maximum calculated static air pressure of the portion of the air duct system in which they are installed.	
			2.34 Engineered Smoke Control System Engineered Smoke Control Systems where required by the AHJ should be provided in addition to the stipulations of the "general requirements" above and should comply with the following stipulations: f) The capacity of an engineered smoke control system should be capable of handling the largest demand for smoke exhaust. g) The design smoke layer base should be above the heads of people escaping beneath it. The minimum height should be 2.5 m h) Smoke reservoirs to prevent the lateral spread of smoke, and to collect smoke for removal should be of non-combustible construction capable of withstanding smoke temperatures i) The smoke reservoir size for a smoke ventilation system should not exceed: i. 2000m^2 for natural smoke ventilation ii. 2600m^2 for mechanical smoke ventilation j) The minimum length of the smoke reservoir should ≤ 60m. k) The smoke ventilation system should be provided with secondary source of	2.34
			2.35 Activation The engineered smoke ventilation system should be activated by smoke detectors located in the "smoke control zone".	2.35
			2.36 Shut down of Air-conditioning systems Air conditioning systems within the area served by the engineered smoke ventilation system should be shut down automatically upon the activation of the smoke ventilation system.	2.36

			2.37 Fire Dampers Should not be installed in the engineered smoke ventilation system.	2.37
			4.25 Two-way telephone communication system with ire Command Centre(FCC) Should be provided for all buildings categorized as High-Rise and Super High-Rise and any other building as requested by AHJ. Should be provided between FCC and following areas or any area specified by AHJ. i. Every fire fighting lobby ii. In basements, where number of basements exceed 2 iii. Fire fighting related mechanical iv. Fire service lifts v. Rooms having smoke control equipment vi. Each area of refuge	4.25
			3.65 Ventilation of Protected shaft c) A protected shaft used for passage of people, should be ventilated complying with relevant provisions. - Where staircase is pressurized the differential pressure between the staircase and any adjoining area to which openings are provided from the staircase should be $\geq$50Pa. Protected shaft containing pipe conveying combustible gas should be adequately ventilated directly to the outside, both at top and bottom.	3.65
	<u>Details</u> 7.2.12.3.1 should accommodate 01 wheelchair space of 30 in. x 48 in. (760mm x 1220 mm) for every 200 occupants based on occupant load served by area - wheelchair space shouldn't reduce required width of means of egress required by occupant load & >915 mm) 7.2.12.3.2 in area of refuge <1000 ft^2 (93 m^2), maximum expected fire protection for 15 minutes should be tested when other side area is exposed	7.2.12.3	3.21 Refuge Floors A refuge floor consisting of a refuge area should be provided for every 10 floors for buildings having the height exceeding 60m of occupiable floors. a) should be of masonry construction having FRR >2 hours and should've external walls on at least 02 sides to provide adequate openings for ventilation - total area of opening should be >25% of the holding floor area b) holding area should be calculated considering the total occupant load of 10 floors above	3.21

7.2.12.3.3 access to any designated wheelchair space shouldn’t pass through >01 wheelchair space	- Area should be sufficient to accommodate 50% of the above load allowing at least $0.5m^2$ per person.
7.2.12.3.4 each area of refuge should separate from remainder of story with min 1-hour FRR barrier, unless,	c) Refuge floor should be counted commencing from the top most occupied floor.
1. a grater rating is required	- A refuge floor should be provided for every 10 floors all the way to the ground floor
2. barrier is an existing barrier with 30-min FRR	d) Holding area should be separated from other areas of the refuge floor by compartment wall with FRR >2 hours.
7.2.12.3.4.1 new fire doors assemblies should be smoke leakage-rated according to 8.2.2.4	- Link to holding are with other occupied rooms/areas should be via an external corridor, or a smoke-stop lobby.
7.2.12.3.4.2 barriers specified above & openings in them should minimize air-leakage & resist passage of smoke	e) Holding area should be naturally ventilated with permanent openings on at least 2 sides of external walls.
	- Height of opening should >1200 mm high and total area of ventilation openings should be >25% of the holding
7.2.12.3.4.3 door assemblies in barriers specified above should’ve >20-minute fire protection rating,	
- unless greater rating is required	f) All parts of the holding area should be within 9 m of any ventilation opening.
- either self-closing or automatic-closing	g) Ventilation opening should be located at least 1.5 m horizontally and 3 m vertically above adjoining unprotected openings.
7.2.12.3.4.4 ducts permitted to penetrate barrier specified in 7.2.12.3.4, unless prohibited in other provision	- Sprinkler system should be provided for refuge floor if there is any non-residential room located on the same floor.
- smoke-actuated dampers /other approved means to resist smoke transfer into areas of refuge, should be provided	h) Escape routes leading to holding area should be through smoke stop/fire fighting lobby or external corridor.
7.2.12.3.5 each area of refuge identified with sign:	i) Sign depicting “REFUGE FLOOR” should be displayed inside the staircase and on wall immediately outside the staircase at the refuge floor.
AREA OF REFUGE	- Sign of letter size >50 mm should be displayed at 1500 mm height above landing/finished floor level.
7.2.12.3.5.1 Above should confirm the standards & should display international symbol for accessibility.	
- Signs should locate as,	j) Emergency lighting should be provided to all areas of holding area.

1.At each area of refuge access door opening 2.At all exits not providing an accessible means of egress defined in 3.3.172.1 3.clearly indicate direction to area of refuge where necessary 7.2.12.3.5.2 above required signs should be illuminated as required for special signs according to 7.10.8.1 7.2.12.3.6 Tactile signage complying with (mentioned) standards should be located at each door opening to an area of refuge		- Such lighting should be connected to secondary power supply, i.e. generator, battery, etc, and should be able to provide a horizontal luminance at floor level of >5 lux. - Delay between the failure of electrical supply to normal lighting and the energization of emergency lighting for occupied areas should <15 seconds. k) Each area of refuge should be provided with two-way communication system with fire command centre l) Design and layout of exit staircases should facilitate with discharge of evacuees into the refuge floor before permitted to proceed downwards.	
Elevators in Towers Elevator comply with section 9.4 & 7.2.13 permit to use as second means of egress from a tower, with (1) Tower & any attached structure should protected by approved, supervised automatic sprinkler (2) Tower occupancy ≤90 persons (3) Primary egress discharge to outside (4) No high hazard content areas (5) 100% of egress capacity provided except of elevators	7.2.13	Fire Lifts and Fire Fighting Shafts 3.96 General In any building or part thereof, in which the floor level of any storey ≥30m in height, there should be provided at least 01 fireman's lift, which should contained within a separate protected shaft or a common protected shaft containing other lifts subject to other lifts being served at each storey by the protected ventilated lobby, which is required by the provisions of Reg. 3(97) of this - In the event of a fire all lifts should be automatically brought down to ground level and remain there with doors open.	3.96
		3.97 Siting A fireman's lift should be adjacent to staircase enclosure and be approached by a protected ventilated lobby at each storey, which is not naturally ventilated, should be mechanically ventilated in accordance with the requirements of the AHJ.	3.97
		3.98 Fireman's lift requirements a) Should be provided with primary power supply connected to a sub main circuit exclusive to the lift and a secondary power supply from a different - Distribution network for both supplies should be adequately protected from fire and water damage.	3.98

	(6) Implement Evacuation plan with elevators. - Staff should be trained in operations & procedures for elevator emergency use in normal operating mode (7) General public shouldn't use Tower		- Supplies should be separated from each other such that a failure in cables or equipment in once system will not affect the other. - Cables supplying power to fireman's lift should be either a fire resisting cable or in an enclosure, both of which should have a fire rating equal to or better than fire rating of the fire enclosure. b) Fireman's lift car should be >1100mmX2100mm with rated load of 1000kg. Minimum entrance width 800mm. c) Fireman's switch should be located within2 m horizontally from lift, and should be located between 1.8 and 2.0 m above the finished floor level. d) Lift should be capable of reaching the uppermost habitable floor from fire service access level within 60 seconds. e) Electrical equipment and fittings within the lift well and lift car should be IP 65 rated.	
			3.99 Fire Fighting Shafts Should be provided in High-Rise, Super High Rise buildings and buildings with basement below 9 m. Fire-fighting shafts should be located to allow access to every part of every storey served, and should, wherever possible, be sited against an exterior wall. - Access to fire fighting shaft should be provided at all levels served "PURPOSE" of a fire fighting shaft is to provide a quick, safe and protected access route for Fire Fighters when fighting fires in tall buildings. It may also serve as a means of escape for the occupants of the buildings in the event of a fire. - "Fire Fighting Shaft" should be installed in all high-rise buildings and should consist of the following: (a) Components of a Fire Fighting Shaft: i. A protected enclosure containing a fire fighting stairway ii. A fire fighting lobby	3.99

			iii. A fire fighting lift (b) Protected Enclosure - Protected enclosure should comply with requirements stipulated in Fire 2(3) (k) and chapter 5 of these regulations. (c) Fire Fighting Lobby – Should comply with requirements stipulated in Fire Regulations 2(19) of these regulations. - Fire fighting lobby should be provided with a Fire Main as stipulated in Fire Reg. 5(8) to 5(14) of these regulations. (d) Fir Fighting Lift – Should comply with the stipulations of Fire Reg. 3(96) and 3(97) of these regulations.	
			'Protected Shafts'	
			3.56 Protecting Structure In this regulation, "protecting structure" means any wall or floor or other structure which encloses a protected shaft other than- a) A wall which also forms part of an external wall, party wall or compartment wall: or b) A floor which is also a compartment floor or a floor laid directly on the ground: and c) A roof.	3.56
			3.57 Use of Protected Shaft No use for any purposes additional to those specified in Chapter 7 other than the accommodation of any pipe or duct. Any pipe or duct located within a protected shaft should've an enclosure having the same fire rating of the shaft.	3.57
			3.58 Enclosure Subject to the provisions of this regulation, any protected shaft should be completely enclosed by walls or floors having necessary fire resistance rating under Reg.3(24) to 3(30)	3.58
			3.59 Non-Combustibility of Protecting Structures	3.59

			a) Should be constructed wholly of non-combustible materials except that floor, wall and ceiling finishes which do not contribute to the fire resistance of such protecting structure. - Such surface finishes should comply with the requirements of Regulation 3(83) to 3(89). b) Any beam or column forming part of, and any structure carrying a protecting structure which is required to be constructed of non-combustible materials should itself comply with the provisions of sub-paragraph (a) as to non-	
			3.60 Openings in Wall or Floor of a) Any wall or other structure enclosing a protected shaft but not being a protecting structure may contain such openings as should be in accordance with other provisions of this code. b) no opening in any protecting structure other than any one or more of the following- i. An opening for a pipe; ii. An opening fitted with a door which has fire resistance complying with Regulation 3(62) and complies with Regulation 3(68) to 3(76) iii. (If the protected shaft contains as a lift) an opening which complies with Regulation 3(63) and iv. (If the protected shaft serves as, or contains a ventilating duct) an inlet to or outlet from that duct or opening for that duct.	3.60.
			3.61 Fire Stopping Any opening for a pipe should be effectively fire-stopped.	3.61
			3.62 Doors in Protected Structure Any door fitted to an opening in protected structure should've fire resistance for not less than half the period required by other provisions of the regulation for the protecting structure surrounding the opening	3.62
			3.63 Protected Shaft for Lift Any protected shaft containing a lift or	3.63

			a) Shall not contain any pipe conveying gas or oil or any ventilation duct b) May have an opening in its protecting structure for the passage of the cables operating the lift into the room containing the lift motor; c) If it serves any basement, it shall be protected by a smoke stop lobby with walls having 1h fire resistance. The protected lobby shall be mechanically ventilated.	
	Elevator Evacuation System Capacity 7.2.13.2.1 min. 08 persons capacity 7.2.13.2.2 Elevator lobby should've >50% occupant load of area served by. - Capacity calculated on 3 ft^2 (0.28 m^2) per person basis - Include 01 wheelchair space 30 9n x 48 in (760 mm x 1220 mm) for every 50 persons of total occupant load served by that lobby	7.2.13.2	Evacuation Lifts	
			3.100 General An Evacuation lift should be provided for buildings categorized as Super High Rise buildings. It should be different from Fire Fighter's lift and should comply with following conditions. (a) Protected lobby and lift-well should be designed to restrict ingress of smoke. Approach should be through a smoke free passage. (b) Floor of fire fighters lobby should be so designed to prevent flow of water to emergency exit stairway and lift shaft (c) If opening are available in the lift car or more than 01 side approaches from every sides should be through a protected smoke approach.	3.100.
			3.102 Evacuation Lift Requirements	
			(a) serve every floor of the building	3.102 (a)
			(b) Evacuation lift car should be large enough to accommodate a stretcher or a bed. Load should be ≥1000kg and the dimensions should be min. 1200mmX2100mm.	3.102 (b)
			(c) Lift should be capable of reaching the uppermost habitable floor from fire service access level within 60 seconds	3.102 (c)

		(e) Elevator lobby should be adequate to accommodate ≥50% of the occupant load of the area served by the lobby and include 01 wheelchair space of 760mmX1220mm for each 50 persons or	3.102 (e)
<u>Elevator Lobby</u> - Every floor served by elevators should have elevator lobby - Barriers/walls should've min. 1-hour FRR & smoke barrier	7.2.13.3	Fire Fighting Lobby A smoke free or fire fighting lobby which acts as buffer space for entry into the protected staircase and used by fire fighters during emergency, should be maintained as common property. (a) Permanent ventilation openings in an external wall to which lobby abuts, such openings being not less than 15% of the area of the lobby and located not more 9 m away from any part of the lobby; (b) Mechanical ventilation complying with Reg. 2(23) (c) Permanent ventilation openings of similar size as in Clause (a) above, opening to an open air well having a superficial plan area of not less than $10m^2$ or $0.1m^2$ for each 300 mm of height of the building whichever is the greater. Enclosure walls of such air well should be of a similar standard of fire resistant as that required for the enclosures of the protected staircase and should be imperforate except for the ventilation opening for the lobby or staircase.	2.2
<u>Elevator Lobby Door Assemblies</u>	7.2.13.4	"Fire Resisting Doors"	
- Should have min. 1-hour Fire protection rating		Should apply to any door(including door frame) which required to have fire resistance by this section	3.68
- Lobby doors should be self-closing or automatic closing		- Automatic self-closing devices doesn't include raising butt hinges except - Fire doors fitted with automatic devices to hold door open during normal operations should've devices to close door upon, i. Detection of smoke by an automatic smoke detector ii. Manual operation of a switch with overriding facility, fixed in suitable iii. Failure of electricity supply to device, apparatus or switch iv. If an evacuation alarm is activated through fire control panel for building	3.69

		Provisions of Closing Devices and Non-Combustible Hinges a) All fire Doors should be fitted with a positively self-closing devices capable of closing the door from any angle against any latch fitted to door b) No holding of any such door open should be provided other than holding device that will release by activation of a smoke detector in vicinity c) No part of a hinge in any such door should be made either of combustible material or non-combustible material with melting point <800˚C	3.70.
Door Leaf Activation - Should close with a smoke detector signal, located directly outside elevator lobby - Elevator lobby doors permit to close with building's fire alarm system signal - All other elevator lobby doors should close in response of above signals	7.2.13.5	(a) No holding of any such door open should be provided other than holding device that will release by activation of a smoke detector in vicinity	3.70 (b)
Water Protection Building elements should use to prevent elevator equipment expose to water	7.2.13.6		_
Power and Control Wiring - both normal & standby power need for elevator equipment, elevator communications, elevator machine room cooling, elevator controller cooling - wiring for power & control locate and properly protected for min. 1-hour operation in a fire	7.2.13.7	3.101 Power supply to fireman's lift and evacuation lift (a) Power supply should be available directly from the main breaker of the generator via a dedicated Automatic Transfer Switch (ATS) panel with manual overriding facility located within the enclosure. (b) Main and auxiliary power supply cables for these systems should be located in a fire protected shaft. Any part of the cable located outside a fire protected shaft should be with enhanced fire resistance and protection against	3.101
Communications	7.2.13.8	(f) Two-way communication systems should be provided between elevator lobbies and the fire command centre and between elevator cars and the fire command centre.	3.102 (f)
- Two-way communication system between elevator lobbies & central control point and between elevator cars & a central control point		(g) Wiring used for two-way communication systems should be fire rated for ≥01 hour and should be provided with mechanical protection	3.102 (g)
- Communications wiring should protect for min. 1-hour operation in a fire		4.25 Two-way telephone communication system with Fire Command Centre(FCC)	4.25

			Should be provided for all buildings categorized as High-Rise and Super High-Rise and any other building as requested by AHJ. Should be provided between FCC and following areas or any area specified by AHJ. i. Every fire fighting lobby ii. In basements, where number of basements exceed 2 iii. Fire fighting related mechanical iv. Fire service lifts v. Rooms having smoke control equipment vi. Each area of refuge (a) Monitoring of the integrity of two-way telephone communications circuit should be provided (b) Two-way telephone communications service should be capable or permitting the simultaneous operation of any 05 telephone stations in a common talk (c) A notification signal at the control equipment, distinctive from any other alarm, supervisory, or trouble signal, should indicate the off-hook condition of a calling telephone circuit (d) In high rise and super high rise buildings equipped with a fire pump(s), a telephone station or jack should be provided in each fire pump room (e) If telephone jacks are provided, at least 05 handsets should be stores at fire command centre (f) All circuit necessary for the operation of two-way telephone communication systems should be installed using 01 of the following methods. iii. Cables of 3-hour fire rated circuit integrity at 950 ˚C. Cat CWZ iv. Cables installed inside 2-hour fire rated enclosure	
	Elevator Operation Elevators should've fire fighters emergency operations according to ASME A17.1/CASA B44	7.2.13.9	3.98 Firemen's lift requirements a) Lift should be provided with the primary power supply connected to a sub main circuit exclusive to the lift and a secondary power supply from a different source.	3.98

			- Distribution network for both supplies should be adequately protected from fire and water damage. - Supplies should be separated from each other such that a failure in cables or equipment is one system will not affect the other. - cables supplying power to the fireman's lift should be either a fire resisting cable or in an enclosure, both of which should have a fire rating equal to or better than the fire rating of the fire enclosure. b) Fireman's lift car should be ≥1100mm wide by 2100mm deep with a rated load of 1000Kg. minimum entrance with 800mm. c) Fireman's switch should be located within 2m horizontally from lift, and located between 1.8 and 2.0m above the finished floor level. d) Lift should be capable of reaching the uppermost habitable floor from fire service access level within 60 seconds. e) Electrical equipment and fittings within the lift well and lift car shall be IP	
	<u>Maintenance</u> - Elevator lobby with 01 elevator car, elevator evacuation system should've schedule maintenance programmed during building shut down or low activity. - Repair perform within 24 hours shutdown	7.2.13.10		_
	<u>Earthquake Protection</u> should capable of shutdown during earthquake where required	7.2.13.11		_
	<u>Signage</u> Should comply with 7.10.8.4	7.2.13.12		_
	'Capacity of Means of Egress'	7.3	Means of Escape Requirements	2.38
7.3	Occupant Load	7.3.1	(a) determination of means of escape requirements for a building should be based on the type of occupancy, occupant load, floor area, travel distance to an exit and the capacity of exits provided in Table-5 (I) to (VIII)	2.38 (a)
	<u>Sufficient Capacity</u> _ Total capacity of means of egress shall be sufficient to the occupant	7.3.1.1	(b) Any building other than Purpose group I having total floor area >800m^2 or the one way travel distance exceeding as	2.38 (b)

		per Table 5 and the height of the occupiable floor exceeding 9 m should be provided with an alternative means of	
Occupant Load Factor Occupant load > no of persons (floor area / occupant load factor for that use) (OLF in table 7.3.1.2)	7.3.1.2	(h) The "occupant load" of a building or part thereof means the maximum number of persons that may occupy such buildings or part thereof at any one time. Should be established either; i. By the number of occupants for whom each occupied space of the building is designed as shown on the plan, ii. By applying to the floor areas available for occupation, appropriate areas per person as in Table 3, whichever	2.3 (h)
Occupant Load Increases Shall be permitted if in accordance with 7.3.1.2	7.3.1.3		_
Exits Serving More than One story Occupant load of each story considered individually should be used to calculate the required capacity of the exit at that story.	7.3.1.4	Determination of Exit Requirements-General a) should be based upon the type of use/ occupancy of the building, occupant load, floor areas, travel distance to an exit, and capacity of the exists as provided in Table 5 and herein. b) Every storey should be provided with an exit facilities for its occupant load c) Vertical exits (staircase of ramp) provided from any storey above Ground level may serve simultaneously all storeys above ground and vertical exits provided from a storey below ground level may serve all stories below ground	2.4
Capacity from a Point of When Means of Egress for upper story and lower story converge in the middle story, capacity of Means of Egress >= sum of the Means of Egress capacities for 2 stories	7.3.1.5		_
Egress Capacity from Balconies and Mezzanines Required capacities for these should be added to the MOE capacity of the room these are connected with.	7.3.1.6		_
Measurement of Means of Egress 7.3.2.1 Width should be measured under clear of the narrowest point of the egress 7.3.2.2 Projections not more than 4.5 in. on each side shall be permitted at a height of 38 in. and	7.3.2	2.11 Measurement Width Width of a staircase should be the clear width between: a) if the staircase is enclosed on both sides of walls, the finished surface of the wall	2.11

7.3.2.3 If stair and handrails forming part of a guard, projections shall be permitted at a height of 42 in. and below.		b) finished surface of the wall and inner side of the balustrade or handrail, - if staircase has wall on one side and balustrade /handrail on the other Or a) the inner sides of balustrade or handrails if the staircase has balustrades or handrails on both sides	
Egress Capacity Shall be based on capacity factors on table 7.3.3.1	7.3.3	2.8 Exit Requirements – Capacity of Exits and Exit Facilities	2.8
		a. Capacity of exits, staircase and other facilities should be measured in units of width of ½ of a 1m & no. of persons per unit of width should be determined by type of occupancy and type of exit listed in Table 5 (I) to (VIII)	2.8 (a)
		b. Fractions of a unit ≤250mm shouldn't be credited. Where 250mm or more added to one or more full units, ½ of a unit of	2.8 (b)
Minimum Width 7.3.4.1 1. Not less than that required for a given egress component 2. Not less than 36 in. 7.3.4.1.1 Width of exit access, if it serves not more than 6 people and have a length < 50 ft, then 1. If height < 38 in. width >18 in. if height >38 in. width > 28 in 2. For new exit access width > 36 in, for existing exit access width > 28 in shall be provided without moving permanent walls. 7.3.4.1.2 In existing buildings, width of exit access > 28 in (710 mm) 7.3.4.2 If single exit access leads to an exit, capacity of the exit access >= capacity of exit	7.3.4	2.9 Minimum Widths a. Width of staircase or other exit facilities shouldn't be less than min. as specified in Table 5 (I) to (VIII) b. Min. clear width of exit door opening ≥1100mm c. the width of exit door serving a room with an occupant load of 2 persons ≥750mm clear d. width of a single leaf swing door along the means of escape ≤1250mm e. Min. width required for wheel chair access ≥950 mm	2.9

	7.3.4.3 If multiple exit access leads to an exit, each shall have a width enough for the no. of persons it accommodates			
	'Number of Means of Egress'	7.4	Number of Exits from Rooms and Spaces	2.12
	General	7.4.1	There should be at least 02 door opening remote from each other and leading to exits, from every room or enclosed space in which the total occupant load exceeds the maximum permissible occupancy load for 01 door as listed in the Table 4.	
7.4	7.4.1.1 no. of means of egress from any balcony, mezzanine, story, or portion should be >02, except, 1. Only 01 permit where allowed in chapter 11		a) Application of Table 4 should be subject to travel distance being in accordance with Regulation 2(3)(i)	2.12 (a)
	2. Only 01 permits for mezzanine or balcony where common path of travel limitations (chapter 11) are met.		b) In a block of residential flat, there should be >02 exit doors from each flat, that should've direct access to the staircase or staircases that are required to be provided for such block of flats under subsequent Reg. 2(13) of this Regulation except;	2.12 (b)
	7.4.1.2 No. of means of egress from any story/portion, as permitted in chapter 11 should be, 1. occupancy load 1000>500		i. that only 01 exit door may be provided when there is a smoke dispersal condition within the flat, or	
	2. occupancy load 4>1000		ii. Exit path is sprinkler protected, to the satisfaction of AHJ and travel distance from the furthermost bedroom door to the exit door doesn't exceed 13m. When there is an alternative escape route from the furthermost bedroom door to single exit door, an extension of the aforesaid travel distance up to 15m may be permitted.	
	7.4.1.3 accessible means of egress, according to 7.5.4		c) a classroom in any educational institution should've at least 2 exits, if the occupancy exceeds 50	2.12 (c)
	7.4.1.4 occupancy load of each story should use in computing the no. of means of egress at each story, that no. of means of egress should not decreased in the direction of egress travel		d) in a block of small residential units consisting of >01 floor, there should be at least 01exit door from each storey of each unit that should've direct access to the staircase or staircases that required to be provided for such block of small residential units under subsequent Reg. 2(13) of this regulation.	2.12 (d)
	7.4.1.5 doors other than hoistway door; the elevator car door; readily openable doors from car side without a key, tool, special knowledge or special effort should prohibit at access point to elevator car		2.13 Number of staircases or Exits per Storey	2.13

			There should be at least 2 independent staircases or other exists from every storey of a building, - unless otherwise permitted under other subsequent provisions of the	
	Elevator Landing and Lobby Exit Access 7.4.1.6.1 each should have min. 01 exit 7.4.1.6.2 required 7.4.1.6.1 should not require to use key, tool special knowledge, special effort (unless permit by 7.4.1.6.3) 7.4.1.6.3 lobby & exit access separation door should permit to be electronically locked according to 7.2.1.6.3	7.4.1.6	3.76 Doors in Lift Shafts Notwithstanding Reg. 3(70) (a) a door which isn't fitted with a self-closing device may be installed in the structure which encloses a protected shaft containing exclusively a lift or lifts if (a) fire resistance of door is ≥1/2 hour and another door installed to close the same opening which is fitted with an automatic self-closing device, held open by an automatic closing device activated by smoke detector or fire alarm and has fire resistance for a period ≥ prescribed by relevant provisions in Reg. 3(2) to 3(3) for the structure surrounding (b) Unless the opening is in a compartment wall and is 01 of 02 openings provided at same level to allow access to a lift from different sides, then door should've fire resistance for a period ≥ prescribed by relevant provisions Reg. 3(24) to 3(30) for the structure surrounding opening.	3.76
	Space about Electrical Equipment 7.4.2.1 600 Volts, Nominal, Less a. min. no of means of egress for electrical equipment working space, should according to NFPA 70 7.4.2.2 Over 600 Volts, Nominal (same as above)	7.4.2		–
	'Arrangement of Means of Egress'			
7.5	General 7.5.4.1 Exits should be readily accessible 7.5.1.1.1 where exits aren't immediately accessible from, an open floor area, continuous passageways, aisles, or corridors leading directly to every exit, provide minimum 02 exits.	7.5.1	2.17 Location of Exists All exits and access facilities should be located as follows: (a) Exists and access facilities should be clearly visible or their locations be clearly indicated with directional signs. - All exists must kept readily accessible and unobstructed at all times	2.17

	7.5.1.1.2 Exit access corridors provide access to minimum 02 approved access 7.5.1.1.3 Above not apply for single exit permits		(b) Every occupant within storey of a building should've direct access to required exit, without passing through spaces occupy by other occupants (c) When >1 exit required each exit should be placed as remote as possible from the other, complying with travel distance requirements	
	7.5.1.1.4 Where common paths of travel, permit in Chap: 11- 43 but not exceed limit specified 7.5.4.2 Corridors should provide exit access without passing through intervening rooms Except, corridors, lobbies, other open spaces permitted		2.21 Cross Ventilated Corridor Cross ventilated corridor having openings in at least 02 external walls; such openings being ≥50% of the superficial area of the said walls and within 13 m of any part of the corridor	2.21
	7.5.1.1 If passing through approved corridor, 1. Path of travel should marked according to 7.10 2. Doors should comply 7.2.1 3. If it's not prohibited by occupancy chapter		2.27 Exit Doors Exit doors giving access to escape corridors should be so positioned that their swing should at no point encroach on the required minimum width of the escape corridor. - Door must be provided with a door closer.	2.27
	7.5.1.2 Corridors not required to fire-resistance rated should permit to discharge to open areas 7.5.1.3 Remoteness should provide according to 7.5.1.3.1 - 7.5.1.3.7 7.5.1.3.1 if more than 01 exit, exit access, exit discharge required, remotely located from each other and not to be blocked by any emergency		2.47 Scissor Exit Staircase Where 02 separate internal exit staircases are contained within same enclosure, each exit staircase should be separated from each other by non-combustible construction having fire resistance for min. period required for the enclosure. (a) Such scissor exit staircases should comply with all applicable provision for exit staircase (b) Door opening into scissor exit staircases should be ≤7 m measured as travel distance between the two closer edges of the staircase doors. (d) Where only one pair of scissor exit staircase, the door opening into scissor exit staircases should be spaced at least 1/3 the diagonal dimension of the area to be served in a sprinkler protected building	2.47

	7.5.1.3.2 if 02 exits, exit access or exit discharge required, distance located should be >1/2 the length of maximum diagonal length of building area, measured straight between nearest edge of exits, exit access, or exit discharges		- ½ the diagonal dimension in a non-sprinkler protected building	
	7.5.1.3.3 for buildings with automatic sprinkler systems, min. distance between 02 exits, exit access, exit discharge should not ≥1/3 length of maximum overall diagonal length of the building area		<u>Exclusions</u> Scissor type staircase shouldn't accepted as alternative means of escape for super high-rise buildings	
	7.5.1.3.4 other than high-rises, where ≥1-hour fire-resistance rated corridors/exit enclosures provided exit separation measured along the shortest line of travel in corridor		2.38 Means of Escape Requirements	2.38
	7.5.1.3.5 in existing buildings, ≥01 exit, exit access, exit discharge required, exempt from above criteria, could remotely located according to 7.5.1.3.1		(a) determination of means of escape requirements for a building should be based on the type of occupancy, occupant load, floor area, travel distance to an exit and the capacity of exits provided in Table-5 (I) to (VIII)	
	7.5.1.3.6 other than existing buildings, ≥01 exit, exit access, exit discharge required, min. 02 should comply with min. separation distance			
	7.5.1.3.7 balance no. of exists, exit access, exit discharge should locate if 01 blocked other are available		(b) Any building other than Purpose group I having total floor area exceeding 800m^2 or the one way travel distance exceeding as per Table 5 and the height of the occupiable floor exceeding 9 m should be provided with an alternative means of escape.	
	7.5.1.4 interlocking or scissor stairs		2.12 Number of Exits from Rooms and Spaces	2.12
	7.5.1.4.1 new permitted as a single (01) exit		There should be at least 02 door opening remote from each other and leading to exits, from every room or enclosed space in which the total occupant load exceeds the maximum permissible occupancy load for 01 door as listed in the Table 4.	
	7.5.1.4.2 existing permitted as separate exits, if:		(a) Application of Table 4 should be subject to travel distance being in accordance with Regulation 2(3)(i)	2.12 (a)

	1. are enclosed according to 7.1.3.2 2. separate from each other by 2-hour FRR non-combustible construction 3. no protected/unprotected openings between the stair enclosures 7.5.1.5 no dead ends in corridors (if only permitted in chapter 11) 7.5.1.6 exit access from rooms/space permitted be through intervening rooms/areas, - if that areas are accessory to the area served - foyers, lobbies, & reception rooms should not constructed as intervening rooms - exit access should design not to pass any hazardous area		(b) In a block of residential flat, there should be >02 exit doors from each flat, that should've direct access to the staircase or staircases that are required to be provided for such block of flats under subsequent Reg. 2(13) of this Regulation except; i. that only 01 exit door may be provided when there is a smoke dispersal condition within the flat, or ii. Exit path is sprinkler protected, to the satisfaction of AHJ and travel distance from the furthermost bedroom door to the exit door doesn't exceed 13m. For an alternative escape route from the furthermost bedroom door to single exit door, an extension of the aforesaid travel distance up to 15m may be permitted.	2.12 (b)
	Impediments to Egress 7.5.2.1 access to exit shouldn't through kitchens, store rooms, restrooms, closets, bedrooms or similar spaces, or other rooms or spaces subject to locking, unless permitted in chapter 18,19,22 or 23	7.5.2	Number of Exits from Rooms and Spaces d) In a block of small residential units consisting of >01 floor, there should be at least 01 exit door from each storey of each unit that should've direct access to the staircase or staircases that are required to be provided for such block of small residential units under subsequent Reg. 2(13).	2.12 (d)

7.5.2.2 exit access and exit doors should clearly recognizable 7.5.2.2.1 No hangings or draperies over exit doors 7.5.2.2.2 Curtains permitted across means of egress in Tent walls, only if, 1. they are distinctly marked in contrast to Tent wall 2. installed across 6 ft (1830mm) wide opening 3. hung to readily move to side from slide rings or equivalent		Exceptions; i. aggregate floor area of the upper storey of the small residential unit should ≤60 m^2; ii. distance from the furthermost bedroom door to the main entrance door should ≤13 m ; iii. The escape route should not pass through or near an unprotected opening of the kitchen; and iv. The small residential unit should not comprise more than 2 storeys.	
		2.17 Location of Exists All exits and access facilities should be located as follows: (d) Exists and access facilities should be clearly visible or their locations be clearly indicated with directional signs. - All exists must kept readily accessible and unobstructed at all times	2.17 2.17 (d)
		(e) Every occupant within storey of a building should've direct access to required exit, without passing through spaces occupy by other occupants	2.17 (e)
Exterior Ways of Exit Access 7.5.3.1 Means of exterior balcony, porch, gallery, or roof that confirms to the requirement of this chapter, 7.5.3.2 long side of balcony, porch, gallery or similar >50% open & arranged to restrict the smoke collection 7.5.3.3 exterior exit access balcony should separate from interior by required walls & opening protective, unless - its served by 02 remote stairs without accessing any unprotected opening to reach them	7.5.3	2.41 External exit Passageway External wall between the exit passageway and rest of the floor space may provide ventilation openings of non-combustible construction, fixed above a level of 1.8 m from the F.F.L of the - such ventilation openings should be located ≥3m from any opening of an exit staircase; (a) May be roofed over provided the depth of the roofed over portion shouldn't exceed 3 m to avoid smoke logging.	2.41

- unless dead-ends on the exterior exit access do not exceed 20ft (6100mm) 7.5.3.4 exterior exit arrange so to, no dead ends in excess permitted		(b) May be enclosed on the open side only, by a parapet wall of ≥1100mm or more than 1200 mm in height. Exit doors opening into an external exit passageway should've fire resistance for at least 30 minutes and fitted with automatic self-closing device.	
		3.39 References to Roofs Any part of a roof should be deemed to be part of an external wall or side of a building if its pitched at ≥70˚ to horizontal and adjoins a space within the building to which persons have access not limited to purpose of maintenance	3.39
Accessible Means of Egress 7.5.4.1 areas access by mobility impaired people, should have ≥02 means of egress 7.5.4.1.1 access within allowable travel distance, provide to ≥01 accessible areas of refuge or 01 accessible exit providing accessible route to an exit discharge 7.5.4.1.2 01 accessible means of egress for buildings permit with 01 7.5.4.1.3 Not required in healthcare with approved, supervised automatic sprinkler systems 7.5.4.1.4 Exit access travel along accessible means of egress, permit to be common for common paths of travel 7.5.4.2 Where 02 required, exits serving those, should locate ≥1/2 of maximum diagonal distance in-between of the areas to be served - Distance should measure straight line between nearest edge of exit doors 7.5.4.2.1 where exit enclosures provided & interconnected by ≥1-hour FRR corridor, exit separation permit to measure along travel line within corridor	7.5.4	(d) Min. width required for wheel chair access should ≥950mm.	2.9 (d)

	7.5.4.2.2 7.5.4.2 not apply to buildings with approved, supervised automatic sprinkler systems 7.5.4.2.3 7.5.4.2 not apply where physical arrangement of means of egress prevents access to both accessible means of egress blocked by fire or any emergency, as approved by AHJ 7.5.4.3 Each required accessible means of egress, should continue from each occupied area to public way or area of refuge 7.5.4.4 Where an exit stair is in an accessible means of egress, should comply with 7.2.12, a. Should incorporate an area of refuge within an enlarged story-level landing Or b. Accessed from areas of refuge 7.5.4.5 an elevator as part of accessible means of egress should up to 7.2.12.2.4 7.5.4.6 part of an accessible means of egress, a smoke barrier according to 8.5 with ≥1-hour FRR or horizontal exit according to 7.2.4 should discharge to area of refuge 7.5.4.7 04 or 05 accessible stories, above or below story of exit discharge should have ≥01 elevator 7.5.4.8 smoke proof enclosure shouldn't require in buildings protected with approved, supervised automatic sprinkler system, where elevators are required in 7.5.4.7 7.5.4.9 area of refuge, as part of accessible means of egress should according to 7.2.12			
	'Measurement of Travel Distance to Exits'	7.6	2.12 Number of exits from rooms and spaces	2.12 (b)

7.6	7.6.1 Measured on the floor or walking surface		b. In a block of residential flat, should be >02 exit doors from each flat, that should've direct access to staircase(s) that required to provide for such block of flats under subsequent Reg. 2(13) of this Regulation except;	
	1. Along the centreline of natural travel path, staring from most remote point subject to occupancy			
	2. At Curved corners or obstructions, with a 12in (305 mm) clearance		ii. Exit path is sprinkler protected, to satisfaction of AHJ and travel distance from furthermost bedroom door to exit door $\leq$13m.	
	3. Terminating at, - Centre of doorway - Points at which exit begins - Smoke barrier in an existing detention & correctional occupancy		When there is an alternative escape route from furthermost bedroom door to single exit door, aforesaid travel distance up to 15m may be permitted.	
			2.38 Means of Escape Requirements	2.38
	7.6.2 When outside stairs not separated from building permit as required exits, travel distance should measure from most remote point to leading nosing of the stair landing at floor level		(a) determination of means of escape requirements for a building be based on type of occupancy, occupant load, floor area, travel distance to an exit and capacity of exits provided in Table-5 (I) to (VIII)	
	7.6.3 When open stairways or ramps permit as travel path to required exits, distance should include travel on the stairway or ramp & travel from the end of stairway or ramp to an outside door or other exit in addition to the distance travelled to reach stairway		(b) Any building other than Purpose group I having total floor area >800m^2 or one way travel distance exceeding as per Table 5 and height of occupiable floor >9 m should be provided with an alternative means of escape.	
			2.40 Internal exit passageways	
	7.6.4 Part of exterior exit is within 10 ft (3050 mm) of horizontal distance of unprotected opening, travel distances to exit should be the length of travel to finished Ground level		b) Minimum width and capacity of exit passageways should comply with requirements given Table 5 (I) to (VIII).	2.40 (b)
	7.6.5 If measurement include stairs, measure in the plane of the tread nosing		c) Changes in level along an exit passageway less than two risers should be a ramp	2.40 (c)
	7.6.6 In occupied space to >01 exit measure according to 7.6.1 – 7.6.5,not exceeding the limits		Table 5 (IV)- maximum travel distance when minimum fire protection measures are provided	
	7.6.7 Travel distance limitations as provided in chapter 11.		Table 5 (VIII) – dead-end travel distance	

	'Discharge from Exits'	7.7		
7.7	Exit Termination Directly at public way or exterior exit discharge. 7.7.1.1 yards, courts, open spaces, other portion of exit discharge should have required width 7.7.1.2 above not apply for interior exit discharge provided in 7.7.2 7.7.1.3 not apply for rooftop exit discharge provided in 7.7.6 7.7.1.4 means of egress terminate in an exterior area for detention & correctional occupancies as otherwise provided in chap 22 & 23	7.7.1		–
	Exit Discharge Through Interior Building Area Permit to discharge for, (1) <50% of required no of exit stairs serving normally occupied areas each floor & >50% of the exit stair capacity required for normally occupied area each floor should discharge through areas on any level of discharge, a. in detention & correctional occupancies, 100% of exits permitted to discharge on any level as otherwise provided in chapter 22 b. in existing buildings, if 50 % limit on the required number of exit is met, 50% limit on egress capacity should not apply (2) discharge directly to outside of Ground level or discharge directly outside & access to ground floor by outside stair or ramp (3) should lead to free and unobstructed way to building exterior and, readily visible & identifiable from discharge point from exit (4) interior exit discharge should protect by,	7.7.2	2.40 Internal exit passageway An internal exit passageway serving as a part of required exit should be enclosed with fire resistant construction complying with the provision of Table 8. (a) Exit doors opening into the exit passageway should've fire rating as required for exit doors opening in to exit staircases fitted with automatic self-closing devices (b) Min. width and capacity of exit passageways should comply with requirements given Table 5 (I) to (VIII). (c) Changes in level along an exit passageway ≤02 risers should be a ramp (d) Any internal passageway connected to a pressurized exit passageway shouldn't be naturally ventilated and should also be pressurized.	2.4
			2.39 Exit Passageways	2.39

	a. level of discharge or portion of it by approved automatic sprinkler system, and separate from non-sprinklered portion of floor by fire barriers with a required fire-resistance rating Or b. this area should be in a vestibule or foyer with following criteria,		All exit passages should be accessible and kept unobstructed at all times. Exit passageways that serve as means of escape of a building should have the requisite fire resistance as per Table 8.	
	i. depth from building exterior <10 ft (3050mm) & length <30 ft (9.1m) ii. foyer separate from remainder of the discharge level by min. 1 hour fire-resistance rating fire barriers & existing wired glass in steel frames installations should be permitted to use iii. Foyer should only serve as means of egress and include direct exit to outside.		2.44 Ventilation All internal exit passageways should be naturally ventilated by fixed ventilation openings in an external wall, such ventilation openings being not less than 10% of the floor area of exit passageway. Internal passageways that cannot be naturally ventilated should be mechanically ventilated in compliance	2.44
	(5) Entire area should separate by required fire-resistance rated construction for enclosure from below areas (6) In an atrium, levels below the discharge level permit to open to level of discharge where it is		2.17 Location of Exists All exits and access facilities should be located as follows: All exits and access facilities required to comply with following: a) Exists and access facilities should be clearly visible or their locations be clearly indicated with directional signs. - All exists must kept readily accessible and unobstructed at all times b) Every occupant within storey of a building should've direct access to required exit, without passing through spaces occupy by other occupants.	2.17
			2.12 Number of Exits from Rooms and spaces	2.12 (b)

			b) In a block of residential flat, there should be >02 exit doors from each flat, that should've direct access to the staircase or staircases that are required to be provided for such block of flats under subsequent Reg. 2(13) of this Regulation except; i. that only 01 exit door may be provided when there is a smoke dispersal condition within the flat, or ii. Exit path is sprinkler protected, to the satisfaction of AHJ and travel distance from the furthermost bedroom door to the exit door doesn't exceed 13m. When there is an alternative escape route from the furthermost bedroom door to single exit door, an extension of the aforesaid travel distance up to 15m may be permitted.	
	Arrangement and Marking of Exit Discharge 7.7.3.1 Where >1 exit discharge is required, those should meet remoteness criteria 7.7.3.2 Arranged & marked to clear directions of egress travel from exit discharge to public way 7.7.3.3 should prevent occupants travel beyond the level of discharge where stairs & ramps continue >1/2 story beyond level of discharge with provided approved means	7.7.3	2.17 Location of Exists All exits and access facilities should be located as follows: All exits and access facilities required to comply with following: a) Exists and access facilities should be clearly visible or their locations be clearly indicated with directional signs. - All exists must kept readily accessible and unobstructed at all times b) Every occupant within storey of a building should've direct access to required exit, without passing through spaces occupy by other occupants. c) When >1 exit required each exit should be placed as remote as possible from the other, complying with travel distance requirements.	2.17
	Components of Exit Discharge	7.7.4		_

Doors, stairs, ramps, corridors, exit passageways, bridges, balconies, escalators, moving walks & other components of exit discharge should comply with detailed requirements of this chapter			
Signs	7.7.5	Exit and Directional Signs	
7.2.2.5.4		2.54 In every building or part thereof, except buildings of purpose Group 1 in table 2, locations of every exit door & exit facility on every storey should be clearly indicated by exit signs using internationally accepted symbols.	2.54
		2.55 Such signs should be placed clearly visible at all times. In long corridors, in open areas, and in all situations where the location of the exits may not readily visible, directional signs using internationally accepted symbols should be provided to serve as guides from all areas of corridors or floors to the exists.	2.55
		2.56 (a) Exit and directional signs should be in white on a green background with letters and or symbols and should be illuminated at all times. (b) Additional low level or floor mounted exit and exit directional signs should be provided where overnight sleeping accommodation is provided (c) Legends, dimensions, design and installation of the exit signs and directional signs should comply with (d) Photo-luminescent exit signs with letters/symbols in white on green background are allowed for use in low rise buildings not exceeding 800 m^2 of total area.	2.56
Discharge to Roofs	7.7.6	3.39 References to Roofs	3.39
If approved by AHJ, exit permit to discharge to roofs or other sections or and adjoining building when, (1) Roof/ceiling assembly construction should have min. required fire-resistance rating for exit-enclosure		Any part of a roof should be deemed to be part of an external wall or side of a building if its pitched at ≥70˚ to horizontal and adjoins a space within the building to which persons have access not limited to purpose of maintenance	

	(2) Continuous & safe means of egress from the roof is available		Roofs Roof coverings and construction to be Non-Combustible	
			3.9 Surface of materials for roof covering and roof construction should have surface spread of flame rating not lower than class I except buildings protected throughout with automatic sprinkler	3.9
	'Illumination of Means of Egress'	7.8	Emergency Lighting	2.53
	General	7.8.1	Occupied areas & escape routes in all buildings, except purpose group 1 (c) should be provided with artificial lighting facilities to the satisfaction of the requirement	
7.8	7.8.1.1 a. Provide for every building & structure b. For above, <u>exit access</u> should include only designated stairs, aisles, corridors, ramps, escalators and passageway leading to an exit.		(a) Min. illuminance to be provided for all exists should be >5 lux measured at	2.53(a)
	c. <u>Exit discharg</u>e should include only designated stairs, aisles, corridors, ramps, escalators, walkways and exit passageways 7.8.1.2 continuous illumination during the occupancy for use 7.8.1.2.1 Use artificial lighting when required to maintain min. illumination values 7.8.1.2.2 Unless prohibited by chap 11, use automatic lighting control devices to temporary turnoff illumination within means of egress, complying, 1. Lighting control device listed in new installations 2. It's equipped to automatically energize controlled lights upon loss of normal power 3. Illumination timers set to min. 15-minute 4. Lighting control device activate by any occupant movement 5. Also by fire alarm system 6. Does not turn off lights for activating photo-luminescent exit signs or path marks 7. Doesn't turn off any battery equipped emergency luminaires, unit equipment, exit signs		(b) Delay between the failure of electrical supply to normal lighting and the energization of the emergency lighting shouldn't exceed 1 second.	2.53 (b)

	7.8.1.2.3 Energy-saving sensors, switches, timers or controllers of the means of egress should not 7.8.1.3 floor & other walking surfaces in exits, portion of exit access & exit discharge illuminated 1. min. illumination is stairs, 10 ft-candle (108 lux) at walking surface 2. min. illumination other than new stairs, 1 ft-candle (10.8 lux) at floor 3. in assembly occupancies, min. illumination of exit access 0.2 ft-candle (2.2 lux) at floor during performances/projections with directed light 4. min. illumination doesn't apply for low light requirements 7.8.1.4 At failure of a single lighting unit shouldn't result <0.2 ft-candle (2.2 lux) lighting level 7.8.1.5 Equipment/units installed for section 7.10 permitted to serve means of egress with 7.8 illumination requirements			
	Source of Illumination 7.8.2.1 Source approved by AHJ 7.8.2.2 Should not use battery-operated electric lights, portable lamps, lanterns as primary illumination source at means of - Battery-operated electric lights permit to use to extent allowed in 7.9	7.8.2	(c) Alternate power supply should be adequate to provide the power to maintain the lighting for >3 hours period.	2.53 (c)
	'Emergency Lighting'	7.9	Emergency Lighting	2.53
7.9	General 7.9.1.1 Provide for following, 1. Building or structures in chapter 2. Underground and limited access structures as addressed 3. High-rise buildings as required by other sections of this	7.9.1	Occupied areas & escape routes in all buildings, except purpose group 1 (c) should be provided with artificial lighting facilities to the satisfaction of the requirement (a) Delay between the failure of electrical supply to normal lighting and the energization of the emergency lighting shouldn't exceed 1 second. (b) Alternate power supply should be adequate to provide the power to maintain the lighting for >3 hours period.	2.53 (a) 2.53 (b)

	4. Doors equipped with delayed-egress locks 5. Stair shafts and vestibules of smoke proof enclosure - Include standby generator - Standby generator use for stair shaft & vestibule lighting power 6. New access-controlled egress doors 7.9.1.2 Exit access should include only designated stairs, aisles, corridors, ramps, escalators, and passageways leading exit. - Exit discharge should only include designated stairs, ramps, aisles, walkways, and escalators leading public way. 7.9.1.3 Changing illumination energy source within 10 seconds.			
	Performance of System 7.9.2.1 Emergency illumination provide minimum for 1 ½ hours of a normal lighting 7.9.2.1.1 Illumination average >1 ft-candle (10.8 lux) & at any point 0.1 ft-candle (1.1 lux) at floor level along egress path 7.9.2.1.2 Illumination decline average to >0.6 ft-candle (6.5 lux) & at any point >0.00 6ft-candle (0.65 lux) at end of 1 ½ hours. 7.9.2.1.3 Maximum-to-minimum illumination ratio <40:1 7.9.2.2 New emergency power system for emergency lighting at least Type 10, Class 1.5, Level 1 7.9.2.3 Illuminate automatically when normal lighting interrupted, 1. Failure of public utility or other outside electrical power supply 2. Circuit breaker or fuse opening 3. Accidentally open a switch controlling normal lighting 7.9.2.4 Emergency generator for emergency lighting, stored electrical energy systems should install, test and maintained to standards.	7.9.2		–

7.9.2.5 List Unit equipment & battery systems 7.9.2.6 Existing battery-operated emergency lights only from reliable rechargeable batteries with provision for maintenance. Batteries should be approved & comply with standards 7.9.2.7 Emergency lighting system should continuously operate or repeat automatic operation (no manual operation)			
Periodic Testing of Emergency Lighting Equipment 7.9.3.1 With one of following three options.	7.9.3	8.1 Systems to be inspected, maintained and tested (h) Emergency Lighting	8.1 (h)
7.9.3.1.1 Conduct as follows, 1. Monthly functional test:- 3 weeks-5 weeks gap for >30 seconds 2. Test Interval extend >30 days with AHJ approval 3. Annual functional test conduct for >1 ½ hour if emergency lights are battery powered 4. Lighting equipment should be fully operational for duration of tests 5. Written records of visual inspections & tests should be kept for inspection 7.9.3.1.2 Conduct as follows, 1. Should provide Self-testing/self-diagnostic battery operated emergency lighting equipment		8.5 Testing of Active Fire Systems (a) All active fire Systems stated in Reg. 8 (1) should be tested for its functionality and ensure that they perform their intended purpose (b) Testing has to be carried out by a trained competent person (c) Testing methodology should be in accordance with manufacturer's recommendations and to comply with stipulated fire regulations	8.5
2. Automatically perform test > once in 30 days for min. 30 seconds & a diagnostic routine 3. Indicate failure by a status indicator 4. Visual inspection at intervals <30 days 5. Conduct annual functional tests for min.1 ½ hours 6. Fully operational during 1 ½ hour test		8.6 Frequency of Testing of Fire Systems (a) Fire Detection & Fire alarm systems i. Weekly testing by the user ii. Monthly testing by the user iii. Testing by competent person every 06 months	8.6

	7. Written records of visual inspection & tests should keep for inspection 7.9.3.1.3 Conduct a s follows, 1. Computer-based, self-testing/self-diagnostic, battery-operated emergency lighting equipment should provide 2. < once in every 30 days, automatically perform a test for min. 30 seconds & diagnostic routine 3. Automatically perform an annual test for min. 1 ½ hour 4. Should fully operate during tests 5. System should provide a report of the history of tests & failures		iv. Annual Testing by a competent person and certified by AHJ (b) Fire Protection Systems i. Monthly testing by the user ii. Testing by competent person every six months iii. Annual Testing by a competent person and certified by AHJ	
	'Marking of Means of Egress'	7.10.	Exit and Directional Signs	
	General	7.10.1		
7.10.	<u>Where Required</u> Means of egress should mark according to Section 7.10	7.10.1.1	In every building or part thereof, except buildings of purpose Group 1 in table 2, locations of every exit door & exit	2.54
	<u>Exits</u> 7.10.1.2.1 Be marked by an approved sign that is readily visible from any direction of exit access. 7.10.1.2.2 If the continuation of the egress path is not obvious horizontal components within an exit enclosure should marked by approved exit or directional exit signs	7.10.1.2	2.55 Such signs should be placed clearly visible at all times. In long corridors, in open areas, and in all situations where the location of the exits may not readily visible, directional signs using internationally accepted symbols should be provided to serve as guides from all areas of corridors or floors to the exists.	2.55
			2.56 (a) Exit and directional signs should be in white on a green background with letters and or symbols and should be illuminated at all times. (b) Additional low level or floor mounted exit and exit directional signs should be provided where overnight sleeping accommodation is provided (c) Legends, dimensions, design and installation of the exit signs and directional signs should comply with (d) Photo-luminescent exit signs with letters/symbols in white on green background are allowed for use in low rise buildings not exceeding 800 m^2 of total area.	2.56

<u>Exit Door Tactile Signage</u> (1) Be located at each exit door requiring an exit sign. (2) Read as follows: EXIT. (3) shall comply with ICC/ANSI A117.1 American National Standard for Accessible and Usable Building and Facilities	7.10.1.3	2.17 Location of Exists All exits and access facilities should be located as follows: (a) Exists and access facilities should be clearly visible or their locations be clearly indicated with directional signs.	2.17(a)
		2.54 Exit and Directional Signs In every building or part thereof, except buildings of purpose Group 1 in table 2, locations of every exit door & exit facility on every storey should be clearly indicated by exit signs using internationally accepted symbols.	2.54
		2.55 Such signs should be placed clearly visible at all times. In long corridors, in open areas, and in all situations where the location of the exits may not readily visible, directional signs using internationally accepted symbols should be provided to serve as guides from all areas of corridors or floors to the exists.	2.55
		2.56 (c) Legends, dimensions, design and installation of the exit signs and directional signs should comply with	2.56 (c)
<u>Existing Exemption</u> Not apply to existing buildings	7.10.1.4		–
<u>Exit Access</u> 7.10.1.5.1 If the exit or way to reach the exit is not readily visible, should be marked by approved readily visible signs. 7.10.1.5.2 For new signs rated viewing distance from nearest sign should be < 100 ft (30 m) from any point in an exit access corridor.	7.10.1.5	In every building or part thereof, except buildings of purpose Group 1 in table 2, locations of every exit door & exit facility on every storey should be clearly indicated by exit signs using internationally accepted symbols	2.54
<u>Floor Proximity Exit Signs</u> - Should comply with 7.10.3, 7.10.4, 7.10.5, and 7.10.6 for externally illuminated signs and 7.10.7 for internally illuminated - Located near the floor level in addition to signs required for doors or corridors.	7.10.1.6		–

- The bottom of the sign >6 in. (150 mm), but < 18 in. (455 mm), above the floor. - For exit doors, should mounted on the door or adjacent to the door, within 4 in. (100 mm) of the door frame.			
Floor Proximity Egress Path Marking - Approved internally illuminated system should install within 18 in. (455 mm) of the floor. - Provide continuous visible delineation of travel path along the designated exit access except architectural features such as doorways, hallways etc. - Operate continuously or at any time the fire alarm system activate. - The activation, duration, and continuity of operation should be according to 7.9.2. - The system maintained according to the product manufacturing listing.	7.10.1.7		_
Visibility - Size, distinctive colour, design should readily visible & contrast with decorations, interior finish or other signs. - Visibility of a sign should not impair by decorations, furnishings, or equipment. - No brightly illuminated sign (for other than exit purposes), display, or object in or near the line of vision of the required exit sign should detract attention from the exit sign.	7.10.1.8	The exit and directional signs should be in white on a green background with letters and or symbols and should be illuminated at all times.	2.56 (a)
Mounting Location Located at a vertical distance of not more than 6 ft 8 in. (2030 mm) above the top edge of the egress opening intended for designation by that marking.	7.10.1.9		_
Directional Signs	7.10.2	Additional low level or floor mounted	2.56 (b)

7.10.2.1 Where the direction of travel to nearest exit is not obvious, directional indicator showing the direction of travel, should place in every such location. 7.10.2.2 Directional exit signs should provide within horizontal components of the egress path within exit enclosures.		exit and exit directional signs should be provided where overnight sleeping accommodation is provided.	
Sign Legend in plainly legible letters, or other appropriate wording, EXIT	7.10.3	The legends, dimensions, design and installation of the exit signs and directional signs should comply with the British Standard.	2.56 (c)
Power Source The signs, other than approved self-luminous signs and listed photo-luminescent signs in accordance with 7.10.7.2, shall be illuminated by the emergency lighting facilities.	7.10.4	Photo-luminescent exit signs with letters/symbols in white on green background are allowed for use in low rise buildings not exceeding 800 m^2 of total area.	2.56 (d)
Illumination of Signs	7.10.5		
General a. Other than places required low lighting levels, suitably illuminated by a reliable light source. b. Externally and internally illuminated signs - in normal and emergency lighting mode.	7.10.5.1		_
Continuous Illumination 7.10.5.2.1 Required signs by 7.10.6.3, 7.10.7, and 7.10.8.1 should continuously illuminate under the provisions of Section 7.8, unless otherwise provided in 7.10.5.2.2. 7.10.5.2.2 Permitted to flash on and off upon activation of the fire alarm system.	7.10.5.2	Exit and directional signs should be in white on a green background with letters and or symbols and should be illuminated at all times.	2.56 (a)
Externally Illuminated Signs	7.10.6		_
Size of Signs 7.10.6.1.1 signs required by 7.10.1and 7.10.2, other than approved existing signs, should read EXIT or shall use other appropriate wording in plainly legible letters sized as follows (1) For new signs, the letters >6 in. (150 mm) high, with the principal strokes of letters >3⁄4 in. (19 mm) wide.	7.10.6.1		_

(2) For existing signs, wording to be plainly legible letters > 4 in. (100 mm) high. (3) Word EXIT letters width > 2 in. (51 mm), except letter I, minimum spacing between letters >3⁄8 in. (9.5 mm). (4) Letter widths, strokes, & spacing in proportion to height of Sign legend elements larger than the minimum in 7.10.6.1.1(1) through 7.10.6.1.2 Not apply to marking required by 7.10.1.3 and 7.10.1.7.			
Size and Location of Directional Indicator 7.10.8.3.1 Should Comply: 1. Locate outside the EXIT legend, not less than 3⁄8 in. (9.5 mm) from any letter 2. Should be of a chevron type 3. Identifiable as a directional indicator at a distance of 40 ft (12 m). 4. Larger than minimum for compliance with 7.10.6.2.1(3) proportionately increased in height, width, and stroke. 5. Located at the end of the sign for the direction indicated. 7.10.8.3.2 Not apply to approved exiting signs	7.10.6.2		_
Level of Illumination - Externally illuminated signs - 5 ft-candles (54 lux) - Contrast ratio > 0.5	7.10.6.3		-
Internally illuminated Signs	7.10.7		-
Listing should list according to standards, unless, 1. Approved existing signs. 2. Existing signs having the required wording in legible letters not less than 4 in. (100 mm) high. 3. Signs that are in accordance with 7.10.1.3 and 7.10.1.6.	7.10.7.1		_
Photo-luminescent Signs - Should continuously illuminated when occupied - Charging illumination should reliable light source determined by - Specified in the product marking	7.10.7.2	Photo-luminescent exit signs with letters/symbol's in white on green background are allowed for use in low rise buildings $\leq 800m^2$ of total area	2.56 (d)
Special Signs	7.10.8		-

<u>Sign Illumination</u> 7.10.8.1.1 Special signs should be illuminated 7.10.8.1.2 For emergency lighting facilities illumination should provide	7.10.8.1		_
<u>Characters</u> should comply with visual character requirements of (mentioned)standards	7.10.8.2		_
<u>No Exit</u> 7.10.8.3.1 Any door, passage, or stairway except an exit or an exit access way, should indicate N O EXIT 7.10.8.3.3 NO EXIT sign shall have the word NO in letters 2 in. (51 mm) high, with a stroke width of 3⁄8 in. (9.5 mm), and the word EXIT in letters 1 in. (25 mm) high, with the word EXIT below the word NO,	7.10.8.3		_
<u>Elevator Signs</u> Elevators in part of means of egress should have 5/8 in (16mm) height following signs posted in elevator lobbies 1. elevator can be used for egress with restrictions if any 2. operation status of elevators	7.10.8.4		_
<u>Evacuation Diagram</u> Floor evacuation diagram should be posted reflecting actual floor arrangement and exit location Oriented in a location & manner accepted by AHJ	7.10.8.5		_
Testing and Maintenance	7.10.9	Systems to be inspected, maintained and tested	8.1
<u>Inspections</u> Illumination of exit signs should be visually inspected within every 30	7.10.9.1	Following should be subjected to regular inspection and testing (g) Exit Signage	8.1 (g)
<u>Testing</u> Exit signs with battery operated illumination source should be tested and maintained	7.10.9.2	8.5 Testing of Active Fire Systems (a) All active fire Systems stated in Reg. 8 (1) should be tested for its functionality and ensure that they perform their intended purpose (b) Testing has to be carried out by a trained competent person	8.5

			(c) Testing methodology should be in accordance with manufacturer's recommendations and to comply with stipulated fire regulations	
			8.6 Frequency of Testing of Fire Systems (a) Fire Detection & Fire alarm systems i. Weekly testing by the user ii. Monthly testing by the user iii. Testing by competent person every 06 months iv. Annual Testing by a competent person and certified by AHJ (b) Fire Protection Systems i. Monthly testing by the user ii. Testing by competent person every six months iii. Annual Testing by a competent person and certified by AHJ	8.6
	'Special Provisions for Occupancies with High Hazard Contents'	7.11		_
7.11	(Storage, High hazard) Travel distance to a safety place/outside not more than 75ft(23m),	7.11.1	High Hazard Occupancy (a) The compartment shouldn't exceed ½ of the sizes given in Table 6 and 7, and each compartment should be limited to 01 storey only.	3.12
	7.11.1 not apply to storage occupancies	7.11.2	(b) If habitable floor ≥18 m, an Automatic Fire Sprinkler System should	
	Egress capacity for Stairs 0.7in.person (18mm/person) or 0.4in/person (10mm/person) for level components and ramps	7.11.3		_
	Minimum 02 means of egress unless following are met, 1) Rooms or space >200 sq.ft (18.6 sq.m) 2) Rooms or space occupancy load > 03 persons 3) Rooms or space travel distance to the door ≥25ft (7620mm)	7.11.4		_
	No dead ends in corridors	7.11.5		-
	Doors for occupancy load ≥5 persons permitted with panic hardware latch or lock only	7.11.6		_
	'Mechanical Equipment Rooms, Boiler Rooms, and Furnace Rooms'	7.12	3.14 Areas of Special Hazard	

7.12	Travel distance of common path not exceeding 50ft (15m), unless otherwise permitted by;		a) Boiler Rooms, Transformer Rooms, Generator Rooms, Storage Areas of highly flammable / combustible materials to be separated from compartment walls and floors having fire resistance of ≥2 hours. If building is provided with an automatic fire suppression system, fire resistance should be a minimum of 1 hour.	3.14 (a)
	(1) Travel distance 100ft(30m)for following,			
			b) Rooms having transformer with flammable liquid and generator rooms should've easy access for Fire Brigade/ Fire Service Department.	3.14 (b)
	a. Approved & supervised sprinkler system		d) Kitchen Separation	3.14 (d)
	b. mechanical equipment room with no fuel- fired equipment		i. Where a kitchen is required for the preparation of food and 'open flame cooking' appliances are used, location should be separated from other parts of the building by a fire separation/ Compartmentation having fire resistance of ≥1 hour.	
	c. Existing building		ii. Opening in the compartment wall and floor comply with the relevant provisions for fire protection of openings	
			iii. Doors should've fire resistance of 30 minutes with automatic self-closing devices	
			iv. Where flue or exhaust duct passes through the compartment wall/floor, penetration should be sealed with fire resistant material of same fire rating.	
			v. If automatic fire suppression system is provided to the cooking range, no fire Compartmentation is required.	
			e) A theatre, cinema or concert hall should be separated from other parts of the building, of a different purpose group, by compartment walls and floors having a fire resistance of minimum 1 hour. If the building is protected by an automatic sprinkler system, fire resistance can be ½ hour. Where openings are provided for access between the theatre, cinema or concert hall and any other part of the same building of a different purpose group, such openings should be protected by fire doors or provided with a smoke free lobby approach.	3.14 (e)
			Areas of Special Risk in any Building	
			6.65 Separation and Permissible Openings	6.65

			A boiler room, generator or transformer room or any other area of special risk in any building should be separated from the other parts of the building by a compartment having fire resistance for a period of ≥4 hours notwithstanding the provision of Reg. 3(24) to 3(30) and Table 8. Such compartment wall or compartment floor should be imperforated except for the following. a) Openings in the wall fitted with doors having fire resistance for a period of not less than that of the compartment, or b) Openings in the floor for protected shafts which should comply with Reg. 3(57) to 3(68), or c) Openings for ventilation ducts which should comply with the Reg. 3(53), or d) Openings for pipes which should comply with the requirements of Reg. 3(48) (d).	
			6.66 Areas of Special Risk in Basements Where the areas of special risk are located in basement storeys, the additional requirements of Reg. 6(46) should also be complied with.	6.66
			6.46 Fire Brigade Foam inlets When flammable liquids are used in basement or locations not easily accessible for fire fighting, following should be provided. i. Foam inlets, pipe works and nozzles for the purpose of delivering foam to the area referred above. ii. Piping at ground level with a pipe run of minimum 65mm bore terminating at area specified above iii. Secondary containment for storage tank having a capacity of ≥110% of fuel capacity.	6.46

			iv. Fixed foam spreaders as part of a foam pouring system with a foam inlet box built in to the wall of the building at a point approved by AHJ where it is easily accessible with a pipe run of minimum 65mm bore terminating at the are referred to above. Box should be placed at a height of 700 to 1000mm above ground level and should be clear of any opening through which heat, smoke or flame can pass. All pipe work should have a slope towards the spreader. Distance between the inlet & furthermost nozzle should ≤18m. v. Signage: 'FOAM INLETS' in red lettering to be displayed on foam inlet vi. In the event a dedicated Automatic Foam Fire Suppression System is provided, fire brigade foam inlet should not be required.	
			6.67 Fuel Storage a) For boiler rooms or generator rooms use flammable liquid as fuel, amount of fuel allowed to be stored within the same compartments should ≤8 hour requirement operation and such storage should be provided with a secondary containment tank having a volume of ≥110% of the storage capacity. Any excess fuel should be stored in separate compartments according to Reg. 6(67), and if its "Petroleum" under the provisions of the Petroleum Act, storage compartments should also confirm to the requirements of the Petroleum Ordinance Regulations, or if such fuel does not qualify as "petroleum" then the storage compartment should conform to the requirements of Reg. 6(72) b) Generators and associated fuel supplies located in buildings other than in basement or ground floor level should be protected by an automatic fire suppression system.	6.67
	'Normally Unoccupied Building Service Equipment Support Areas'	7.13		_
	Hazard of Contents	7.13.1		_

7.13	7.13.1.1 Apply unless prohibited by chapter 11 – 23, to normally unoccupied building service equipment support areas, that don't contain high hazard contents/ operations 7.13.1.2 Shall not contain fuel-fired equipment			
	Egress Doors 7.13.2.1 Should provide doors complying 7.2.1 where area >45,000 ft^2 (4180 m^2) in buildings not protected by approved, supervised automatic sprinkler system according to 9.7.1.1(1) 7.13.2.2 Should provide doors complying 7.2.1 where area >90,000 ft^2 (8370 m^2) in buildings protected by approved, supervised automatic sprinkler system according to 9.7.1.1(1) 7.13.2.3 Absence of sprinklers, as permitted by exemption of NFPA 13, Standard for the installation of sprinkler systems, not cause to building be classified as non-sprinklered for applying 7.13.2.2	7.13.2	2.27 Exit Doors Exit doors giving access to escape corridors should be so positioned that their swing should at no point encroach on the required minimum width of the escape corridor. - The door must be provided with a door closer.	2.27
			2.45 Facility for Re-entry Internal staircases where entry is restricted with fire doors, facility to re-enter the building should be provide at every 5th floor. Monitoring facilities should be provided for such doors to prevent unauthorized entry.	2.45
			2.51 Exit Doors Exit doors and doors providing access to exits should open to direction of escape and comply with relevant parts of following:	2.51
			(a) exit doors – should be openable simply by pushing open or by means of a panic bar (not applicable to buildings under purpose Group 1)	2.51 (a)
			(b) exit doors, which required to have FRR, should comply with relevant provisions for fire resisting doors	2.51 (b)
			(c) exit doors opening into exit staircases and exit passageways shouldn't impeded the egress of occupants when such doors are swung open	2.51 (c)

			(d) door opening into exit path should close when pushed into direction of the movement	2.51 (d)
			(e) any door located in path of travel should be hung & should be full width of exit path	2.51 (e)
			(f) Width and height of doors: The capacity of exit and corridor door openings should be listed in Table 5 (I) to (VIII). Door jambs or stops and the door thickness when the door opens should reduce ≥80mm. - Min. open width of the exit doors 1m, where corridor width is 1.2 m. - Min. clear height of door opening should be 2.1 m	2.51 (f)
			(g) Fire door protected staircase and smoke stop/Fire lift lobby should be with a vision panel. - Vision panel should have a clear view size of 100mm width x 600mm height and same FRR.	2.51 (g)
			(h) Provision of vision panel shouldn't apply to exit doors of residential apartment or maisonette units.	2.51 (h)
			(j) All compartment doors on long exit paths should swing both ways and should be provided with a vision panel, as specified in above (c).	2.51 (j)
			2.52 Area of Refuge e) Doors providing access to an area of refuge should be kept unlocked at all times, when the floor area served by the area of refuge is occupied. - Such doors should be swinging and self-closing with FRR of 1 ½ hours, except that doors in fire resistance rating of 3 hours. - They should swing in the direction of exit travel	2.52 (e)
			3.62 Doors in Protected Structure Any door fitted to an opening in protected structure should've FR for ≥ ½ the period required by other provisions of the regulation for the protecting structure surrounding the opening	3.62
			Fire revisiting Doors 3.68 Application of Regulation Should apply to any door(including door frame) which required to have fire resistance by this section	3.68

			3.69 Application of Regulation - Automatic self-closing devices doesn't include raising butt hinges except - Fire doors fitted with automatic devices to hold door open during normal operations should've devices to close door upon, (a) Detection of smoke by an automatic smoke detector (b) Manual operation of a switch with overriding facility, fixed in suitable (c) Failure of electricity supply to device, apparatus or switch (d) If an evacuation alarm is activated through fire control panel for building	3.69
			3.70 Provisions of Closing Devices and Non-Combustible Hinges (a) All fire Doors should be fitted with a positively self-closing devices capable of closing the door from any angle against any latch fitted to door	3.70 (a)
			(b) No holding of any such door open should be provided other than holding device that will release by activation of a smoke detector in vicinity	3.70 (b)
			(c) No part of a hinge in any such door should be made either of combustible material or non-combustible material with melting point <800˚C	3.70 (c)
			3.74 Two Separate Doors to One Opening If 02 separate doors (whether single or double leaf doors) are installed in an opening, it should be sufficient if the required fire resistant is achieved by 02 doors together or by either of them separately.	3.74
			3.76 Doors in Lift Shafts Notwithstanding Reg. 3(70) (a) a door which isn't fitted with a self-closing device may be installed in the structure which encloses a protected shaft containing exclusively a lift or lifts if	3.76

			(a) <u>fire resistance of door is ≥1/2 hour</u> and there's also installed to close the same opening which is fitted with an automatic self-closing device, held open by an automatic closing device activated by smoke detector or fire alarm and has fire resistance for a period ≥ prescribed by relevant provisions in Reg. 3(2) to 3(3) for the structure surrounding (b) Unless the opening is in a compartment wall and is 01 of 02 openings provided at same level to allow access to a lift from different sides, then door should've fire resistance for a period ≥ prescribed by relevant provisions Reg. 3(24) to 3(30) for the structure	
	Means of Egress Path 7.13.3.1 Designated path should provide for >45,000 sq.ft (4180 sq.m) in buildings without approved & supervised sprinkler system. 7.13.3.2 Designated path should provide for >90,000 sq.ft (8370 sq.m) in buildings with approved & supervised sprinkler system.	7.13.3	Means of Escape Requirements (a) determination of means of escape requirements for a building should be based on the type of occupancy, occupant load, floor area, travel distance to an exit and the capacity of exits provided in Table-5 (I) to (VIII) (b) Any building other than Purpose group I having total floor area exceeding 800m2 or the one way travel distance exceeding as per Table 5 and the height of the occupiable floor exceeding 9 m should be provided with an alternative means of escape.	2.38
	7.13.3.3 If permitted by NFPA 13,'Standard for the installation of Sprinkler System' should not classify as non-sprinklered for the above. 7.13.3.4 Egress path should be >28in. (710mm) 7.13.3.5 Egress path headroom >6ft 8in. (20130mm) 7.13.3.6 Exit signage is not required along the path 7.13.3.7 Where 02 means of egress are required, egress path should connect them		2.17 Location of Exists All exits and access facilities should be located as follows: All exits and access facilities required to comply with following: a) Exists and access facilities should be clearly visible or their locations be clearly indicated with directional signs. - All exists must kept readily accessible and unobstructed at all times b) Every occupant within storey of a building should've direct access to required exit, without passing through spaces occupy by other occupants c) When >1 exit required each exit should be placed as remote as possible from the other, complying with travel distance requirements	2.17

7.13.3.8 If the access is obstructed egress path should be within 25ft (7.6m)			
Illumination 7.13.4.1 Min 0.2ft-candle (2.2lux) 7.13.4.2 Not required if egress is not required to illuminate under applicable occupancy	7.13.4	Emergency Lighting Occupied areas and escape routes in all buildings, except purpose group 1(c) should be provided with artificial lighting facilities to the satisfaction of the requirements under this regulation. a) Minimum illuminance to be provided for all exits should be ≥5 lux measured at the floor. b) The delay between the failure of the electrical supply to normal lighting and the energization of the emergency lighting should ≤1 second. c) Alternate power supply should be adequate to provide the power to maintain the lighting for a period ≥3 hrs.	2.53
Number of Means of Egress 7.13.5.1 Two remote means of egress required for ≥45,000 sq.ft (4180 sq.m) in buildings without approved & supervised sprinkler system.	7.13.5	Number of Staircases or Exits per Storey There should be at least 02 independent staircases or other exits from every storey of a building, unless otherwise permitted under other subsequent provisions of the regulation	2.13
7.13.5.2 Two remote means of egress required for ≥90,000 sq.ft (8370 sq.m) in buildings with approved & supervised sprinkler system.		2.12 Number of Exits from Rooms and Spaces Should be >02 door openings remote from each other and leading to exits, from every room or enclosed space in which the total occupant load exceeds the maximum permissible occupancy load for 01 door as listed in the Table 4.	2.12
7.13.5.3 If permitted by NFPA 13,'Standard for the installation of Sprinkler System' should not classify as non-sprinklered for applying		a) Application of Table 4 should be subject to travel distance being in accordance with Regulation 2(3) (i).	2.12 (a)
		b) In a block of residential flats, ≥02 exit doors from each flat, that should've direct access to staircase/staircases that are required to be provided for such block of flats under subsequent Reg. 2(13) of this Regulation except;	2.12 (b)

			i. That only 01 exit door may be provided when there is a smoke dispersal condition within the flat, or ii. Exit path is sprinkler protected, to the satisfaction of the AHJ and travel distance from the furthermost bedroom door to the exit door ≤13m. When there is an alternative escape route from the furthermost bedroom door to single exit door, an extension of the aforesaid travel distance up to 15m may be permitted.	
			d) In a block of small residential units consisting of more than 01 floor, there should be at least 01 exit door from each storey of each unit that should've direct access to the staircase or staircases that are required to be provided for such block of small residential units under subsequent Reg. 2(13). Exceptions; v. aggregate floor area of the upper storey of the small residential unit should ≤60 m^2; vi. distance from the furthermost bedroom door to the main entrance door should ≤13 m ; vii. The escape route should not pass through or near an unprotected opening of the kitchen; and viii. The small residential unit should not comprise more than 2 storeys.	2.12 (d)
	'Occupant Evacuation Elevators'	7.14	'Evacuation Lifts'	
7.14			3.100 General An Evacuation lift should be provided for buildings categorized as Super High Rise buildings. It should be different from Fire Fighter's lift and should comply with following conditions. (a) Protected lobby and lift-well should be designed to restrict ingress of smoke. Approach should be through a smoke free passage. (b) Floor of fire fighters lobby should be so designed to prevent flow of water to emergency exit stairway and lift shaft	3.100.

		(c) If opening are available in the lift car or more than 01 side approaches from every sides should be through a protected smoke approach.	
		3.101 Power supply to fireman's lift and evacuation lift (a) Power supply should be available directly from the main breaker of the generator via a dedicated Automatic Transfer Switch (ATS) panel with manual overriding facility located within the enclosure. (b) Main and auxiliary power supply cables for these systems should be located in a fire protected shaft. Any part of the cable located outside a fire protected shaft should be with enhanced fire resistance and protection against	3.101
		3.102 Evacuation Lift Requirements a) Serve every floor of the building. b) Evacuation lift car shall be large enough to accommodate a stretcher or a bed. The load shall be not less than 1000 kg and the dimensions shall be minimum 1100 mm wide by 2100 mm deep. c) Lift shall be capable of reaching the uppermost habitable floor from fire service access level within 60 seconds. d) Electrical equipment and fittings within the lift well and lift car should be IP 65 rated. (e) Elevator lobby should be adequate to accommodate ≥50% of the occupant load of the area served by the lobby and include 01 wheelchair space of 760mmX1220mm for each 50 persons or part thereof. (f) Two-way communication systems should be provided between elevator lobbies and the fire command centre and between elevator cars and the fire command centre. (g) Wiring used for two-way communication systems should be fire rated for not less than 01 hour and should be provided with mechanical protection	3.102
General	7.14.1	3.100 General	3.100.

7.14.1.1 If passenger elevators are allowed to use for occupant evacuation prior to emergency recall operation mandated by fire-fighters, elevator system should comply with this section 7.14.1.2 Above shouldn't apply where limited or supervised use of elevators for evacuation is practiced 7.14.1.3 Evacuation elevators should be according to occupant evacuation operation requirements & building emergency action plan 7.14.1.4 occupant evacuation elevators shouldn't be part of 1. number of means of egress 2. capacity of means of egress 3. arrangement of means of egress		An Evacuation lift should be provided for buildings categorized as Super High Rise buildings. It should be different from Fire Fighter's lift and should comply with following conditions. (a) Protected lobby and lift-well should be designed to restrict ingress of smoke. Approach should be through a smoke free passage. (b) Floor of fire fighters lobby should be so designed to prevent flow of water to emergency exit stairway and lift shaft (c) If opening are available in the lift car or more than 01 side approaches from every sides should be through a protected smoke approach.	
Information Features 7.13.3.1 AHJ approved emergency action plan should implement showing occupant evacuation using exit stairs & occupant evacuation 7.13.3.2 Occupant elevators should indicate suitability for evacuation during fires with signage	7.14.3		–
<u>Condition for Safe Continued Operation</u> 7.14.3.3.1 Condition of occupant elevators, elevator lobbies & elevator machine rooms should be continuously monitored and displayed at the <u>fire command centre</u> by a standard emergency service 7.14.3.3.2 Monitoring & display should include,	7.14.3.3	8.7 Responsible Person for Fire Systems in buildings Any building coming under all-purpose groups except, 1(b) and 1(c) should've a person responsible for Active and Passive Fire Protection System in the building. Such person should be appointed by property owner or operator or occupier or <u>Condominium Management Corporation.</u>	8.7

1. Floor location of each elevator car 2. Direction of travel of each elevator car 3. Status of each elevator car – occupied or not 4. Status of normal power to the elevator equipment, elevator controller cooling equipment and elevator machine room ventilation and cooling equipment 5. Status of standby or emergency power system that provide back-up power to the same as above		Such person will be responsible for maintaining of fire systems in good and proper working conditions and conducting fire risk assessments. Liabilities arising from malfunctioning of active and passive fire protection systems in buildings should remain with property owner or operator or occupier or Condominium Management Corporation as applicable.	
6. Activation of fire alarm-initiating device in any elevator lobby, elevator machinery/control room or machinery/control space, or elevator hoist way 7.14.3.3.3 <u>Fire command centre location</u> should be able to override normal elevator operations and to initiate manually a Phase I emergency recall operation of the occupant evacuation elevators		4.26 Fire Command Centre(FCC) (a) Any High-Rise and Super High-Rise building should be provided with a Fire Command Centre (FCC) (b) FCC should be located in the Ground Floor or any other raised floor level where Fire services access provided as approved by AHJ, in close proximity to fire fighting shaft (c) FCC should be manned 24 h	4.26
	7.14.3.4		
Fire Detection, Alarm and Communication	7.14.4	'Fire Alarm Control Panel (FACP)'	
7.14.4.1 Building should have approved fire alarm system 7.14.4.2 It should include an emergency voice/alarm communication system with ability to provide voice directions on a selective basis to any floor		4.14 Location Should be located in the FCC - In the absence of FCC in a location manned and monitored 24 hours of the day, on the Ground Floor close to entrance to the building likely to be used by the Fire Service.	4.14
7.14.4.3 When the elevator lobby doors are closed, intelligible voice instructions should be audible inside the lobbies.		4.15 Power Requirement (a) At least 02 independent & reliable power supplies should be provided	4.15

			- Each should be of adequate capacity for application. - Integrity of power supplies should be monitored by the FACP - 01 supply should be dedicated circuit of main supply and other from a dedicated standby battery (b) Secondary power supply should automatically provide power to the protected premises system (c) Secondary power supply should've sufficient capacity to operate the system under quiescent load (system operating in a non-alarm condition) for min. 24 hours - And at the end of period, should be capable of operating all alarm notification appliances used for evacuation or to direct aid to the location of an emergency for an additional 5 (d) Under normal operating condition, standby power source should be capable of operating all alarm notification appliances used for 30 minutes.	
			'Voice Evacuation System'	
			(a) one way emergency voice evacuation and communication system and an emergency command centre should be provided as follows: i. for all large buildings with gross floor area ≥2800 m^2 or having a total occupant load ≥1000 persons and large industrial and warehouse buildings with gross floor area ≥5000 m^2 ii. for all High-Rise and Super High-Rise buildings iii. for hotel or health care occupancies ≥18m height (b) emergency voice evacuation and communication system should override any public address system (c) speakers for emergency voice evacuation should provide in every lift lobby, staircase enclosure, corridors and other strategic positions with audible distance of all parts of all storeys of the building	4.2

			(d) speakers with flashers (strobe lights) should be provided for basement car parks, mechanical or machine rooms, large machine areas of factories ($\geq 5000m^2$) and at locations where ambient noise level is ≥75db	
			4.23 Control of Voice Evacuation System a. Controls for emergency voice/alarm communication system should be at Fire Command Centre / central location accessible by building staff and emergency responders. b. Controls should be located or secured to allow access by only trained and authorized personnel. c. Operating controls should be clearly identified. d. If there are multiple control locations, only 01 should be in control at any given time e. Location having control of the system should be identified by a visible indication at that location f. If live voice instructions are provided, they should override previously initiated signals to the selected notification zones(s) and should've priority over any subsequent automatically initiated signals to the selected zone(s).	4.23
	Two-way Communication System should be provided in each occupant evacuation elevator lobby to communicate with fire command centre or an approved location by fire department 7.14.4.4.1 Design & Installation – system should include audible and visible signals and should be designed & installed to (mentioned) requirements 7.14.4.4.2 Instructions – instructions to use & location of the station should permanently located near the	7.14.4.4	3.102 Evacuation Lift Requirements (f) Two-way communication systems should be provided between elevator lobbies and the fire command centre and between elevator cars and the fire command centre. (g) Wiring used for two-way communication systems should be fire rated for ≥01 hour and should be provided with mechanical protection	3.102(f) 3.102(g)
			4.25 Two-way telephone communication system with Fire Command Centre(FCC)	4.25

			Should be provided for all buildings categorized as High-Rise and Super High-Rise and any other building as requested by AHJ. Should be provided between FCC and following areas or any area specified by AHJ. i. Every fire fighting lobby iv. Fire service lifts vi. Each area of refuge (a) Monitoring of the integrity of two-way telephone communications circuit should be provided (b) Two-way telephone communications service should be capable or permitting the simultaneous operation of any 05 telephone stations in a common talk (c) A notification signal at the control equipment, distinctive from any other alarm, supervisory, or trouble signal, should indicate the off-hook condition of a calling telephone circuit (d) In high rise and super high rise buildings equipped with a fire pump(s), a telephone station or jack should be provided in each fire pump room (e) If telephone jacks are provided, at least 05 handsets should be stores at fire command centre (f) All circuit necessary for the operation of two-way telephone communication systems should be installed using 01 of the following methods. i. Cables of 3-hour fire rated circuit integrity at 950 ˚C. Cat CWZ ii. Cables installed inside 2-hour fire rated enclosure	
	Sprinklers	7.14.5	'Automatic Sprinkler Systems'	
	7.14.5.1 Building should have an approved and supervised automatic sprinkler system 7.14.5.1.1 Each floor should have a sprinkler control valve and a water flow device		General 5.33 Following should be provided with an automatic sprinkler system: (a) All indoor car parks	5.33 (a)

7.14.5.1.2 Above devices should be monitored by fire alarm system 7.14.5.2 Sprinklers should not install in elevator machine/control rooms and machinery/control spaces serving occupant evacuation elevators. It shouldn't cause the building to be classified as non-sprinklered. 7.14.5.3 When a hoistway serves occupant evacuation, sprinklers should not install at the top or at other points in hoistway more than 24 in (610mm) above the pit floor.		(b) All High-Rise & Super High-Rise buildings as defined by these regulations. It should be note that sprinklers systems should cover all storeys including basements and not limited to storeys above 30m. - Exceptions are toilets, electrical switch gear rooms, server rooms or any other area where water damage will be significant and that will not escalate the fire spread to adjoining areas (c) Any part of a basement storey which is used as a place of public resort, shops, office, factory or warehouse irrespective of whether or not the compartmentation requirements are complied with.	5.33 (b) 5.33 (c)
Elevator Installation 7.14.6.1 Occupant evacuation elevators should install according to codes mentioned 7.14.6.2 Shunt breakers should not installed on occupant evacuation elevators 7.14.6.3 Occupant evacuation elevators should limit to passenger elevators located in non-combustible hoistways	7.14.6		_
Elevator Machine/Control Rooms and Machinery/Control Spaces 7.14.7.1 these should separate from all building areas with 2-hour fire resistance construction other than hoistways 7.14.7.2 these shouldn't use for other purposes	7.14.7		_
Electrical Power and Control Wiring	7.14.8	3.101 Power supply to fireman's lift and evacuation lift	3.101(a)
7.14.8.1 Following features should be supplied by both normal power and type 60, class 2, level 1 standby power 1. elevator equipment 2. ventilation and cooling equipment for elevator machine/control rooms and machinery/control spaces 3. elevator car lighting		(a) Power supply should be available directly from the main breaker of the generator via a dedicated Automatic Transfer Switch (ATS) panel with manual overriding facility located within the enclosure. (b) Main and auxiliary power supply cables for these systems should be located in a fire protected shaft. Any part of the cable located outside a fire protected shaft should be with enhanced fire resistance and protection against	3.101(b)
		3.102 Evacuation Lift Requirements	3.102(d)

7.14.8.2 wires or cables locate outside provide normal power, standby power control signals, communication with cars, lighting, heating, air-conditioning, ventilation and fire detecting systems to occupant evacuation elevators should 1. type C1 cables with a minimum 2-hour fire resistance rating 2. wiring should enclosed in a minimum 2-hour fire resistance construction 3. approved 2-hour fire resistance alternative wire 7.14.8.3 no need to protect control signal wiring and cables that do not serve Phase II emergency in-car service		(d) Electrical equipment and fittings within the lift well and lift car should be IP 65 rated.	
Occupant Evacuation Shaft System	7.14.9	3.57 Use of Protected Shaft	3.57
7.14.9.1 Should include, (1) elevator hoistway		No protected shaft should be constructed or use for any purposes additional to those specified in Chapter 7 other than the accommodation of any pipe or duct. - Any pipe or duct located within a protected shaft should've an enclosure having the same fire rating of the shaft	
(2) enclosed elevator lobby outside the group of hoistway doors on each floor need not to enclose on street floor or exit discharge level (3) at and above grade level, enclosed exit staircase with access to each level should serve by elevators		3.63 Protected Shaft for Lift any protected shaft containing a lift or lifts: (a) shouldn't contain any pipe conveying gas or oil or any ventilation duct (b) May have an opening in its protected structure for passing cables operating the lift into the room containing the lift motor. (c) If it serves any basement, it should be protected by a smoke stop lobby with walls having 01 hour fire resistance. - protected lobby should mechanically ventilated	3.63
		3.66 Protected shaft of staircase (Protected shaft containing exit staircase) (a) A protected shaft which contains an exit staircase shouldn't contain any services except for: i. Cut off sprinkler and pipe for that staircase	3.66

		ii. Rainwater down pipes serving the roof directly above the exit staircase iii. Rising mains (b) Protecting structure should be constructed of masonry or dry wall. - If dry wall construction is used, should be of non-combustible material. - Wall should've fire resistance for less than relevant period specified in Table-8, having regard to the purpose group of building.	
Elevator Lobby Size 7.14.9.2.1 Elevator lobbies should have minimum floor area. 1. 3 ft^2 per person (0.28 m^2) minimum 25 % of the occupant load at the same floor 2. Should accommodate 01 wheelchair space 30 in x 48 in (760mm x 1220 mm) for each 50 persons of the occupant load of the same floor 7.14.9.2.2 Size of elevator lobbies serving multiple banks should except from above. Areas of such lobbies should approved on individual basis	7.14.9.2	Evacuation Lift Requirement (e) Elevator lobby should be adequate to accommodate $\geq$50% of the occupant load of the area served by the lobby and include 01 wheelchair space of 760mmX1220mm for each 50 persons or part thereof.	3.102 (e)
Access to the Exit Stair Access to the exit stairway should be from enclosed elevator lobby	7.14.9.3	2.17 Location of Exists All exits and access facilities should be located as follows: (a) Exists and access facilities should be clearly visible or their locations be clearly indicated with directional signs. - All exists must kept readily accessible and unobstructed at all times (b) Every occupant within storey of a building should've direct access to required exit, without passing through spaces occupy by other occupants (c) When >1 exit required each exit should be placed as remote as possible from the other, complying with travel distance requirements	2.17
The Occupant evacuation shaft Occupant evacuation shaft should separate from other areas by walls, 1. Walls should be smoke barriers	7.14.9.4	<u>Fire Resistance of Elements Of Structure</u> 3.24 Minimum Period of Fire Resistance	3.24

	2. Elevator lobby walls should have minimum 1 hour fire resistance rating and ¾ hour fire-protection rated opening protective 3. Elevator hoist way walls should have minimum 2hour fire resistance rating and minimum 1 ½ hour fire-protection rated opening protective 4. Enclosed exit stairway walls should have minimum 2 hour fire resistance rating and minimum 1 ½ hour fire-protections rated opening protective		Subject to any express provision to the contrary any element of structure should be so constructed as to have fire resistance for ≥ that the relevant period specified in Table 8 having regard to the purpose group of building of which it forms part and the dimensions specified in that Table, provided that; (a) Any party wall should've a fire resistance of ≥01 hour (b) Any compartment wall/floor which separates a part of a building falling within purpose group 1(a), 1(b) or 1(c) from any other part of building falling within a group other than group 1(a), 1(b) or 1(c) should've a fire resistance of ≥01	
			3.58 Enclosure Subject to the provisions of this Regulation, any protected shaft should be completely enclosed by walls or floors having the necessary fire resistance rating under Reg. 3(24) to 3(30).	3.58
			3.59 Non-Combustibility of Protecting Structures (a) Every protective structure should be constructed wholly of non-combustible materials except floor, wall and ceiling finishes which don't contribute to fire resistance of such protecting structure - such finishes should comply with Reg. 3(83) to 3(89) (b) any beam/column forming part of, and any structure carrying a protecting structure which required to be constructed of non-combustible materials should itself comply with provisions of sub-paragraph (a) as to non-	3.59
			3.78 Special Requirements for Buildings for Purpose Group I exceeding 3 storeys In any building of purpose group I which exceed 9 m in height, any internal staircase(including any hall or landing associated herewith and any part of a floor which affords passage between flights of the staircase) should be separated from all other parts of the building by structure complying with	3.78

			a) structure should've fire resistance for not less than the minimum period required by Reg. 3(24) to 3(30) for elements of structure forming part of the storey in which it is situated; b) any opening in the structure which gives access to a habitable room, garage, or kitchen should be fitted with a door which has fire resistance of >1/2 hour and complies with requirements of Reg. 3(68) to 3(76)	
			3.100 (a) General (a) Protected lobby and lift-well should be designed to restrict ingress of smoke. Approach should be through a smoke free passage.	3.100(a)
	Construction of occupant evacuation shaft system enclosures should provide min: of classification level 2	7.14.9.5		–
	Elevator lobbies should be waterproofed to an approved method	7.14.9.6	(b) Floor of fire fighters lobby should be so designed to prevent flow of water to	3.100 (b)
	Occupant evacuation shaft system elevator lobby doors should have, 1. ¾ hour fire-protection rating 2. Smoke leakage-rated assemblies 3. Automatic positioning bottom seal to prevent water coming out of shaft system	7.14.9.7	3.62 Doors in protected Structure Any door fitted to an opening in protected shaft structure should've fire resistance for ≥½ the period required by other provisions of the regulation for protecting structures surrounding the	3.62
			3.74 Two Separate Doors to One Opening If 02 separate doors (whether single or double leaf doors) are installed in an opening, it should be sufficient if the required fire resistant is achieved by 02 doors together or by either of them separately.	3.74
			3.75 "Deemed to Satisfy" Provisions Where any door is required under the provisions of this publication to be fire resisting, it should be deemed to have: (a) The requisite fire resistance if a similar door made to the same specifications as that door is proved to have requisite fire resistance under the conditions of test prescribed in foregoing paragraphs of this publication; (b) Requisite fire resistance for minimum period of:	3.75

			i. ½ hour if it's constructed in accordance with 01 of the relevant specifications for Class A in Table 11 and if not less standard than that of such class; or ii. 01 hour if it's constructed in accordance with 01 or the relevant specifications for Class B in Table 11	
			3.100 (a) (a) Protected lobby and lift-well should be designed to restrict ingress of smoke. Approach should be through a smoke free passage.	3.100(a)
	All elevator lobby doors should, 1. door other than to the hoistway, exit stair enclosure, control room/control space, should be automatic closing 2. elevator lobby doors in every floor should close in response to alarm signals 3. have a viewing panel in each door	7.14.9.8	3.76 Doors in Lift Shafts Notwithstanding Reg. 3(70) (a) a door which isn't fitted with a self-closing device may be installed in an opening in the structure which encloses a protected shaft containing exclusively a lift or lifts (a) Door has fire resistance for a period ≥1/2 hour and there's also installed so as to close the same opening another door which is fitted with an automatic self-closing device, is held open by an automatic closing device activated by smoke detector or fire alarm and has fire resistance for a period ≥ prescribed by relevant provisions in Reg. 3(2) to 3(3) for the structure surrounding opening; (b) Unless the opening is in a compartment wall and is 01 of 02 openings provided at same level to allow access to a lift from different sides, then door should've fire resistance for a period ≥ prescribed by relevant provisions Reg. 3(24) to 3(30) for the structure	3.76
	Vision Panel exit stair doors should have a viewing panel	7.14.9.9	Exit Doors (d) Fire door protected staircase and smoke stop/Fire lift lobby should be with a vision panel. - Vision panel should have a clear view size of 100mm width x 600mm height and same FRR.	2.51 (g)

Not Complied	
Fully complied	
Partially complied	

	NFPA	Required Clause No.			Number of Require ments	Relevant CIDA Clause	Number of Clauses to cover the requirement of NFPA	Comparison 1	Comparison 2
7	Means of Egress								
7.1	General	7.1.1				2			
		7.1.2			1	2.1	1		
		7.1.3	7.1.3.1		2	2.3 2.4	4		
			7.1.3.2			2.3 (g)			
		7.1.4				3.86	4		
		7.1.5				2.42 (a)	1		
		7.1.6			4	-			
		7.1.7	7.1.7.1		2	-			
			7.1.7.2			2.42 (ii) 2.40 C	2		
		7.1.8				-			
		7.1.9				2.51 C	1		
		7.1.10	7.1.10.1		2	2.17 2.39	2		
			7.1.10.2			-			
		7.1.11				5.34	1		

7.2	Means of Egress components	7.2.1	7.2.1.1		3	2.51 3.71 3.72	3		
			7.2.1.2		3	2.9 a,b,c 2.51 f	4		
			7.2.1.3		7	-			
			7.2.1.4		4	2.51 2.52 3.72 2.27	9		
			7.2.1.5	7.2.1.5.1					
				7.2.1.5.2					
				7.2.1.5.3					
				7.2.1.5.4					
				7.2.1.5.5					
				7.2.1.5.6					
				7.2.1.5.7					
				7.2.1.5.8		2.45	1		
				7.2.1.5.9					
				7.2.1.5.10					
				7.2.1.5.11					
				7.2.1.5.12					
			7.2.1.6		1	3.76	1		
			7.2.1.7		4	2.51 j	1		
			7.2.1.8		3	2.51 k 3.69 3.7 a,b	4		
			7.2.1.9		2	2.51 i	1		
			7.2.1.10		4	2.51 m	1		

			7.2.1.11		3	-			
			7.2.1.12		2	-			
			7.2.1.13		1	2.51 a	1		
			7.2.1.14		1	2.51 n	1		
			7.2.1.15		7	2.51 o 8.6 8.2 2.26 d 2.51 I 3.7 a,b 2.27	8		
		7.2.2	7.2.2.1		1	2.2	1		
			7.2.2.2		4	2.8 a,b 2.9 a 2.10 2.11 2.15 2.47 2.49	8		
			7.2.2.3		6	2.48 2.42 2.45	3		
			7.2.2.4		6	2.43	1		
			7.2.2.5		5	2.51 2.47 3.58 2.14	4		

			7.2.2.6		6	2.3 j 2.46 3.66 3.77 3.78	5		
		7.2.3	7.2.3.1		1	2.19 2.22	2		
			7.2.3.2		1	-			
			7.2.3.3		3	2.18	1		
			7.2.3.4		1	-			
			7.2.3.5		1	2.19 2.20 2.40	3		
			7.2.3.6		1	-			
			7.2.3.7		1	2.18 2.20 a,b 2.40 d	4		
			7.2.3.8		1	2.23 2.29 2.30 2.33 2.34 2.37	6		
			7.2.3.9		3	2.23 2.24 2.25 2.26 3.65	5		

			7.2.3.10		1	2.26 I 2.9 a 2.35 2.36	4		
			7.2.3.11		1	-			
			7.2.3.12		1	2.26 I,j,k 3.14 a 6.67	5		
			7.2.3.13		1	8.5 8.2 8.10	3		
		7.2.4	7.2.4.1		1		1		
			7.2.4.2		4	3.5 3.6 3.7 3.8 3.9 3.10 3.12 3.14 3.17 3.51	10		
			7.2.4.3		11	-			
			7.2.4.4		5	-			
		7.2.5	7.2.5.1		1	2.5	1		
			7.2.5.2		1	-			
			7.2.5.3		2	2.5 a	1		

			7.2.5.4		3	2.5 b 2.5 C 2.5 d	3		
			7.2.5.5		4	2.5 e	1		
			7.2.5.6		1	2.5 f	1		
			7.2.5.7		2	2.5 g,h	2		
		7.2.6	7.2.6.1		1	2.39	1		
			7.2.6.2		1	2.4	1		
			7.2.6.3		1	-			
			7.2.6.4		2	-			
			7.2.6.5		1	-			
		7.2.7			1	-			
		7.2.8	7.2.8.1		3	-			
			7.2.8.2		4	2.41	1		
			7.2.8.3		5	-			
			7.2.8.4		1	-			
			7.2.8.5		2	2.43	1		
			7.2.8.6		2	3.77	1		
			7.2.8.7		9	-			
			7.2.8.8		2	-			
		7.2.9	7.2.9.1		1	-			
			7.2.9.2		2	-			
			7.2.9.3		1	-			
		7.2.10	7.2.10.1		2	-			
			7.2.10.2		2	-			
		7.2.11	7.2.11.1		1	-			
			7.2.11.2		1	-			

7.2.12	7.2.12.1		2	2.6 2.52 a 2.52 b 4.25	4		
	7.2.12.2		6	2.9 d 2.52 c,d,e 2.26 2.28 2.29 2.30 2.31 2.32 2.34 2.35 2.36 2.37 4.25 3.65 2.35 2.36 2.37 4.25 3.65	21		
	7.2.12.3		6	3.21	1		

		7.2.13	7.2.13.1		1	3.96 3.97 3.98 3.99 3.56 3.57 3.58 3.59 3.60 3.61 3.62 3.63	12		
			7.2.13.2		2	3.100 3.102 a,b,c,e	5		
			7.2.13.3		1	2.2	1		
			7.2.13.4		1	3.68 3.69 3.70	3		
			7.2.13.5		1	3.70 b	1		
			7.2.13.6		1	-			
			7.2.13.7		1	3.101	1		
			7.2.13.8		1	3.102 f,g 4.25	3		
			7.2.13.9		1	3.98	1		
			7.2.13.10		1	-			
			7.2.13.11		1	-			
			7.2.13.12		1	-			
7.3	Capacity of Means of Egress	7.3.1	7.3.1.1		1	2.38 a,b	2		

			7.3.1.2		1	2.3 h	1		
			7.3.1.3		1	-			
			7.3.1.4		1	2.4	1		
			7.3.1.5		1	-			
			7.3.1.6		1	-			
		7.3.2	7.3.2.1		1	2.11	1		
			7.3.2.2		1				
			7.3.2.3		1				
		7.3.3			1	2.8 a	1		
		7.3.4			3	2.9	1		
7.4	Number of Means of Egress	7.4.1	7.4.1.1			2.12 a	1		
			7.4.1.2			2.12 b	1		
			7.4.1.3			2.12 c	1		
			7.4.1.4			2.12 d	1		
			7.4.1.5			2.13	1		
			7.4.1.6			3.76	1		
		7.4.2	7.4.2.1		1	-			
			7.4.2.2		1	-			
7.5	Arrangement of Means of Egress	7.5.1	7.5.1.1		4	2.17	1		
			7.5.1.2		2	2.21	1		
			7.5.1.3		7	2.27 2.47 2.38	3		
			7.5.1.4		2	2.12 a,b	2		
			7.5.1.5		1				
			7.5.1.6		1	2.12	1		
		7.5.2	7.5.2.1		1	2.12 d	1		
			7.5.2.2		2	2.17 d, e	2		

		7.5.3			4	2.41 3.39	2		
		7.5.4			9	2.9 d	1		
7.6	Measurement of Travel Distance to exits	7.6.1			3	2.12 b	1		
		7.6.2			1	2.38	1		
		7.6.3				2.4 b,c	2		
		7.6.4				2.4	1		
		7.6.5				-			
		7.6.6				-			
		7.6.7				-			
7.7	Discharge from Exits	7.7.1			4	-			
		7.7.2			6	2.4 2.39 2.44 2.17 2.12 b	5		
		7.7.3			3	2.17	1		
		7.7.4			1	-			
		7.7.5			1	2.54 2.55 2.56	3		
		7.7.6			1	3.39 3.9	2		
7.8	Illumination of Means of Egress	7.8.1			2	2.53 a,b	2		
		7.8.2			2	2.53 c	1		
7.9	Emergency Lighting	7.9.1			3	2.53 a,b,	2		
		7.9.2			7	-			

		7.9.3				8.1 h 8.5 8.6	3		
7.10	Egress	7.10.1	7.10.1.1		1	2.54	1		
			7.10.1.2		2	2.55 2.56	2		
			7.10.1.3			2.17 a 2.54 2.55 2.56 C	4		
			7.10.1.4		1	-			
			7.10.1.5		2	2.54			
			7.10.1.6		1	-			
			7.10.1.7		1	-			
			7.10.1.8		1	2.56 a			
			7.10.1.9		1	-			
		7.10.2			2	2.56 b	1		
		7.10.3			1	2.56 C	1		
		7.10.4			1	2.56 d	1		
		7.10.5	7.10.5.1		1	-			
			7.10.5.2		2	2.56 a	1		
		7.10.6			3	-			
		7.10.7	7.10.7.1		1	-			
			7.10.7.2			2.56 d	1		
		7.10.8			5	-			
		7.10.9	7.10.9.1		1	8.1 g			
			7.10.9.2			8.5 8.6	2		

7.11	Special Provisions for Occupancies with High Hazard Contents’	7.11.1				3.12	1		
		7.11.2				3.12	1		
		7.11.3				-			
		7.11.4				-			
		7.11.5				-			
		7.11.6				-			
7.12	Mechanical Equipment Rooms, Boiler Rooms, and Furnace Rooms				1	3.14 a,b,d,e 6.65 6.66 6.46 6.67	8		
7.13	Normally Unoccupied Building Service Equipment Support Areas	7.13.1			2	-			
		7.13.2			3	2.27 2.45 2.51 a,b,c,d,e,f,g,h,I 2.52 e 3.62 3.68 3.69 3.70 a,b,c 3.74 3.76	20		
		7.13.3			8	2.38 2.17	2		
		7.13.4			2	2.53	1		

		7.13.5			3	2.13 2.12 a,b,d	4		
7.14	Occupant Evacuation Elevators	7.14				3.100 3.101 3.102	3		
		7.14.1			4	3.1	1		
		7.14.3	7.14.3.1		1	-			
			7.14.3.2		1	-			
			7.14.3.3		3	8.7 4.26	2		
			7.14.3.4						
		7.14.4	7.14.4.1		1	4.14	1		
			7.14.4.2		1	4.14	1		
			7.14.4.3		1	4.15 4.20 4.23	3		
			7.14.4.4		2	3.102 f 3.102 g 4.25	3		
		7.14.5	7.14.5.1		2	5.33 a, b	2		
			7.14.5.2			5.33 c	1		
			7.14.5.3			5.33 c	1		
		7.14.6			3	-			
		7.14.7			2	-			
		7.14.8	7.14.8.1		1	3.101 a,b	2		
			7.14.8.2			3.102 d	1		
			7.14.8.3			3.102 d	1		

		7.14.9	7.14.9.1		1	3.57 3.63 3.66	3		
			7.14.9.2		2	3.102 e	1		
			7.14.9.3		1	2.17	1		
			7.14.9.4		1	3.24 3.58 3.59 3.78 3.100 a	5		
			7.14.9.5		1	-			
			7.14.9.6		1	3.100 b	1		
			7.14.9.7		1	3.62 3.74 3.75 3.100 a	4		
			7.14.9.8		1	3.76	1		
			7.14.9.9		1	-			

Note: Comparison 01 depicts sub-clause by sub-clause comparion

Note: Comparison 02 depicts clause by clause comparion

Fully complied
Partially complied
Not Complied

Key Section	NFPA101		CIDA	Pertinent Reg. No	Case study 01	Case study 02	Case study 03
7.1	'General'		General	2.1			
	Separation of Means of Egress						
		7.1.3.1	2.3 (I) Exit passageway	2.3(l),			
			2.4 Determination of Exit Requirements	2.4			
	Exits	7.1.3.2	Exit	2.3 (g)			
	Interior Finish in Exit Enclosures	7.1.4	Class of Flame spread to be not Lower than Specified in Table	3.86			
	Headroom	7.1.5		2.42 (i)			
	Walking Surfaces in the Means of Egress	7.1.6					
	General	7.1.6.1		_			
	Changes in Elevation	7.1.6.2		_			
	Level	7.1.6.3		_			
	Slip Resistance	7.1.6.4		_			

	Change in Level in Means of Egress	7.1.7.1		–			
	If not in excess of 21 in (535 mm),	7.1.7.2	2.42 Internal Staircases	2.42 (ii)			
			2.40 Internal Exit Passageways	2.40 (c)			
	Guards	7.1.8		–			
	Impediments to Egress	7.1.9		2.51 (c)			
	Means of Egress Reliability	7.1.10		-			
	Maintenance	7.1.10.1	2.17 Location of Exists	2.17			
			2.39 Exit Passageways	2.39			
	Furnishing and Decorations in Means of Egress	7.1.10.2		–			
	Sprinkler System Installation	7.1.11	Commencement of the Installation	5.34			
7.2	'Means of Egress Components'	7.2	'Means of Escape'				
	Door Openings	7.2.1	2.51 Exit Doors	2.51 (a)		N/A	
				2.51 (b)			
				2.51 (c)			
			3.71 Door to be Manually Openable	3.71			
			3.72 Direction of Opening	3.72			

Occupied Building	7.2.1.1.3		_			
Door Leaf Width	7.2.1.2	2.9 Minimum widths	2.9 (a)			
			2.9 (b)			
			2.9 (c)			
		2.51 Exit Doors	2.51 (f)			
Floor Level	7.2.1.3		_			
Swing and Force to Open	7.2.1.4	2.51 Exit Doors	2.51 (d)			
			2.51 (e)			
			2.51 (f)			
			2.51 (g)			
			2.51 (h)			
			2.51 (i)			
		2.52 Area of Refuge	2.52 (e)			
		3.72 Direction of Opening	3.72			
		2.27 Exit Doors	2.27			
Locks, Latches and Alarm Devices	7.2.1.5		_			
	7.2.1.5.1					
	7.2.1.5.2		_			
	7.2.1.5.3		_			
	7.2.1.5.4		_			
Key-Operated Locks	7.2.1.5.5		_			

Electrically Controlled Egress Door Assemblies	7.2.1.5.6		–			
	7.2.1.5.7		_			
	7.2.1.5.8	2.45Facility for Re-entry	2.45			
	7.2.1.5.9		_			
	7.2.1.5.10		_			
	7.2.1.5.11		_			
	7.2.1.5.12		_			
Special Locking Arrangements	7.2.1.6		–			
			_			
			3.76	N/A	N/A	N/A
Panic Hardware and Fire Exit Hardware	7.2.1.7		2.51 (j)			
Self-Closing Devices	7.2.1.8	2.51 Exit Doors	2.51 (k)			
		Fire revisiting Doors	3.69			
		3.69 Application of Regulation				
		3.70 Provisions of Closing Devices and Non-Combustible Hinges	3.70 (a)			
			3.70 (b)			

Powered Door Leaf Operation	7.2.1.9		2.51 (l)			
Self-Closing or Self-Latching Door Leaf Operations						
Revolving Door Assemblies	7.2.1.10		2.51 (m)	N/A	N/A	N/A
Turnstiles and Similar Devices	7.2.1.11		–			
Door Openings in Folding Partitions	7.2.1.12		–			
Balanced Door Assemblies	7.2.1.13	2.51 Exit Doors	2.51 (a)		N/A	
Special-Purpose Horizontally Sliding Accordion or Folding Door Assemblies	7.2.1.14		2.51 (n)	N/A	N/A	N/A
Inspection of Door Openings	7.2.1.15	2.51 Exit Doors	2.51 (o)			
		8.6 Frequency of Testing of Fire Systems	8.6			
		8.2 Inspection and Maintenance	8.2			
		2.26 Pressurization Level	2.26 (d)			
		2.51 Exit Doors	2.51 (l)			

			3.70 Provisions of Closing Devices and Non-Combustible Hinges	3.70 (a)			
				3.70 (b)			
			2.27 Exit Doors	2.27			
	Stairs	7.2.2	Staircase Identification	2.2			
	7.2.2.2. Dimensional Criteria	7.2.2.2	2.8 Exit Requirements – Capacity of Exits and Exit Facilities	2.8 (a)			
				2.8 (b)			
			2.9 Minimum Widths	2.9 (a)			
			2.10 Maximum Widths	2.10.			
			2.11 Measurement Width	2.11			
			2.15 Number of staircase or Exit per Story	2.15	N/A		N/A
			2.47 Scissor Exit Staircase	2.47	N/A		N/A
			2.49 Spiral Staircases	2.49	N/A	N/A	N/A
			2.48 Hardwood Stairs	2.48			

	Stair Detail	7.2.2.3	2.42 Internal Staircases	2.42			
			2.46 Facility for Re-entry	2.45			
	Guards and Handrails	7.2.2.4	Handrails Balustrades etc.	2.43			
	Enclosure and Protection of Stairs	7.2.2.5	2.15 Number of staircase or Exit per Storey	2.15			
			2.47 Scissor Exit Staircase	2.47			
			3.58 Enclosure	3.58			
	7.2.2.5.4 Stairway Identification	7.2.2.5.4	Number of Staircases or Exits per Story	2.14			
	Special Provision for Outside Stairs	7.2.2.6	2.3(j) External Staircases	2.3(j)	N/A	N/A	N/A
			2.46 External Staircases	2.46	N/A	N/A	N/A
			3.66 Protected Shaft of Staircase	3.66			
			‘Staircases’				
			Non-Combustibility of Structure	3.77			

			Special Requirements for Buildings for Purpose Group I exceeding 3 storeys	3.78	N/A		N/A
	Smoke proof Enclosures	7.2.3	2.19 Smoke free Lobby	2.19			
			1.22 Smoke free Approach in basement	2.22	N/A	N/A	N/A
	Performance Design	7.2.3.2		_			
	Enclosure	7.2.3.3	Smoke Free Approach Staircase	2.18			
	Vestibule	7.2.3.4		_			
	Discharge	7.2.3.5	2.19 Smoke free Lobby	2.19			
			2.20 Fire Fighting Lobby	2.2o			
			2.40 Internal exit Passageways	2.40 (d)			
	Access	7.2.3.6		_	_		
	Natural Ventilation Smoke-proof enclosures with natural ventilation;	7.2.3.7	2.18 Smoke Free Approach Staircase	2.18			
			2.20 Fire-fighting Lobby	2.20 (a)			
				2.20 (b)			

			2.40 Internal exit Passageways	2.40 (d)			
	Mechanical Ventilation	7.2.3.8	2.23Pressurized system for Stairways	2.23			
			2.29(A) General Requirements	2.29			
			2.30(B) Additional Requirement	2.3o			
			2.33 Air duct Access and Inspection	2.33			
			2.34 Engineered Smoke Control System	2.34	N/A	N/A	N/A
			2.37 Fire Dampers	2.37	N/A	N/A	N/A
	Enclosure Pressurization	7.2.3.9	2.23Pressurized system for Stairways	2.23			
			2.24Pressurization of Exit stairway	2.24			
			2.25Pressurization of Internal corridors in hotels	2.25		N/A	
			2.26 Pressurization Level	2.26			
			3.65 Ventilation of Protected shaft	3.65			

Activation of Mechanical Ventilation and Pressurized Enclosure Systems	7.2.3.10	2.26 Pressurization Level	2.26 (I)			
		2.29(A) General Requirement	2.29 (a)			
		2.35 Activation	2.35	N/A	N/A	N/A
		2.36 Shut down of Air-conditioning systems	2.36			
Door Leaf Closures	7.2.3.11					
Emergency Power Supply System(EPSS)	7.2.3.12	2.26 Pressurization Level	2.26 (i)			
			2.26 (j)			
			2.26 (k)			
		3.14 Areas of Special Hazard	3.14(a)			
		6.67 Fuel Storage	6.67			
Testing	7.2.3.13	8.5 Testing of Active Fire Systems	8.5			
		8.2 Inspection and Maintenance	8.2			
		8.10 Documentation	8.1o			
Horizontal Exits	7.2.4	Provision of Compartment Walls and Compartment Floors				

	Fire Compartments	7.2.4.2	3.5 Excess floor area and cubicle extent	3.5		N/A	
			3.6 Compartmentation by height	3.6		N/A	
			3.7 Building Authority may Consent to Greater sizes	3.7			
			3.8 Excess Height	3.8			
			3.9 Other Cases requiring Compartment walls and Compartment Floors	3.9 (b)			
				3.9 (d)			
				3.9 (e)			
				3.9 (f)			
				3.9 (g)			
			Sizes limitations of buildings and				
			3.10 Compartmentation	3.1o			
			(a) Size Limitations	3.11 (a)			
			(b) Cubicle extent for Compartment exceeding 4m in height	3.11 (b)(2)	N/A	N/A	N/A
			3.12 High Hazard Occupancy	3.12			

		3.14 Areas of Special Hazard	3.14 (a)			
			3.14 (b)			
			3.14 (d)			
			3.14 (e)			
		3.17 Atrium Space	3.17	N/A	N/A	N/A
		3.51 Use of Fire Shutters and Curtains	3.51			
Fire Barriers	7.2.4.3		–			
Bridges Serving Horizontal Exits Between Buildings	7.2.4.4		–			
Ramps	7.2.5	Exit Ramps	2.5o	N/A	N/A	N/A
Vehicle Ramps If not an accessible means of egress exempt from below	7.2.5.2		–			
Dimensional Criteria	7.2.5.3		2.50 (a)			
Ramp Details	7.2.5.4		2.50 (b)			
			2.50 (c)			
			2.50 (d)			
Guards and Handrails	7.2.5.5	(a) Guards and Handrails:	2.50 (e)	N/A	N/A	N/A
Enclosure and Protection of Ramps	7.2.5.6	(b) Surface:	2.50 (f)			

Special Provisions for Outside Ramps	7.2.5.7		2.50 (g)			
			2.50 (h)	N/A	N/A	
Exit Passageways	7.2.6	Exit Passageways	2.39			
Enclosure	7.2.6.2	Internal exit Passageways	2.4o			
Stair Discharge	7.2.6.3		_			
Width	7.2.6.4		_			
Floor Solid without perforations	7.2.6.5		_			
Escalators and Moving Walks	7.2.7		_			
Fire Escape Stairs	7.2.8		_			
Protection of Openings	7.2.8.2	External exit Passageway	2.41			
Access	7.2.8.3		_			
Stair Details	7.2.8.4		Table 5(V), 5(VI) 5(VII)			
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Material and Strength	7.2.8.6	Non-combustibility of structure	3.77			
Swinging Stairs	7.2.8.7		_			
Intervening Spaces	7.2.8.8		_			
Fire Escape Ladders	7.2.9		_			

Construction and Installation	7.2.9.2		_			
Access	7.2.9.3		_			
Slide Escapes	7.2.10		_			
Capacity	7.2.10.2		_			
Alternating Tread Devices	7.2.11		_			
Area of Refuge	7.2.12	2.16 Exit Reduction	2.16			
		2.52 Area of Refuge	2.52 (a)			
			2.52 (b)	N/A	N/A	N/A
		4.25 Two-way telephone communication system with Fire Command Centre(FCC)	4.25			
Accessibility	7.2.12.2	2.9 Minimum Widths	2.9 (d)			
		2.52 Area of Refuge	2.52 (c)			
			2.52 (d)			
			2.52 (e)			
		2.26 Pressurization Level	2.26			
		2.28 Smoke Control System	2.28			
		2.29(A) General Requirements	2.29 (A)			

		2.30(B) Additional Requirement	2.30 (B)			
		2.31 (C) Ductless Jet Fan system in basement Car park	2.31 (C)			
		2.32 Fire Dampers	2.32			
		2.34 Engineered Smoke Control System	2.34	N/A	N/A	N/A
		2.35 Activation	2.35	N/A	N/A	N/A
		2.36 Shut down of Air-conditioning systems	2.36			
		2.37 Fire Dampers	2.37	N/A	N/A	N/A
		4.25 Two-way telephone communication system with ire Command Centre(FCC)	4.25			
		3.65 Ventilation of Protected shaft	3.65			
Details	7.2.12.3	3.21 Refuge Floors	3.21			

Elevators in Towers	7.2.13	Fire Lifts and Fire Fighting Shafts	3.96			
		3.96 General				
		3.97 Siting	3.97			
		3.98 Fireman's lift requirements	3.98			
		3.99 Fire Fighting Shafts	3.99			
		'Protected Shafts'				
		3.56 Protecting Structure	3.56			
		3.57 Use of Protected Shaft	3.57			
		3.58 Enclosure	3.58			
		3.59 Non-Combustibility of Protecting Structures	3.59			
		3.60 Openings in Wall or Floor of	3.60			
		3.61 Fire Stopping	3.61			
		3.62 Doors in Protected Structure	3.62			
		3.63 Protected Shaft for Lift	3.63			

Elevator Evacuation System Capacity	7.2.13.2	Evacuation Lifts				
		3.100 General	3.1oo			
		3.102 Evacuation Lift Requirements	3.102 (a)			
			3.102 (b)			
			3.102 (c)			
			3.102 (e)			
Elevator Lobby	7.2.13.3	Fire Fighting Lobby	2.2o			
Elevator Lobby Door Assemblies	7.2.13.4	"Fire Resisting Doors"				
			3.68			
			3.69			
		Provisions of Closing Devices and Non-Combustible Hinges	3.7o			
Door Leaf Activation	7.2.13.5		3.70 (b)			
Water Protection	7.2.13.6		_			
Power and Control Wiring	7.2.13.7	3.101 Power supply to fireman's lift and evacuation lift	3.101			
Communications	7.2.13.8		3.102 (f)			
			3.102 (g)			

			4.25 Two-way telephone communication system with Fire Command Centre(FCC)	4.25			
	Elevator Operation	7.2.13.9	3.98 Firemen's lift requirements	3.98			
	Maintenance	7.2.13.10		_			
	Earthquake Protection	7.2.13.11		_			
	Signage	7.2.13.12		_			
7.3	'Capacity of Means of Egress'	7.3	Means of Escape Requirements	2.38			
	Occupant Load	7.3.1		2.38 (a)			
	Sufficient Capacity	7.3.1.1		2.38 (b)		N/A	
	Occupant Load Factor	7.3.1.2		2.3 (h)			
	Occupant Load Increases	7.3.1.3		_			
	Exits Serving More than One story	7.3.1.4	Determination of Exit Requirements-General	2.4			
	Capacity from a Point of Convergence	7.3.1.5		_			
	Egress Capacity from Balconies and Mezzanines	7.3.1.6		_			

	Measurement of Means of Egress	7.3.2	2.11 Measurement Width	2.11			
	Egress Capacity	7.3.3	2.8 Exit Requirements – Capacity of Exits and Exit Facilities	2.8 (a)			
				2.8 (b)			
	Minimum Width	7.3.4	2.9 Minimum Widths	2.9			
7.4	'Number of Means of Egress'	7.4	Number of Exits from Rooms and Spaces	2.12			
	General	7.4.1	2.12 Number of Exits from Rooms and Spaces	2.12 (a)			
				2.12 (b)	N/A		N/A
				2.12 (c)	N/R	N/R	N/R
				2.12 (d)	N/R	N/R	N/R
			2.13 Number of staircases or Exits per Storey	2.13			
	Elevator Landing and Lobby Exit Access	7.4.1.6	3.76 Doors in Lift Shafts	3.76	N/A	N/A	N/A
	Space about Electrical Equipment	7.4.2		–			

7.5	'Arrangement of Means of Egress'	7.5					
	General	7.5.1	2.17 Location of Exists	2.17			
			2.21 Cross Ventilated Corridor	2.21	N/A	N/A	N/A
			2.27 Exit Doors	2.27			
			2.47 Scissor Exit Staircase	2.47	N/R		N/R
			2.38 Means of Escape Requirements	2.38			
			2.12 Number of Exits from Rooms and Spaces	2.12 (a)			
				2.12 (b)	N/A		N/A
	Impediments to Egress	7.5.2	2.17 Location of Exists	2.12 (d)	N/R	N/A	N/R
				2.17 (d)			
				2.17 (e)			
	Exterior Ways of Exit Access	7.5.3	2.41 External exit Passageway	2.41			
			3.39 References to Roofs	3.39			
	Accessible Means of Egress	7.5.4		2.9 (d)			

7.6			2.12 Number of exits from rooms and spaces	2.12 (b)	N/A		N/A
			2.38 Means of Escape Requirements	2.38			
			2.40 Internal exit passageways	2.40 (b)			
				2.40 (c)			
	'Measurement of Travel Distance to Exits'	7.6	Table 5 (IV)- maximum travel distance when minimum fire protection measures are provided				
			Table 5 (VIII) – dead-end travel distance				
7.7	'Discharge from Exits'	7.7					
	Exit Termination	7.7.1					
			2.40 Internal exit passageway	2.4o			
			2.39 Exit Passageways	2.39			

	Exit Discharge Through Interior Building Area	7.7.2	2.44 Ventilation	2.44			
			2.17 Location of Exists	2.17			
			2.12 Number of Exits from Rooms and spaces	2.12 (b)	N/R		N/R
	Arrangement and Marking of Exit Discharge	7.7.3	2.17 Location of Exists	2.17			
	Components of Exit Discharge	7.7.4		–			
	Signs	7.7.5	Exit and Directional Signs				
			2.54	2.54			
			2.55	2.55			
			2.56	2.56			
	Discharge to Roofs	7.7.6	3.39 References to Roofs	3.39			
			Roofs				
			Roof coverings and construction to be Non-Combustible				
			3.9o	3.9o	N/A	N/A	N/A
7.8	'Illumination of Means of Egress'	7.8	Emergency Lighting	2.53			
	General	7.8.1		2.53(a)			
				2.53 (b)			

	Source of Illumination	7.8.2		2.53 (c)			
7.9	‘Emergency Lighting’	7.9	Emergency Lighting	2.53			
	General	7.9.1		2.53 (a)			
				2.53 (b)			
	Performance of System	7.9.2					
	Periodic Testing of Emergency Lighting Equipment	7.9.3	8.1 Systems to be inspected, maintained and tested	8.1 (h)			
			8.5 Testing of Active Fire Systems	8.5			
			8.6 Frequency of Testing of Fire Systems	8.6			
7.10.	‘Marking of Means of Egress’	7.10.	Exit and Directional Signs				
	General	7.10.1					
	Where Required	7.10.1.1		2.54			
	Exits	7.10.1.2	2.55	2.55			
			2.56	2.56			
	Exit Door Tactile Signage	7.10.1.3	2.17 Location of Exists	2.17(a)			
			2.54 Exit and Directional Signs	2.54			
			2.55	2.55			
			2.56	2.56 (c)			

Existing Exemption Not apply to existing buildings	7.10.1.4		–	–		
Exit Access	7.10.1.5		2.54			
Floor Proximity Exit Signs	7.10.1.6		_			
Floor Proximity Egress Path Marking	7.10.1.7		–			
Visibility	7.10.1.8		2.56 (a)			
Mounting Location	7.10.1.9		--			
Directional Signs	7.10.2		2.56 (b)			
Sign Legend	7.10.3		2.56 (c)			
Power Source	7.10.4		2.56 (d)	N/A	N/A	N/A
Illumination of Signs	7.10.5					
General	7.10.5.1		_			
Continuous Illumination	7.10.5.2		2.56 (a)			
Externally Illuminated Signs	7.10.6		_			
Size of Signs	7.10.6.1		_			
Size and Location of Directional Indicator	7.10.6.2		–			
Level of Illumination	7.10.6.3		-			
Internally illuminated Signs	7.10.7		-			
Listing	7.10.7.1		_			
Photo-luminescent Signs	7.10.7.2		2.56 (d)	N/R	N/R	N/R
Special Signs	7.10.8		-			
Sign Illumination	7.10.8.1		_			

	Characters	7.10.8.2		–			
	No Exit	7.10.8.3		–			
	Elevator Signs	7.10.8.4		–			
	Evacuation Diagram	7.10.8.5		–	–		
	Testing and Maintenance	7.10.9	Systems to be inspected, maintained and tested	8.1			
	Inspections	7.10.9.1		8.1 (g)			
	Testing	7.10.9.2	8.5 Testing of Active Fire Systems	8.5			
			8.6 Frequency of Testing of Fire Systems	8.6			
7.11	'Special Provisions for Occupancies with High Hazard Contents'	7.11		–			
	(Storage, High hazard) Travel distance to a safety place/outside not more than 75ft(23m),	7.11.1	High Hazard Occupancy	3.12			
	7.11.1 not apply to storage occupancies	7.11.2					

	Egress capacity for Stairs 0.7in.person (18mm/person) or 0.4in/person (10mm/person) for level components and ramps	7.11.3		–			
	Minimum 02 means of egress unless following are met,	7.11.4		–			
	No dead ends in corridors	7.11.5		-			
	Doors for occupancy load ≥5 persons permitted with panic hardware latch or lock only	7.11.6		–			
7.12	‘Mechanical Equipment Rooms, Boiler Rooms, and Furnace Rooms’	7.12	3.14 Areas of Special Hazard	3.14 (a)			
				3.14 (b)			
				3.14 (d)		N/A	
				3.14 (e)			
			Areas of Special Risk in any Building				
			6.65 Separation and Permissible Openings	6.65			
			6.66 Areas of Special Risk in Basements	6.66			
			6.46Fire Brigade Foam Inlets	6.46			

			6.67 Fuel Storage	6.67			
7.13	'Normally Unoccupied Building Service Equipment Support Areas'	7.13					
	Hazard of Contents	7.13.1					
	Egress Doors	7.13.2	2.27 Exit Doors	2.27			
			2.45 Facility for Re-entry	2.45			
			2.51 Exit Doors	2.51 (a)		N/A	
				2.51 (b)			
				2.51 (c)			
				2.51 (d)			
				2.51 (e)			
				2.51 (f)			
				2.51 (g)			
				2.51 (h)			
				2.51 (j)			
			2.52 Area of Refuge	2.52 (e)			
			3.62 Doors in Protected Structure	3.62			
			Fire revisiting Doors	3.68			
			3.68 Application of Regulation	3.69			

			3.70 Provisions of Closing Devices and Non-Combustible Hinges	3.7o			
			3.74 Two Separate Doors to One Opening	3.74			
			3.76 Doors in Lift Shafts	3.76	N/A	N/A	N/A
	Means of Egress Path	7.13.3	Means of Escape Requirements	2.38			
			2.17 Location of Exists	2.17			
	Illumination	7.13.4	Emergency Lighting	2.53			
	Number of Means of Egress	7.13.5	2.13 Number of Staircases or Exits per Storey	2.13			
			2.12 Number of Exits from Rooms and Spaces	2.12 (a)			
				2.12 (b)	N/A		N/A
				2.12 (d)	N/R	N/R	N/R
7.14	'Occupant Evacuation Elevators'	7.14	'Evacuation Lifts'				
			3.100 General	3.1oo			
			3.101 Power supply to fireman's lift and evacuation lift	3.101			

			3.102 Evacuation Lift Requirements	3.102			
	General	7.14.1	3.100 General	3.1oo			
	Information Features	7.14.3		_			
	Condition for Safe Continued Operation	7.14.3.3	8.7 Responsible Person for Fire Systems in buildings	8.7			
			4.26 Fire Command Centre(FCC)	4.26			
		7.14.3.4		_			
	Fire Detection, Alarm and Communication	7.14.4	'Fire Alarm Control Panel (FACP)'				
			4.14 Location	4.14			
			4.15 Power Requirement	4.15			
			'Voice Evacuation System'				
				4.2o			
			4.23 Control of Voice Evacuation System	4.23			
			3.102 Evacuation Lift Requirements	3.102(f)			
				3.102 (g)			

	Two-way Communication System	7.14.4.4	4.25 Two-way telephone communication system with Fire Command Centre(FCC)	4.25			
	Sprinklers	7.14.5	'Automatic Sprinkler Systems'	5.33 (a)			
			General 5.33	5.33 (b)			
				5.33 (c)	N/R	N/R	N/R
	Elevator Installation	7.14.6		–			
	Elevator Machine/Control Rooms and Machinery/Control Spaces	7.14.7		–			
	Electrical Power and Control Wiring	7.14.8	3.101 Power supply to fireman's lift and evacuation lift	3.101(a)			
				3.101(b)			
			3.102 Evacuation Lift Requirements	3.102(d)			
			3.57 Use of Protected Shaft	3.57			
			3.63 Protected Shaft for Lift	3.63			

Occupant Evacuation Shaft System	7.14.9	3.66 Protected shaft of staircase (Protected shaft containing exit staircase)	3.66			
Elevator Lobby Size	7.14.9.2	Evacuation Lift Requirement	3.102 (e)			
Access to the Exit Stair	7.14.9.3	2.17 Location of Exists	2.17			
The Occupant evacuation shaft system	7.14.9.4	Fire Resistance of Elements Of Structure				
		3.24 Minimum Period of Fire Resistance	3.24			
		3.58 Enclosure	3.58			
		3.59 Non-Combustibility of Protecting Structures	3.59			
		3.78 Special Requirements for Buildings for Purpose Group I exceeding 3 storeys	3.78	N/A		N/A
		3.100 (a) General	3.100(a)			

	Construction of occupant evacuation shaft system enclosures should provide min: of classification level 2	7.14.9.5		–			
	Elevator lobbies should be waterproofed	7.14.9.6		3.100 (b)			
	Occupant evacuation shaft system elevator lobby doors should have,	7.14.9.7	3.62 Doors in protected Structure	3.62			
			3.74 Two Separate Doors to One Opening	3.74			
			3.75 “Deemed to Satisfy” Provisions	3.75			
			3.100 (a)	3.100 (a)			
	All elevator lobby doors should,	7.14.9.8	3.76 Doors in Lift Shafts	3.76	N/A	N/A	N/A
	Vision Panel	7.14.9.9		2.51 (g)			