“ACTIVE FIRE PROTECTION FOR A HOSPITAL BUILDING”

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Abstract: The main objective of firefighting Design of buildings should be assurance of Life safety, property protection and continuity of operations of functioning. Fire protection system are some of the Most ignored, underutilized, and misunderstood technologies available to protect life and property today. Although the requirements for these system has been codified and the benefits of installing fire protections system to protect life and property in all types of structures are widely acknowledge, fire protection remain of the little or no interest to some people include the public. Perhaps it is because many people are unaware of their existence and function or if they are aware, rarely consider how important the fire protection system is to their safety. Perhaps in some design professionals, minds, fire protection systems are not aesthetically pleasing or they lack the knowledge and understanding of the benefits they have when installed. Two ways to overcome the misinformation is to provide education and information about the firefighting systems. Although health care facilities still represent a small percentage of the total building stock, in case of fire they have a disproportionate impact on the public who disproportionate impact on the public who occupy the building and on the public who occupy the building and on surrounding. So there is need to introduce the firefighting system in the new hospitals and retrofit the existing buildings with comprehensive equipment’s of firefighting. This project specially focuses on the different types of active fire protection system and components, and their operational characteristics.

CHAPTER 1

INTRODUCTION:

RECENT FIRE ACCIDENTS IN HOSPITALS:

Due to lack of among awareness public about the firefighting systems, fire spreads easily in the building causing loss of lives and property. List of some of the fire accidents in hospitals is given below:
August 2020: 8 Patients killed in fire at ICU in Ahmedabad COVID Hospital.
October 2012: A fire in the geriatric section of a hospital in Taiwan, Taiwan claims the lives of 12.
December 2011: At least 93 die in a fire in a Calcutta hospital.
September 2009: A fire at a drug addiction clinic in Kazakhastan causes the deaths of at least 38 patients.
May 2009: A fire at a hospital in the Turkish city of bursa claims the lives of eight patients in an intensive care unit. Many of those rescued, including newly born babies, suffer from smoke inhalation.
March 2007: A fire in a home for the aged in Russia’s Krasnodar region causes the death of 62 largely bed-ridden men and women.
December 2006: Smoke inhalation causes the deaths of 46 women held in a Moscow clinic for addition after a fire breaks out at night. The escape routes were closed off and the window barred.

NEED FOR THIS STUDY: Fire protection systems may not be apparent in many buildings, but they stand ready to raise the alert, control, or even extinguish a fire. A basic knowledge and understanding of these systems may offer an alternative method for protecting the contents of a property because there are different types of fire protection systems available that use different types of fire protection system available that use different detection techniques and suppression agents other than water. Some not only detect fire at the very earliest stages, but they also to control and suppress in a way that avoids additional damage to the surrounding area. Generally people who come to hospital are with some health problems. In case of fire, they cannot be evacuated easily. Hence, having a firefighting system in hospital is viral.

OBJECTIVE:

- Study the design criteria and fire safety standards required for a hospital.
- Study the fire safely techniques and methods used in existing hospital buildings.
- Analyse the pros and cons of fire safety design in existing hospital buildings.
- Design the sophisticated firefighting systems for hospital building and introducing green technology where possible.
- Achieve the design in compliance with standards and norms for hospital buildings in India.

CHAPTER 2
LITERATURE REVIEW:

2.1. Science of fire:
For many years, the “fire triangle” (oxygen, fuel, and heat) was used to teach the components of fire. While this simple example is useful, it is not technically correct. For combustion to occur, four components are necessary:

Oxygen (oxidizing agent)
Fuel
Heat
Self-sustained chemical reaction (also referred to as the chain reaction)

These components can be graphically described as the “fire tetrahedron”. Each components of the tetrahedron must be in place for combustion to occur. This concept is extremely important to fire suppression personnel. Remove any one of the four components and combustion will not occur. If ignition has already occurred, the fire is extinguished when one of the components is removed from the reaction.

2.2 FIRE EXTINGUISHMENT THEORY:
The extinguishment of fire is based on an interruption of one or more of the essential elements in the combustion process. With flaming combustion the fire may be Extinguishment by reducing temperature, eliminating fuel or oxygen, or by stopping the uninhibited chemical chain reaction. If a fire is in the smouldering mode of combustion, only three extinguishment options exist: reducing of temperature, elimination of fuel or oxygen.

2.3 CLASSIFCATION OF FIRES AND EXTINGUISHMENT METHODS:
Class A Fire – Fires involving ordinary combustible material, such as wood, cloth, paper, rubber and many plastics.

Water is used in a cooling or quenching effect to reduce the temperature of the burning material below its ignition temperature.

Class B fires – fires involving flammable liquids, greases and gases.
This fire can sometimes be controlled by a non-conducing extinguishing agent. The safest procedures are always to attempt to de-energize high voltage circuits and treat as a class A or B fire depending upon the fuel involved.

Class D fires – fires involving combustible metals, such as magnesium, titanium, zirconium, sodium and potassium.
The extremely high temperature of some burning metals makes water and other common extinguishing agents ineffective. There is no agent available that will effectively control fires in all combustible metals. Special extinguishing agents are available for control of fire in each of the metals and are marked specifically for that metal.

Class K fires – Class K is a new classification of fire as of 1998 and involves

Fires in combustible cooking fuels such as vegetable or animal fats.
Its fuels are similar to class B fuels but involve high temperature cooking oils and therefore have special characteristics. Class

2.1.5. Fire alarm systems:
An automatic fire alarm system is designed to detect the unwanted presence of fire by monitoring environmental changes associated with combustion. In general, a fire alarm system is classified as either automatically actuated, manually actuated, or both. Automatic fire alarm systems are intended to notify the building occupants to evacuate in the event of a fire or other emergency, report the event to an off-premises location

2.2 Design of firefighting:
2.3.1. Hydrants:
As based from the general purpose of delivering water for firefighting, the hydrant design selected must be based on a number of operational elements. Some issues to consider include:
- How much water (GPM or L/min) is needed for fire-fighting?
- How many and what size hose connections are required.
- The established hose sizes and coupling threads in the region.

K agents are usually wet chemicals, water based solutions of potassium carbonate based chemical, potassium acetate- based chemical, or potassium citrate-based chemical or a combination.
- Current (and future) configuration of fire apparatus.
- Issues of clearance and visibility.
- Operating characteristics of the hydrants.
- Amount of head (static pressure) that is present in the system.

- Climate conditions in the area.

2.3.2. Dry Riser:

A dry riser is in effect an empty vertical pipe which becomes a firefighter's hose extension to supply hydrants at each floor level. Risers should be disposed so that no part of the floor is more than 60 m from a landing valve. This distance is measured along a route suitable for a firefighting hose line, to include any dimension up or down a stairway. Buildings with floors up to 45 m above fire service vehicle access level require one 65 mm landing valve on each floor from 100 mm i.e. riser. Building between 45 m and 60 m a wet riser must be installed. Two 65 mm i.e. inlet. Hose couplings are required for a 100 mm riser and four 65 mm i.e. inlets are required for a 150 mm riser. The riser must be electrically bonded to earth.

2.3.3. Wet Riser Requirements:

A permanently charged rising pipe 100mm in diameter or greater supplies a 65mm instantaneous valved outlet terminal at each floor at a pressure of between 410 and 520 kPa. The upper pressure limit is to protect the fire brigade Hoses from busting and is achieved by fitting an orifice plate restriction before the landing valve on the lower floors of a tall building. The maximum static pressure in system when all the landing valves are shut is limited to 690 kPa by recirculating water to the supply tanks through a 75mm return pipe.

2.4 SPRINKLER SYSTEM:

A fire sprinkler system is an active fire protection measure, consisting of a water supply system, providing adequate pressure and flow rate to a water distribution piping system, onto which fire sprinklers are connected. Although historically only used in factories and large commercial buildings, home and small building systems are not available at a cost-effective price.

2.4.1. Type of Sprinkler system:

- **Wet pipe systems.**
- **Dry pipe systems.**
- **Deluge systems.**
- **Pre-action systems.**
- **Foam water sprinkler systems.**
- **Water spray.**
- **Water mist system.**

2.4.2. Design of sprinkles systems:

Sprinkles systems are intended to either control the fire or to suppress the fire. Control mode sprinklers are intended to control the heat release rate of the fire to prevent building structure collapse, and pre wet the surrounding combustibles to prevent fire spread. The fire is not extinguished until the burning combustibles are exhausted until the burning combustibles are exhausted or manual extinguishment is effected by firefighters. Suppression mode sprinklers (formerly known as early suppression fast response (ESFR) sprinklers) are intended to result in severe sudden reduction of heat release rate of the fire, followed quickly by complete extinguishment, prior to manual intervention.

2.5 Hose reels connectivity:

Hose reels are firefighting equipment for uses as a first – aid measure by building occupants. They should be located where users are least likely to be endangered by the fire, i.e. the staircase landing. The hose most distant from the source of water should be capable of discharging 0.4 I/S at 6 m distance from the nozzle, when the two most remote hose reels are operating simultaneously. A pressure of 200 kPa is required at the highest reel. If the water main cannot provide this, a break/suction tank and booster pumps should be installed. . The tank must have a minimum volume of water of 1.6 m 3 A 50 mm i.e. supply pipe is adequate for buildings up to 15 m height and a 65 mm i.e. pipe will be sufficient for buildings greater than this. Fixed or swinging hose reels are located in wall recesses at a height of about 1 m above floor level. They are supplied by a 25 mm i.e. pipe to 20 or 25 mm i.e. reinforced non-kink rubber hose in lengths up to 45 m to cover 800 m 2 of floor area per installation.

2.6. Gas Extinguishing Systems:

- **Halon and Halon Substitutes**
- **Carbon Dioxide**

2.7. Fire detectors and alarms:

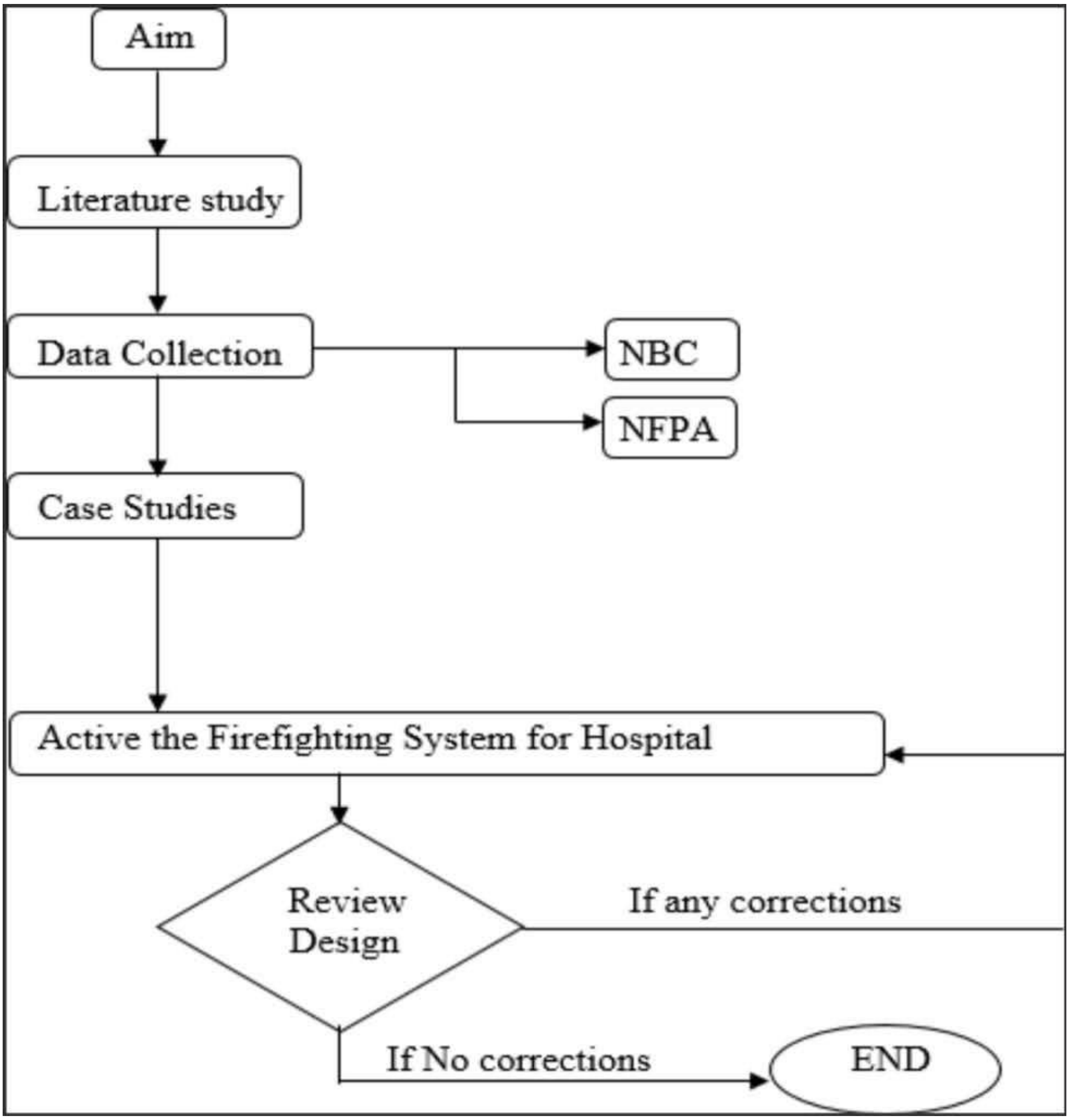
Detection of a potentially dangerous rise in air temperature or pressure or the presence of smoke is required at the earliest possible moment to start an alarm. Of the building and manual or automatic contact with the fire brigade monitoring switchboard should take place before people are at risk. Means of detection can be combined with security surveillance. Fire detection takes the following forms.

- **Hazard detectors:**
  1. Temperature rise
  2. Flammable vapour detector:

3. Diffusion
4. Explosion
5. Ionization smoke detector
6. Visible smoke detector
7. Laser beam
8. Closed-circuit television

CHAPTER 3

METHODOLOGY:



CHAPTER 4
FUTURE TRENDS AND EMERGOING TECHNOLOGY:

4.1 Fire Suppression System:

Novec 1230 Clean Agent:
Using water as a fire suppressant in areas where electronics operate and replaceable, high-value assets are stored could be as devastating as fire itself. Protect them instead with a clean agent system, custom-engineered to quickly suppress fires and protect sensitive equipment without causing harm to people or the environment. The heart of the system is revolutionary 3M™ Novec™ 1230 fire protection fluid. Stored in cylinders in its fluid form, Novec 1230 instantly vaporizes upon discharge, totally flooding protected spaces and absorbing heat better than water. The Novec 1230 system suppresses a fire before it can start by detecting it at invisible levels. And once the danger has passed, Novec 1230 quickly evaporates without harming any valuable assets. Novec 1230 supression systems represent the most effective fire protection on the market today. These systems are especially suited to suppress fires in areas where an electrically non-conductive medium is required, where electronic systems cannot be shut down in an emergency, where cleanup of other agents poses a problem, and in normally occupied areas that demand a non-toxic agent.

Water Mist:
Water is an outstanding fire suppression agent due to its high heat capacity and latent heat of vaporization.

4.2 Fire Detection and Alarm Systems
Exit Marking Audible Notification:
In an emergency, speedy evacuation is critical. NOTIFIER's ONYX Exit Point audible exit technology can reduce evacuation times, preventing injuries and saving lives. ONYX Exit Point acts as audible exit sign that helps building occupants pinpoint the nearest exit location and guides them to the building exit quickly, reliably and safely even when visibility is impaired.

Video Image Smoke Detection:
Video Imaging Smoke Detection (VISD) systems have been developed to overcome many of the problems associated with smoke detection. It provides solution for previously unsolvable fire detection scenarios, working externally as well as internally and represents a true technological breakthrough in fire detection. VISD is based on the computer analysis of video images identifying the particular motion pattern of smoke or flames and alerts the system operator to its presence in the shortest time possible. This enables a fast response to a potential fire, saving valuable time even in massive spaces or where a high airflow may be present

CHAPTER 5
CASE STUDY:

Fortis Hospital:
Location: Fortis Hospital, Mulund
No. Of Floors: Cellar + G + 11
No. of beds 300
Height of the building: 36.6M
Distance from nearest Fire Station: 2.0kms (Mulund Fire station)

5.1 Fire tank capacity calculations:
Total number of people occupying: Beds 300 + visitors 300 = 600
Employees (Doctors, nurses, administration, O & M dept.) = 700
Students = 150 Residents =150
Total = 1900
NBC Standard for portable water for more than 100 beds hospital = 450lit/head/day.
Roof tank storage for firefighting: 20% of drinking water storage = 427500 X (20/100) = 85,500 lit.
Fire water storage tank @ground level:
Ground water storage tank (2hours) = 399200 Say 4, 00,000 lit

5.2 PUMPS:
According to National Building Code (NBC 2005) for Intuitional buildings above 24m Two electric and one diesel pump of capacity 2280 lit/min and one electric pump of capacity 180 lit/min are required.
As per NFPA 20:
Fire water tank Volume = gallons x 0.0037854 m3/gal. = 103620 x 0.0037854 = 393 m 3

Fire Pump design:
Pump design calculations
Pump HP
HP= (Q x H)/ 3960 Where, H= Total head (ft.) HP = Horse power Q = Flow rate or Discharge (GPM)

HP = (3454 x 143)/ 3960 = 124.72 say 125 HP
Diesel fuel tank capacity = ~ 510 lit.

5.3 YARD HYDRANTS:
Two yard hydrants are provided with main pipe of 100dia connecting the landing valve with a 80mm pipe. Landing valve is installed at a height of 1.2m.

5.4 WATER MONITOR:
Four water monitors are to be provided on ground floor.

5.5 WET MONITOR:
A riser of 150dia is installed with landing valves on each floor-landing for firefighting purposes and permanently charged with water from a pressurized supply in the building.

HOSE REEL DRUM AND PIPE:
Hose reel pipe of 30m length and 19mm which is reeled to a Hose drum is installed at every landing valve.

HOSE PIPE:
Besides the hose reel drum and yard hydrants at every landing valve two hose pipes of 15m length and 63mm along with a nozzle of 20mm that can be fitted to the hose pipe are provided in the hose cabinet.

5.6 SPRINKLERS:
As per NBC, an institutional building which is more than 24m in height should have sprinkler system installed. Entire building is designed with sprinkler system except some spaces which are sensitive to water. i.e., it may react with other substances and cause damage to the property.

- In cellar and corridors of all floors sprinklers are designed for every 3m distance between sprinklers whereas in light hazard areas like waiting rooms 3 to 4m distance between sprinklers is taken into consideration for design.
- To know where to install the reducer pipe diameters are mentioned in the drawings.
- Electrical room, science labs, kitchens are excluded from sprinkler system design.
- 150 sprinkler riser is used in the design.

5.7 FIRE ALARM AND DETECTORS:
SMOKE DETECTOR: depending on the activity, in corridors and in spaces where provision of sprinkler system is not possible smoke detectors are placed for every 7m.

HEAT DETECTORS: since the activities that are happening in the cellar are more hazardous, entire cellar is covered by the heat detection system. For every 7m a heat detector is to be placed. After cellar next more hazardous area in the building is kitchen. Heat detectors must be installed in kitchen too.

MANUAL CALL POINT (MCP): MCP’s are provided on each floor in corridors and near lift with travel distance less than 22.5m. They must be installed at 1.2m height from the finished floor level.

HOOTER: Hooters are installed on each floor near in corridors with travel distance less than 22.5m. They should be installed at 2m height.

5.8 FIRE EXTINGUISHER:
Where the vulnerability of fire is more and in places which are easy to access like corridors, ABS rated portable fire extinguishers are provided.

5.9 DRAIN PIPE:
A 50mm drain riser is installed and connected to the sprinkler branch pipes from each floor with necessary valve installations to remove water in the sprinkler pipes for maintenance/repair.

5.10 WATER CURTAIN SYSTEM:
Hospital building is attached with commercial area up to first floor. Due to deficiency of the setbacks around the hospital building water curtain system is designed. For every two meters water curtain nozzles should be installed at first level of the building as shown in drawing. As per NFPA 13 standard pressure for water curtains is 37 I/min.

5.11 NOVEC 1230(clean agent): this gas suppression system is designed for only in library, Auditorium on eleventh floor and store on sixth floor in this building
NOVEC 1230 Quantity required – 225 kg

5.12 Number and size of nozzles-

Number of nozzles:

Total Volume of hazard area / coverage area of each nozzle
360^0 pattern: 418.52 / 450=0.95 say 1 + 1 factor of safety = 2
180o pattern: 418.52 / 560=0.74 say 1
Nozzle size:
Agent flow = 22.5 kg/s
Nozzle size = 65 mm

CHAPTER 6
CONCLUSION:

1. Fire protection system provide a superior degree of life safely and property protection that is under unmatched by any other construction methods or material. Hence there is always a need to know about these fire protection systems and I have attempted to include all the know active fire protection system in this project.
2. Using the novec 1230 gas suppression system (clean agent) design and data in this project is to create awareness about global warming issues with the uses of inert gases in the building services.
3. I have successfully attempted the design of all that active fire protection system required for a hospital building in compliance with the standards and codes.

CHAPTER 7
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