FUNDAMENTALS OF FIRE SAFETY

BEHAVIOURAL ASPECTS AND CONTROL MITIGATION MEASURES IN HIGH RISE BUILDINGS

V RAVINDRANATH

NATIONAL FIRE PROTECTION ASSOCIATION, USA, CERTIFIED FIRE PROTECTION SPECIALIST
What is Fire safety ???
Why is Fire safety important ???
How to ensure fire safety ???

What happened in the past few years ???
Let us take a tour.....
Date of tragedy: 23rd March 2010
Fatalities: 43
AMRI HOSPITAL - KOLKATA

Date of tragedy: 9\textsuperscript{th} December 2011
Fatalities: 95, mainly due to asphyxiation
Fire started in the basement, where flammable substances were stored
CARLTON TOWERS - BANGALORE

Date of tragedy: 23rd February 2010
Fatalities: 9 (3 jumped from upper floors to escape the blaze)
Fire started on the 3rd floor, smoke engulfed the upper floors

Reason: Blatant disregard for fire safety rules and regulations by the building owners.
Preliminary investigations revealed at least three glaring violations:

1. Deviations from the approved municipal plan – corridors encroached to form large office spaces
2. 10 – 15 Diesel Generators (DG) installed on the terrace - several barrels of diesel stored to power the DGs
3. Exit routes and emergency exit staircases locked – preventing egress
The Code of Hammurabi...King Hammurabi, Babylonian ruler approx. 1795 to 1750 B.C.

Courtesy NFPA FP Hand Book
CODES & STANDARDS FOR BUILT ENVIRONMENT

FIGURE 1.3.2 The Great Earthquake and Ensuing Conflagration That Devastated San Francisco in 1906
The first building code was developed in Boston, Massachusetts in 1631.

First volunteer fire department set up in 1736, in Philadelphia, Pennsylvania.

Fire & building codes for construction materials developed in 1871, after the Great Chicago Fire.

Sprinkler system concept first designed in 1812 – first automatic sprinkler system patented in 1872.

WHERE ARE WE AFTER A CENTURY....

Garment Factory fire – Dhaka

- Date of the tragedy: 24\textsuperscript{th} November, 2012
- Fire started in a restaurant and adjacent kitchen
- Fatalities: 117
- Major deaths occurred due to narrow and blocked exits
COMPONENTS OF FIRE SAFETY

- Fire detection system
- Fire Protection system
  - Passive fire protection – compartmentation
  - Active fire protection
    - Portable fire extinguishers
    - Fire Hydrants
    - Automatic sprinklers
    - Water spray system
THE FIRE CURVE

- Incipient stage
- Smoldering stage
- Flaming stage
- Fully developed stage
- Degradation stage

Temp

Time
THE FIRE CURVE, HOW IT HAS CHANGED OVER YEARS

Modern room - The floor covered with carpet. The furnishings included polyester microfiber covered polyurethane foam filled sectional sofa, engineered wood coffee table, end table, stand, remove, synthetic plant, magazines, and book case.

Legacy room - The hardwood floor without any furnishing. The furnishings included cotton covered batting filled sectional sofa, solid wood coffee table, end tables, television stand, remove, synthetic plant, magazines, and book case.

Reference: UL, research paper
THE FIRE CURVE, HOW IT HAS CHANGED OVER YEARS

Reference: UL, research paper
What is a fire detection system?

- A system which detects the presence of fire conditions in the enclosure, verifies the same and confirms the presence of fire conditions by raising the alarm.

What is its purpose?

- To detect fire in the early stages
- To alert occupants / fire service dept.
- To activate automatic extinguishing systems
Why is fire detection important?

- Undetected fire can grow to a large size.
- Toxic emissions from fire can kill people.
- Fire can damage property and contents in the building.
- Business Disruption.
FIRE DETECTION SYSTEM

Types of detection system devices

Smoke Detectors
- Optical type
- Linear beam type
- Air sampling type

Heat Detectors
- Fixed temperature type
- Rate of rise type
- Linear heat sensing cables
- Rate of rise cum fixed temperature type

Radiation/Flame detectors
- UV detectors
- IR detectors
What is fire compartmentation?

- National Fire Protection Association (NFPA) defines compartmentation as “Subdivision of building into fire tight cells or compartments enclosed by boundary of structural and constructional components with the necessary fire endurance characteristics.”
- Means to restrict spread of fire from one area to another.
FIRE COMPARTMENTATION

How is fire compartmentation achieved?

- Develop the Fire Compartmentation Plan at the **design stage** of the building.
- Divide the Building into several zones/ risk areas – “Fire Compartments” as required by the codes and guidelines
- Each Fire Compartment is separated from the other by fire resistant elements such as fire walls, fire doors, fire dampers, etc.
FIRE COMPARTMENTATION
Simulation of the Windsor Tower fire
MEANS OF ESCAPE

- Almost 74% of fire deaths have been due to panic and inhalation of smoke and other toxic fire gases.

- Causes of deaths
  ✓ Inadequate exiting arrangements
  ✓ Exits kept locked preventing people from escaping
  ✓ Inhalation of toxic gases such as Carbon monoxide, hydrogen cyanide (burning of plastics), phosgene (vinyl materials), etc.
### MEANS OF ESCAPE

<table>
<thead>
<tr>
<th>When oxygen levels are at...</th>
<th>a person experiences:</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 percent</td>
<td>Normal outside air</td>
</tr>
<tr>
<td>17 percent</td>
<td>Impaired judgment &amp; coordination</td>
</tr>
<tr>
<td>12 percent</td>
<td>Headache, dizziness, nausea, fatigue</td>
</tr>
<tr>
<td>9 percent</td>
<td>Unconsciousness</td>
</tr>
<tr>
<td>6 percent</td>
<td>Respiratory arrest, cardiac arrest, death</td>
</tr>
</tbody>
</table>

*Percentage values are approximate and do not reflect actual conditions.*
MEANS OF ESCAPE

- A means of egress (escape) is a continuous and unobstructed way of travel from any one point in a building or structure to a public way.

- Can be achieved using:
  - Fire escape routes
  - Fire Exit doors
  - Fire Exit Staircases

- To be planned at the design stage of the building
Exit width design considerations:

- National Building Code (NBC) prescribes sizes of exit staircases based on occupancy classification.
  - (E.g. Minimum two exits in opposite direction to be available for every person on all floors or sections to go out of the building in the event of fire.)

- NFPA 101 uses a calculative approach depending on the occupant load in a specific area.
MEANS OF ESCAPE – NFPA’S Approach
FIRE PROTECTION

- Portable fire extinguishers
- Fire Hydrants
- Automatic Sprinklers
- Water spray system
FIRE EXTINGUISHMENT

- **Smothering** – Removal or dilution of air or oxygen to a point where combustion ceases.
- **Cooling/Quenching** – Cooling of the fuel to a point where combustible vapours are no longer produced.
- **Starvation** – Removal of fuel to a point where there is nothing remaining to oxidize.
- **Inhibition of chain reaction** – Interruption of the flame chemistry of the chain reaction of combustion by injection of chemical compounds.
CLASSES OF FIRE

- **Class A**: Ordinary combustibles (wood, cloth, paper, etc.)
- **Class B**: Flammable liquids & flammable gases (HSD, gasoline, oil-based paints, etc.)
- **Class C**: Energized electrical equipment
- **Class D**: Combustible metals (Magnesium, titanium, sodium, etc.)
- **Class K**: Cooking media such as cooking oil, fats, etc.
PORTABLE FIRE EXTINGUISHERS

- Water type - Class A fires
- Foam type - Class B fires
- Carbon Dioxide type - Class C fires
- Dry powder type - Class A, B & C fires
- Selection and installation to be done as per IS 2190: 2010
FIRE HYDRANTS

Network of piping installed underground or overhead around various facilities with hydrant standposts fitted with landing valves at regular intervals or at distances from the protected risks according to the occupancies.
HYDRANTS – INSTALLATION CONSIDERATIONS

- Type of Hazard being protected
- Number of hydrants required for all the facilities
- Adequate sizing of pipes to achieve appropriate discharge
- Adequate selection of fire pumps
- Adequate provision of water for the installed pumping capacity
- Provisions for interruption free maintenance
- Trained manpower to handle emergencies
HYDRANTS

- External Hydrants - for fire fighting from outside the building
- Internal Hydrants & rubber hose reels - for fire fighting within the building envelope, especially high rise buildings
AUTOMATIC SPRINKLERS

Myth
• A smoke detector provides enough protection

Fact:
• Smoke detectors save lives by providing a warning system but cannot extinguish a growing fire or
• Cannot protect those physically unable to escape on their own.
AUTOMATIC SPRINKLERS

😊 **Myth**
• When a fire occurs, every sprinkler head goes off

😊 **Fact:**
• Sprinkler heads are individually activated by fire.
• Fires are usually controlled with one sprinkler head.
• 90% of all fires are controlled with six or fewer heads.
• Study report shows that 82% of the fires were controlled by two or fewer sprinklers.
AUTOMATIC SPRINKLERS

adamente

Myth

• Water damage from a sprinkler system will be more extensive than fire damage

Fact:

• Water damage from a sprinkler system will be much less severe than the damage caused by water from fire-fighting hose lines or smoke and fire damage if the fire goes unabated.
• Quick response sprinklers release 30-91 liters of water per minute compared to 189-473 litres per minute released by a fire hose.
AUTOMATIC SPRINKLERS

 ограниченный

Myth

• Sprinklers are designed to protect property, but are not effective for life safety.

Fact:

• Sprinklers provide a high level of life safety.
• Statistics indicates that there has never been any multiple loss of life in a fully sprinkled building.
• Property losses are 85% less in buildings with fire sprinklers compared to those without sprinklers.
AUTOMATIC SPRINKLERS

- A facility designed to discharge water automatically in sufficient density (LPM/ Sq.m) and control fire in its early stages.
- To give alarm and alert people about the occurrence of fire.
- Design and installation to comply with IS 15105:2002 & NFPA13
AUTOMATIC SPRINKLERS - BENEFITS

- Control or extinguishment of fire in its early stage
- Most Suitable for unmanned areas.
- Early extinguishment of fire in high rise buildings
- Automatic extinguishment of fire during non working hours
- Controlled use of water
AUTOMATIC SPRINKLERS - BENEFITS
AUTOMATIC SPRINKLERS

Method of actuation

- Glass Bulb type - Rupture of quartzoid bulb when exposed to higher temperatures.

OR

- Fusible link type - Melting of fusible link.
HIGH RISE STRUCTURES

Unique attributes affecting fire safety in high rise buildings

• Height beyond available resources of fire department ladders
• Extended evacuation times
• Pronounced stack effect
• Water supply limitations
• Greater challenges of mixed occupancies
• Iconic nature
VICTORIA VIEW RESIDENTIAL PROPERTY

- Victoria View - a 83.5m high residential property on 241/2 AJC Bose Road, developed for ITC employees
- Protected fire exit staircases designed and constructed to ensure safe egress in case of fire in the building.
- Floor to floor compartmentation to prevent vertical spread of fire.
- Wet risers with tap offs at each floor.
- Every resident is trained on fire emergency procedures prior to occupation.
Do not admit repair men without checking with the management/
Never admit person with unsolicited deliveries.
Identify all callers through door viewer before opening the door

PLAN AHEAD
Familiarize yourself with the following
- Emergency escape routes, location of fire exit stairs on your floor
- Fire alarm call points on your floor
- Fire extinguishing equipment
- Refuge areas in the building (4th, 8th, 12th, 16th & 20th floors
- i.e. near service lifts)

IF YOU DETECT A FIRE OR HEAR THE FIRE ALARM OR EVACUATION MESSAGE
Do not panic
Raise the fire alarm using the nearest fire alarm call point OR inform the security if you detect a fire.
Alert fellow residents
Leave the floor immediately using the nearest fire exit. If there is smoke in the corridor, crawling is
advised and hold a wet cloth in front of your mouth.
If you find smoke or fire at the nearest fire exit, move to the alternate exit or the nearest refuge area.
Do not use lifts for evacuation.

IF YOU ARE STUCK IN YOUR HOUSE
Try to remain calm, do not panic
Keep the door closed. Block the door sill with wet cloth to prevent smoke from entering into your house.
Inform the security about your location.
Fill containers with water for extinguishing fire.
SAMPLE LEARNINGS...

- Fire watch for hot work
- Non usage of extension boards/ strips
- Safe use of comfort ACs for continuous cooling applications – auto switching arrangement;
- P2 type burst proof capacitors for fans, ACs;
- Fire compartmentation of UPS Battery rooms;
- Mandatory cooling clearances for white goods like refrigerators, microwave, etc.,
- Flexible hose for combustible fluids – shelf life management
LEARNINGS..HOUSEKEEPING
THANK YOU

Let's make a difference...