Fire Safety in Office Buildings
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Overview

1. Nature of building occupancies
2. Prevention by design
3. Limitation of post fire damage by design
4. Designed post fire events
5. Safe Evacuation

Nature of building occupancies

PRIME FUNCTION OF AN OFFICE BUILDING IS TO ACCOMODATE ITS OCCUPANTS IN A SAFE AND EFFICIENT MANNER. UNDERLYING PRINCIPLES OF FIRE SAFETY IN SUCH A FACILITY IS THAT THE LOSS AND DAMAGE TO PROPERTY IS SECONDARY TO THE NEED TO PRESERVE LIFE AND PREVENT INJURY TO THE OCCUPANTS, EVEN IF THE WHOLE BUILDING HAS TO BE SACRIFICED.

Nature of building occupancies

OCCUPANCY CONSISTS OF ENTERPRISES THAT USE THE OFFICE SPACE LEASED TO HOUSE THEIR STAFF IN ANY FUNCTIONS VARYING FROM KNOWLEDGE PROCESSES TO CALL CENTRE OPERATIONS

DENSITY OF SEATING SPECIFIED BY THE NATIONAL BUILDING CODE IS **10 SQM PER PERSON**.

HOWEVER HIGHER DENSITIES ARE SEEN IN USES SUCH AS CALL CENTRES WHICH CAN GO UP TO
4 SQM PER PERSON

DENSITY IS IMPORTANT IN THE DESIGN OF EMERGENCY EGRESS AND EVACUATION ARRANGEMENTS

OCCUPANTS ARE GENERALLY UNAWARE OF THE BACKGROUND PROCESSES THAT RUN A BUILDING AND THE POSSIBILITY OF A FIRE EVENT . SAFETY OF THE BUILDING IS TAKEN FOR GRANTED.

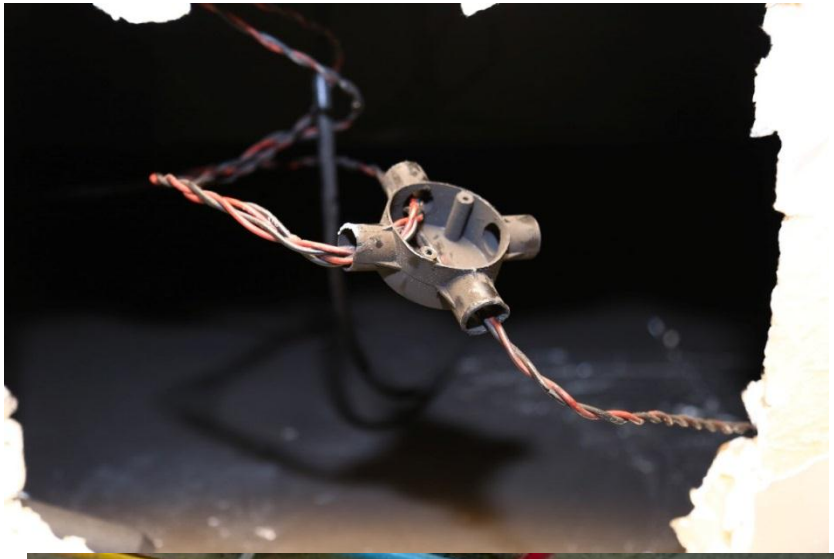
IN THE EVENT OF A FIRE IN THE BUILDING, THE FOCUS IS TO FIRST EVACUATE ALL THE OCCUPANTS TO SAFETY, EVACUATE ANY DIFFERENTLY ABLED OR INJURED PERSONNEL.

THERAFTER THE FIRE FIGHTING PERSONNEL WHO WILL ENTER THE BUILDING TO FIGHT THE FIRE NEED TO BE ABLE TO TAKE REFUGE OR ESCAPE SAFELY THEMSELVES IF THE GOING GETS TOUGH.

THE STRUCTURE HAS TO RETAIN ITS SAFE AND STABLE CONDITION TILL ALL SUCH PROCESSES ARE OVER OR TILL THE FIRE ITSELF IS DOUSED.

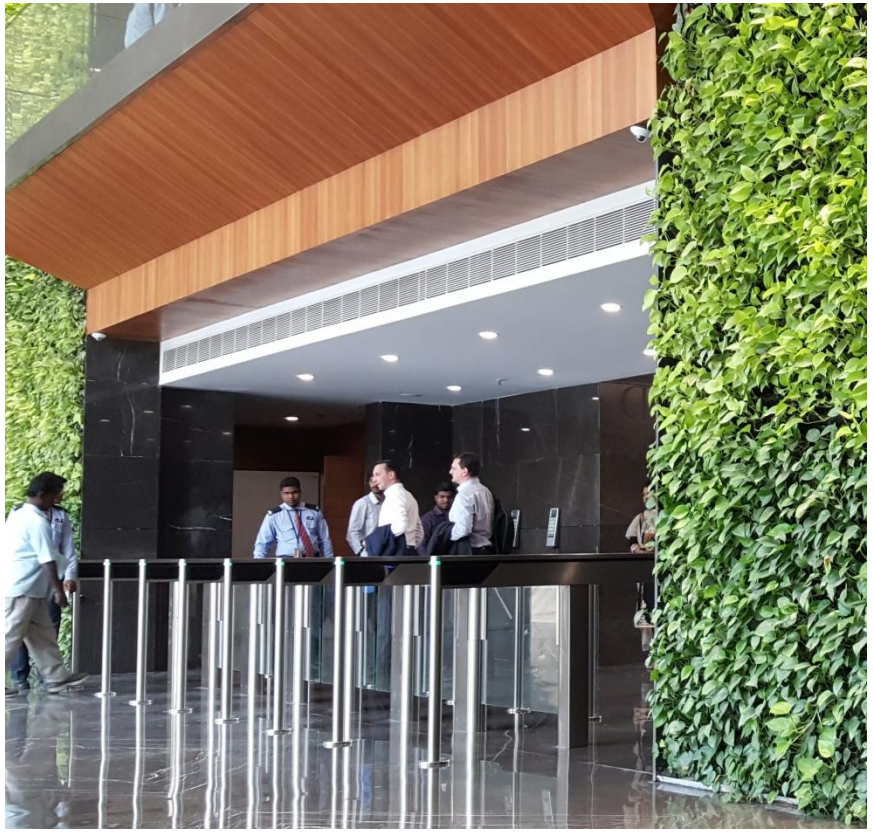
Sources of Fire

Most Common: Electrical short circuit
Others:
Batteries used for UPS systems.
LPG pipelines issues
Unauthorized smoking issues
Unsafe use of combustible materials
(Example: Hospital AHU case)

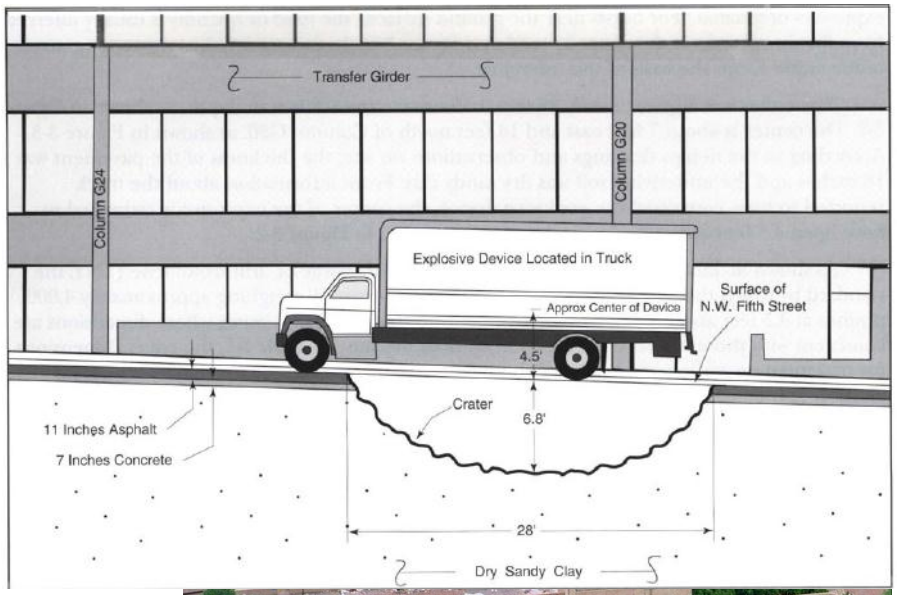


Non accidental Sources of Fire
Arson, terrorist attacks

Mitigation of intentional sources of fire are heavily dependent on the security, CCTV and screening systems incorporated into the building. Extent of damage depends on the amount of explosives that can be carried in to the building.
A terrorist act can be devastating enough to bring down a whole building



Ref: FEMA – 426 2011



Example of intentional act – Arson, Oklahoma Bomber, USA, Murrah Federal Building before and after. Perpetrator – Mc Veigh. Event leading to progressive collapse. 1995

Mitigation strategies in design - Fire rating of structures

- Elements of the core structure and enclosures are specified fire resistance ratings based on their performance requirements, possibility of inducing either local or progressive collapse .

- For office buildings, these values vary from 2 to 1 hours, staring from 2 hours for a primary structural element such as a column.

- Fire resistance is also specified as stability, integrity and insulation values.

- These ratings enable a building to provide the required stable condition for enough time for evacuation as well as the activity of fire fighting.

- The ratings also provide safe exits via enclosed routes for the occupants

Fire rating of structures common methods

For Concrete structures- by adjusting the cover to reinforcement.

For steel structures- in order of increasing cost :

1. Concrete encasement
2. Fire rated gypsum board fabrication
3. Vermiculite Spray
4. Intumescent paint

Vermiculite coating to steel structure

Mitigation strategies - Fire rating of structures

Particular attention should be given to the detailing of connections and junctions, especially in precast concrete structures.

Eg: Ronan Point collapse, London 1968

Modern large panel precast concrete structure: The Sail, Singapore

Mitigation strategies in design- Smoke and fire spread control

Post initiation, fire spreads rapidly in a non sprinklered building in all directions along the path of least resistance.

Out of the three modes of transfer, convection is what we see in vertical transfer in shafts. The other two modes if radiation and conduction are more responsible for setting off secondary fires by flashover within the enclosure and spontaneous combustion across partitions.

Convection carries hot gases along with soot and smoke capable of inter-floor transfer:

Vertically : via shafts used for plumbing, HVAC electrical , lifts and communications. More devastating due to stack and chimney effects

Horiziontally: via open plan office space and HVAC ducts.

Mitigation strategies for these are:

Fire rated horizontal shaft closure

Fire rated shaft doors

Fire compartmentation of floors

Fire dampers in HVAC ducts.

Pressurization for lift shafts and staircases- to prevent smoke entering escape routes

Compartmentation: The code actually asks for a compartmentation of space into 1125 sqm modules with a length of 40 m max. (To be elaborated.) As per the amendment in Sept 2015, this has been increased to 2000 sq m

Compartmentation example: Unsealed post construction puncture in a 2 hr rated enclosure showing smoke ingress after fire

Compartmentation example: weakening of 2 hr rated enclosure showing signs of smoke ingress due to reduced wall thickness

Mitigation strategies – Example of vertical transfer and protection in a communication shaft fire

Mitigation strategies – Floor to floor transfer via curtainwall

Most high rise buildings are clad with glass curtain walls for better daylighting and Architectural aesthetics.

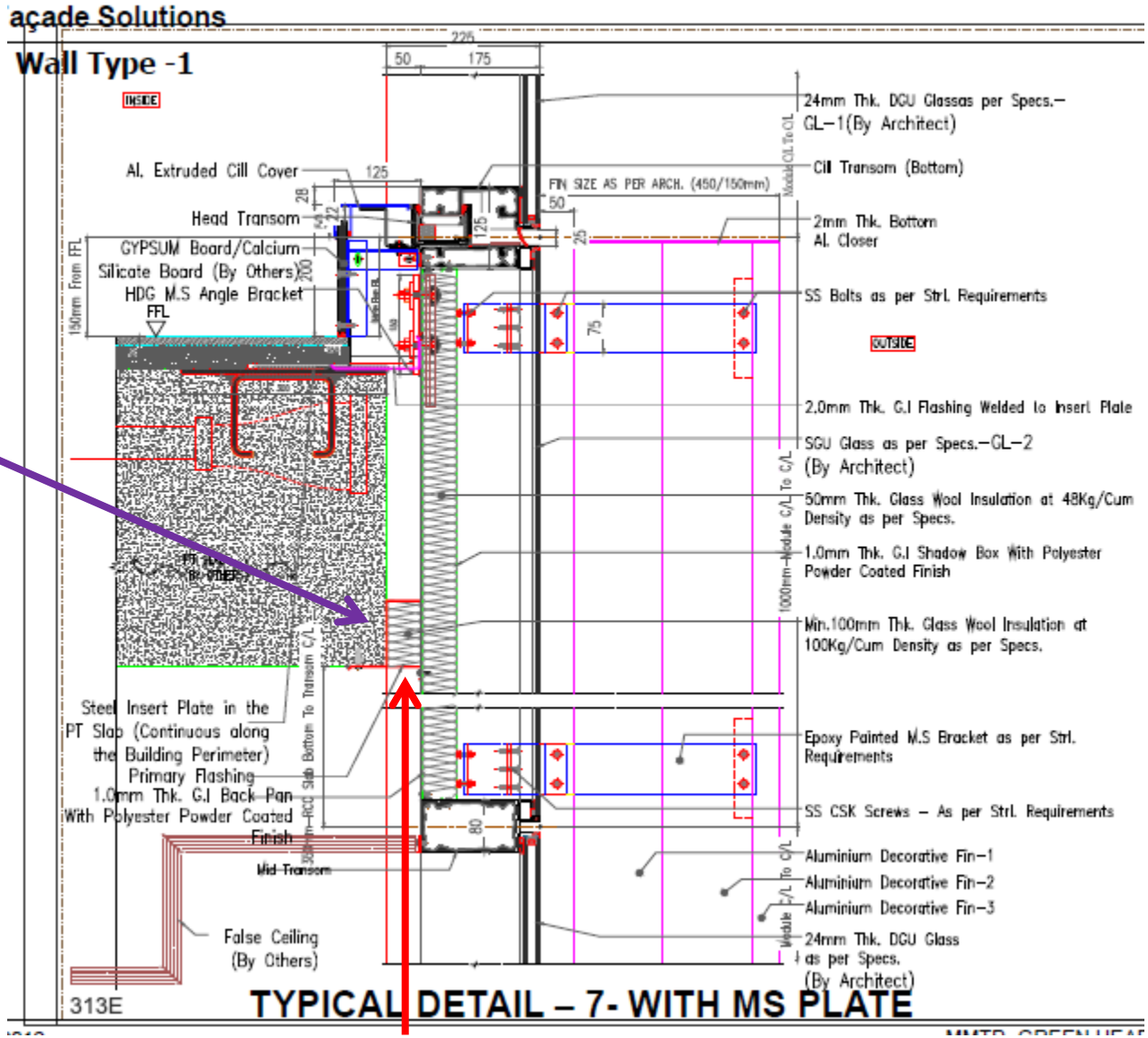
These are fixed to the floor edges and necessarily have a gap between the floor edge and the glazing system.

This is one route for vertical transfer, floor to floor, if not designed and built correctly.

Mitigation strategies – Floor to floor transfer via curtainwall

Floor to floor transfer along the edge of the curtainwall is prevented by the use of the smoke stop and fire seal at the location shown.

The glass and glazing itself have a low fire rating

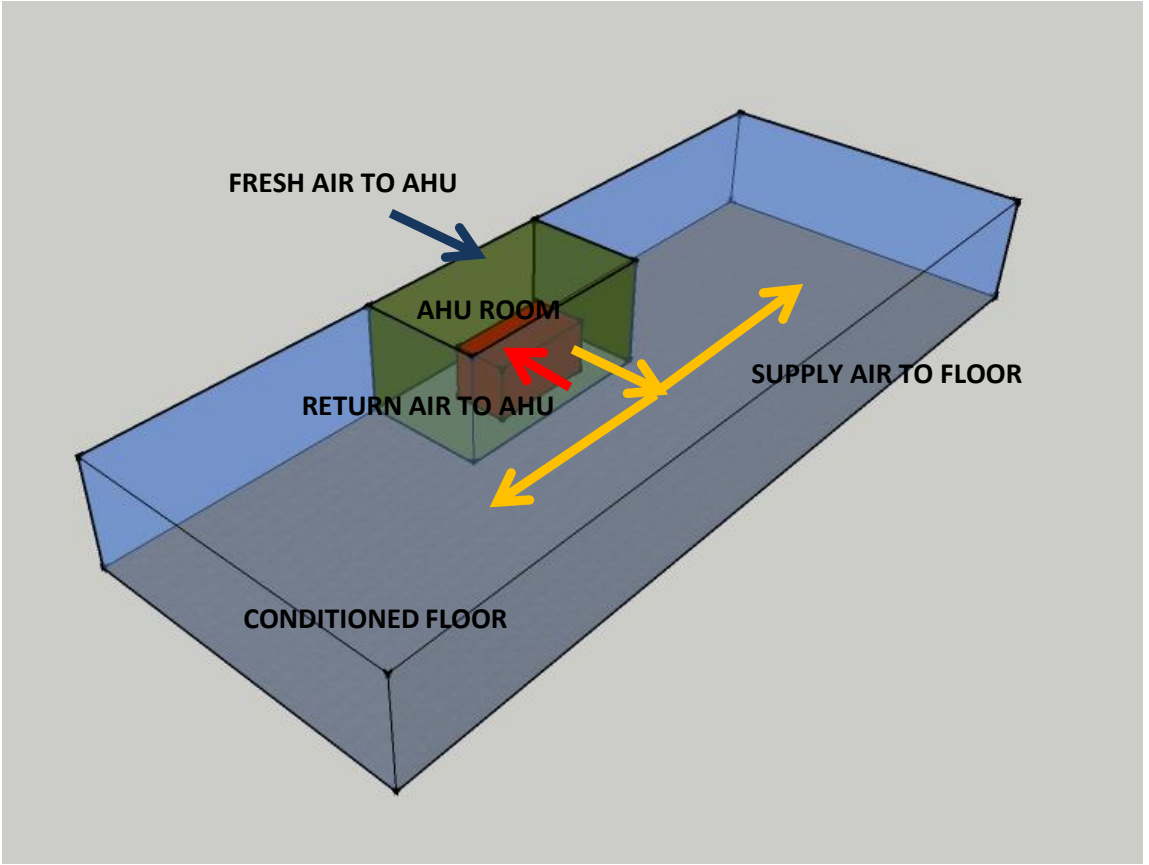


Fire travel

Mitigation strategies – Importance of AHU rooms

AHU rooms receive return air from the floor.
Deliver cooled supply air back to the floor.
Receive treated fresh air to the AHU from the rooftop.

In case the AHU continues normal operation during a fire, it becomes a deadly aid in collecting and spreading hot gases and smoke throughout the floor.
At the time of a fire, these processes will have to stop instantly.
Discussed below.



Mitigation strategies – Smoke control

Mitigation strategies – Smoke control

Smoke is responsible for more fatalities than burn injuries in a building

First line of mitigation is the avoidance of materials in the construction of the building interiors that are known to emit toxic and heavy soot fumes on combustion

Typical products to watch out for are: PVC conduits, pipes, electrical insulation, carpets, glues, certain paints etc.

Specify low smoke, fire resistant material

Post fire events – fire alarm

Fire alarm system using an addressable smoke detector system in multiple loops is used to relay any smoke event to a central fire alarm panel and a few repeater units.

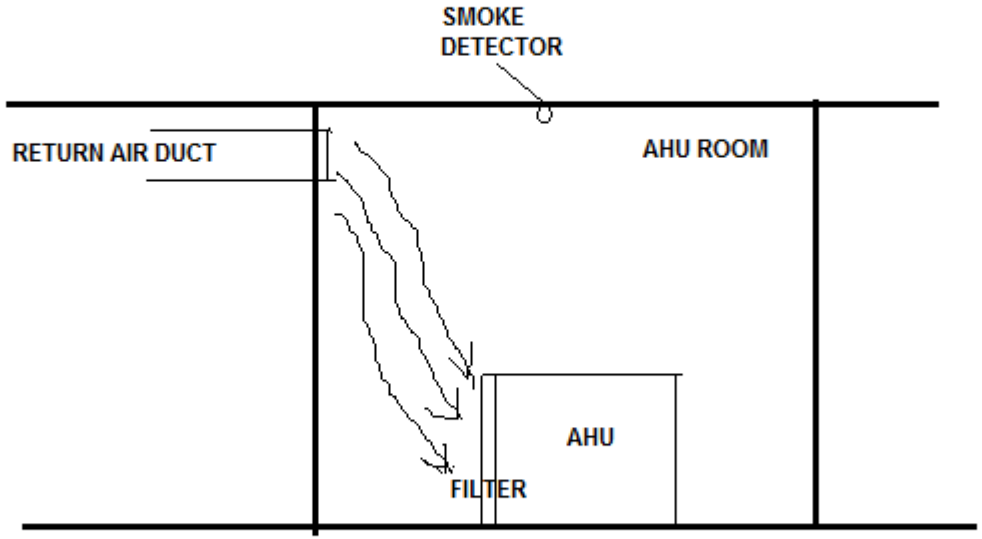
This is usually the first response of the building to the initiation of a fire

Once the device is triggered, it automatically and simultaneously initiates the following actions (protocol may vary from building to building):

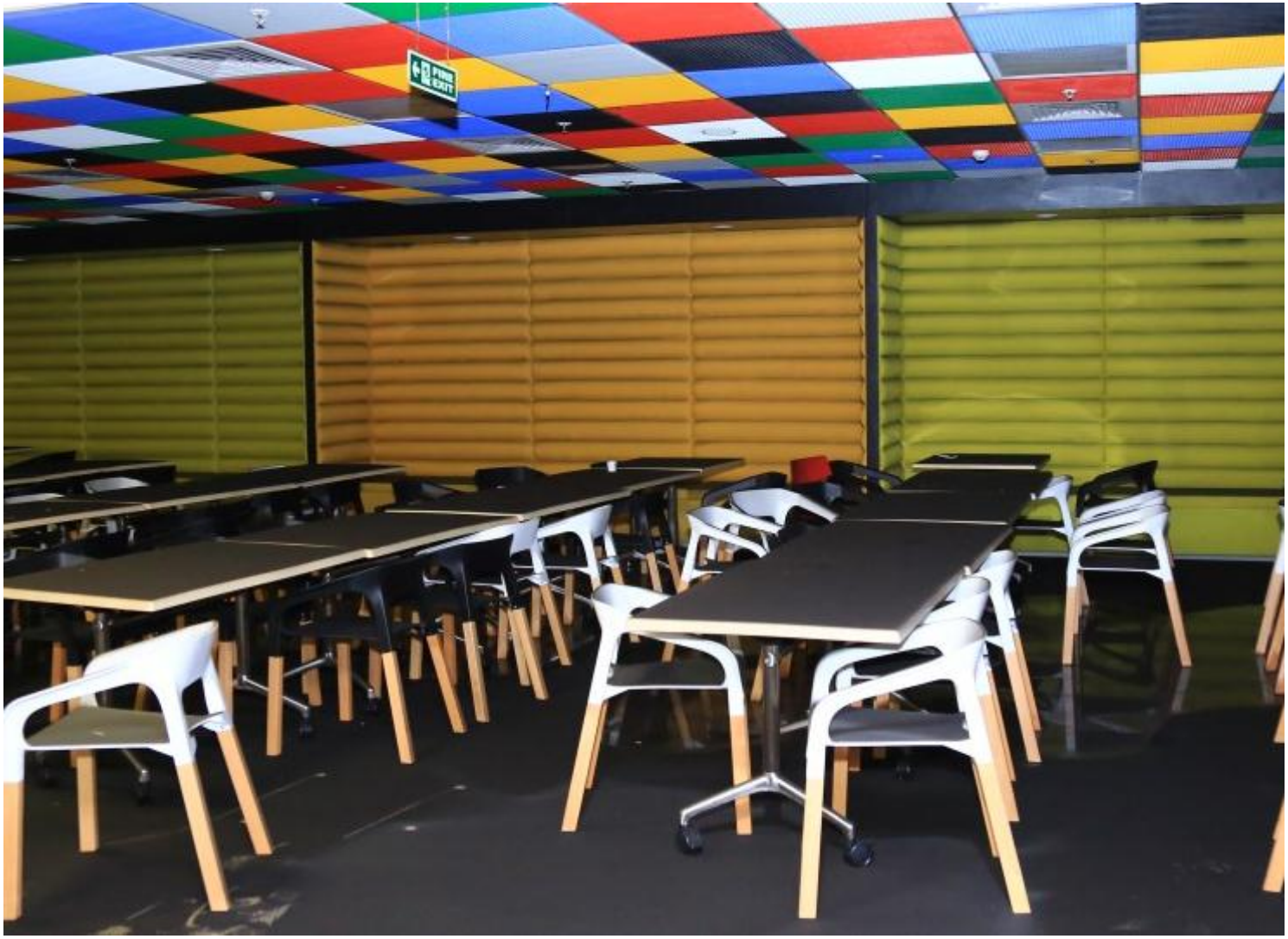
Fire alarm signals sent to all alarm panels and logged.	Release all fire escape doors that have been magnetically locked for security	Evacuation announcements made to alarm floor , one above and one below
General alert announcement sent to all floors	Switch off AHUs and start staircase and lift pressurization fans	Close all HVAC fire dampers
Bring all lifts to ground floor and open doors	Release and keep open all security flap barriers	Shut off LPG lines where used.

Response indicator with address of overceiling smoke detector seen after fire damage

Failure of smoke detector to signal closure of HVAC fire damper seen as soot deposit on floor of AHU room after smoke entry. Notice soot on filters.



Common mistake in location of smoke detector to alert smoke in return air. Return air misses the detector and proceeds to the AHU to be pumped back to the user space. Detector should be at the duct entry



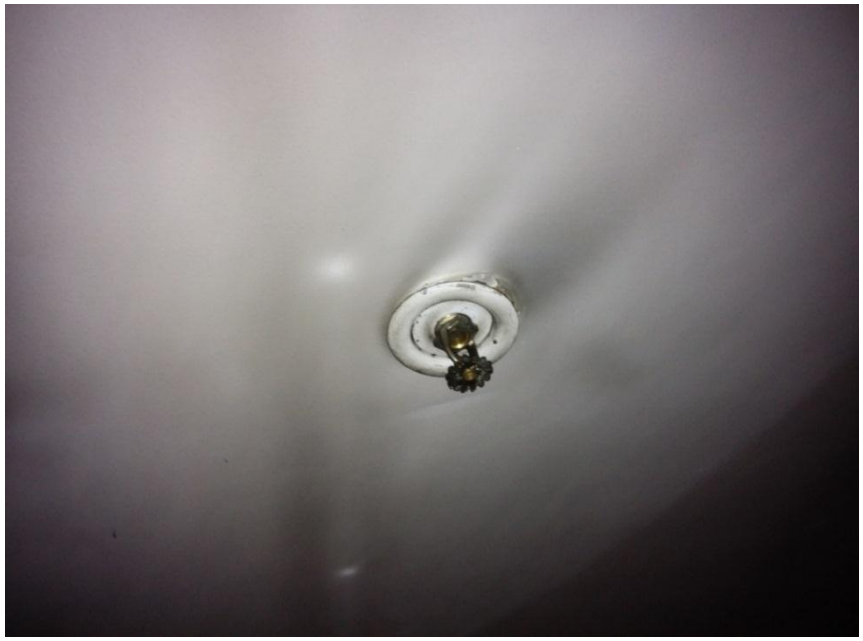
Soot seen on horizontal surfaces delivered through HVAC ducts and ceiling diffusers

Post fire events – fire suppression

Once the alarm is triggered, comes the business of suppression. Considering normal office space, the principal player and the most effective is the automatic sprinkler system.

Each sprinkler bulb covers an area of approximately 100 sq ft in an open space while each smaller enclosure has at least one sprinkler if it is less than 100 sq ft.

Sprinklers are backed by a water pressure maintained at 4 to 10 Kg/sqcm depending on the floor elevation, with central controls in the fire pump room.



Sprinklers are triggered by exploding of the bulb at 68 to 70 deg C.

Release of pressure on explosion starts the main pumps by a cascade of pressure switches in the pump room.

The sprinklers not only help to douse the source of fire but keep the surface temperatures so low that the chance of a flashover is greatly reduced

Post fire events – fire suppression

Secondary actions of the sprinkler activation are:

1. Flow switch in the sprinkler mains at the floor zone triggers a signal to the Fire alarm panel.
2. Turbine driven bell (“Gong”) drives a mechanical bell alarm outside the building at the installation control valve.

Egress

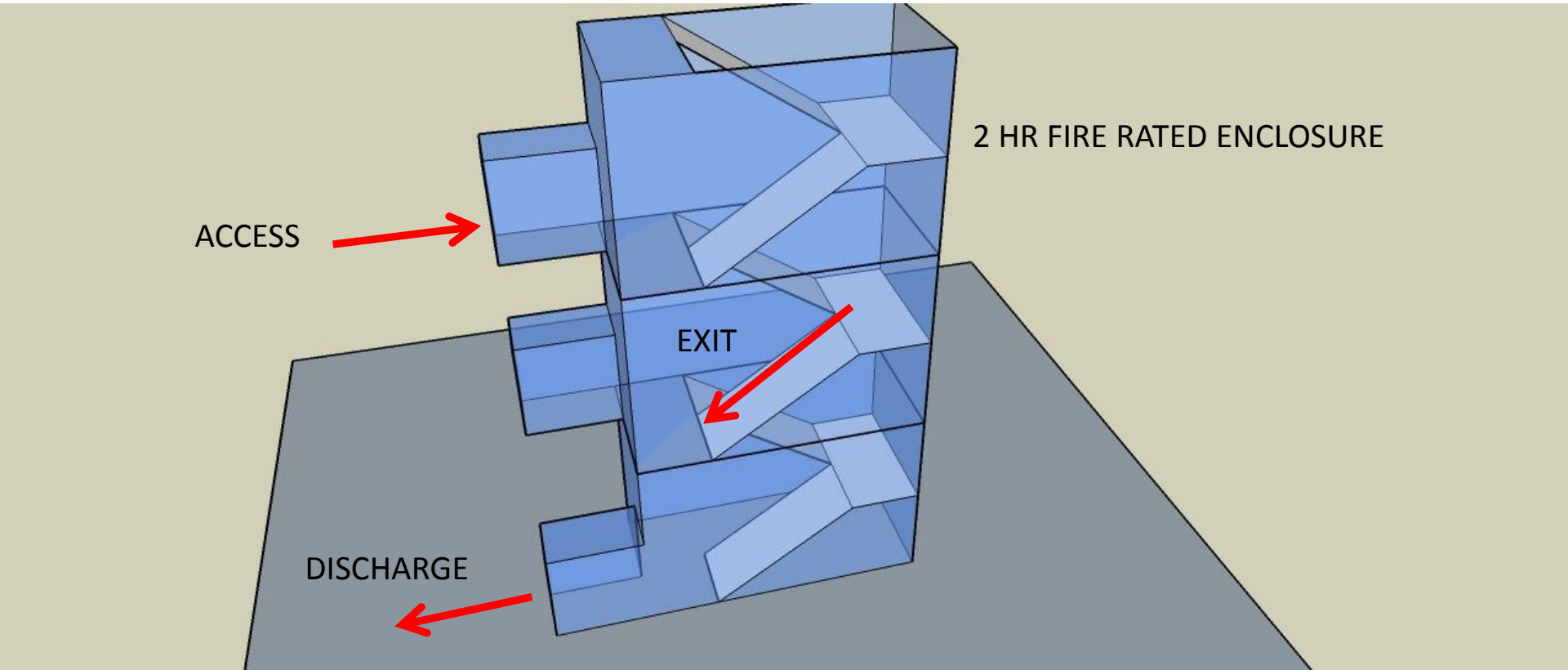
Goal of all the processes above is the safe evacuation of all the occupants.

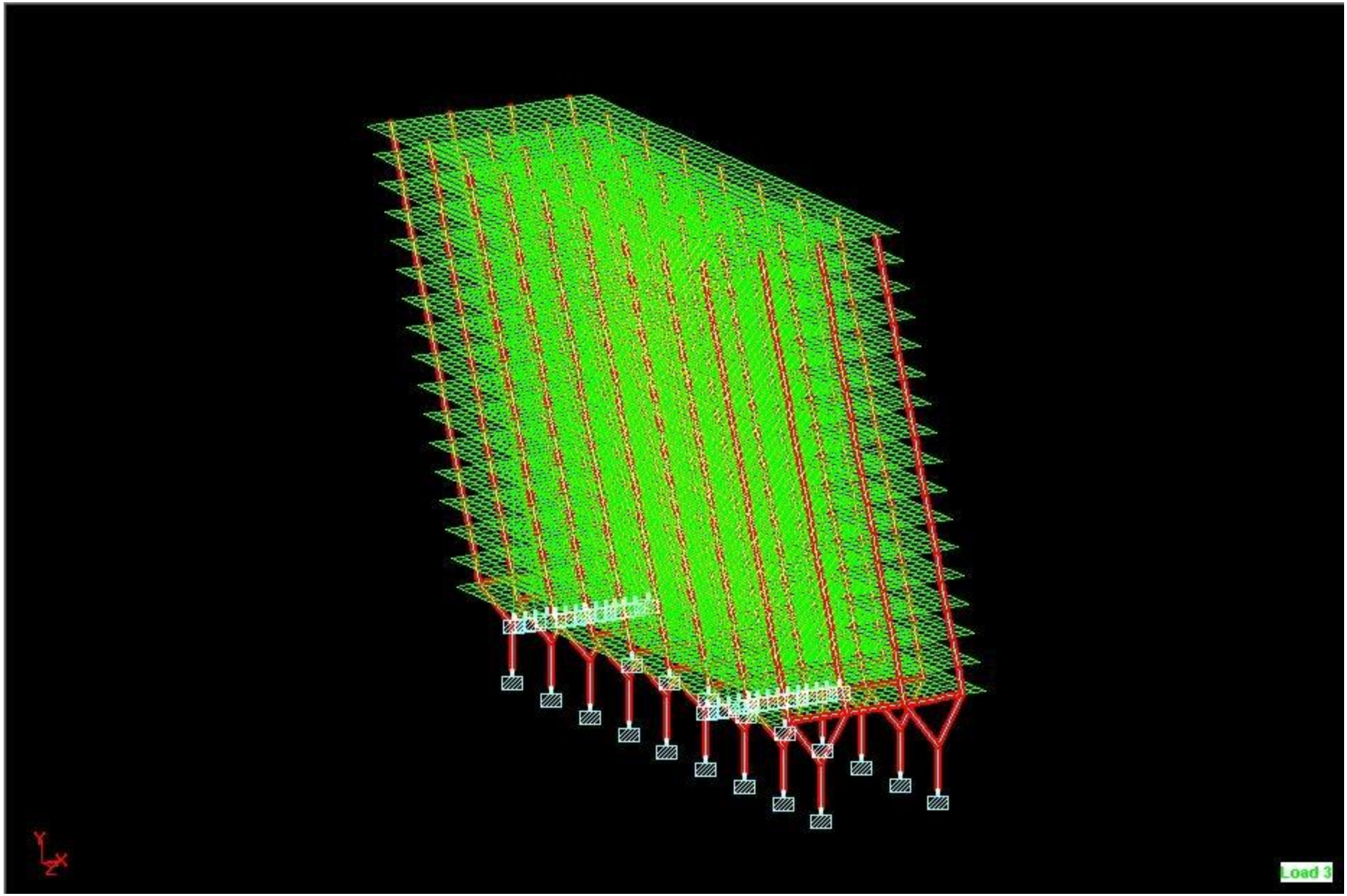
Three components of egress are shown below.

Code requires a minimum **45 metre** travel distance for fully sprinklered buildings where user has a choice of two exits, and **22.5 metre** where there is only one choice, such as a dead end corridor.

Apart from the travel distance, if the exit widths are checked against the floor population, the egress is considered to be adequate.

Where direct access becomes inaccessible, they make take refuge in the refuge area till fire department evacuation

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