The role of Passive Fire Protection

Dr Gabrielle Peck, BSc (Hons), Ph.D., MRSC,
Technical Director

NFCA® National Fireproofing Contractors Association

FCIA Firestop Contractors International Association

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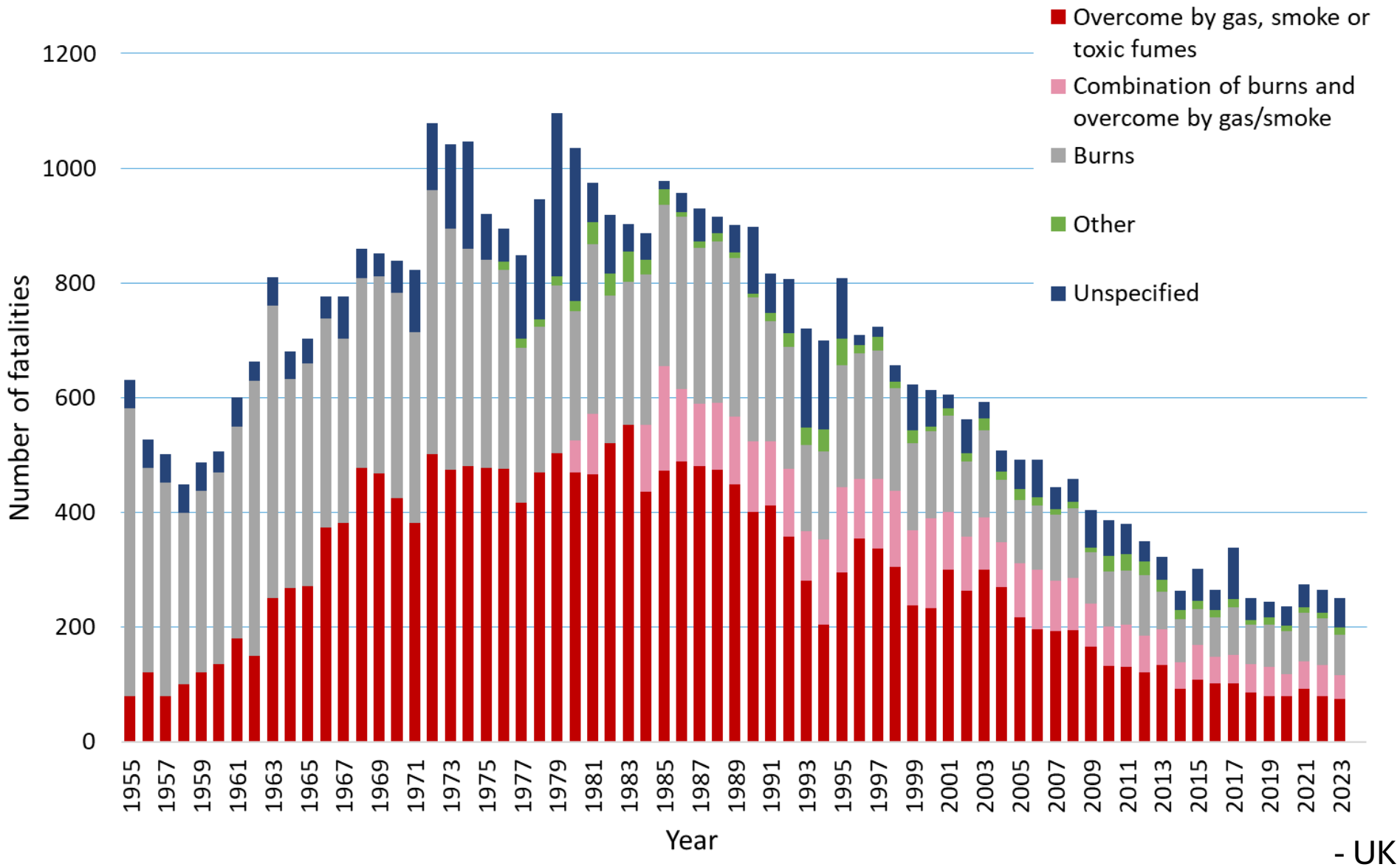
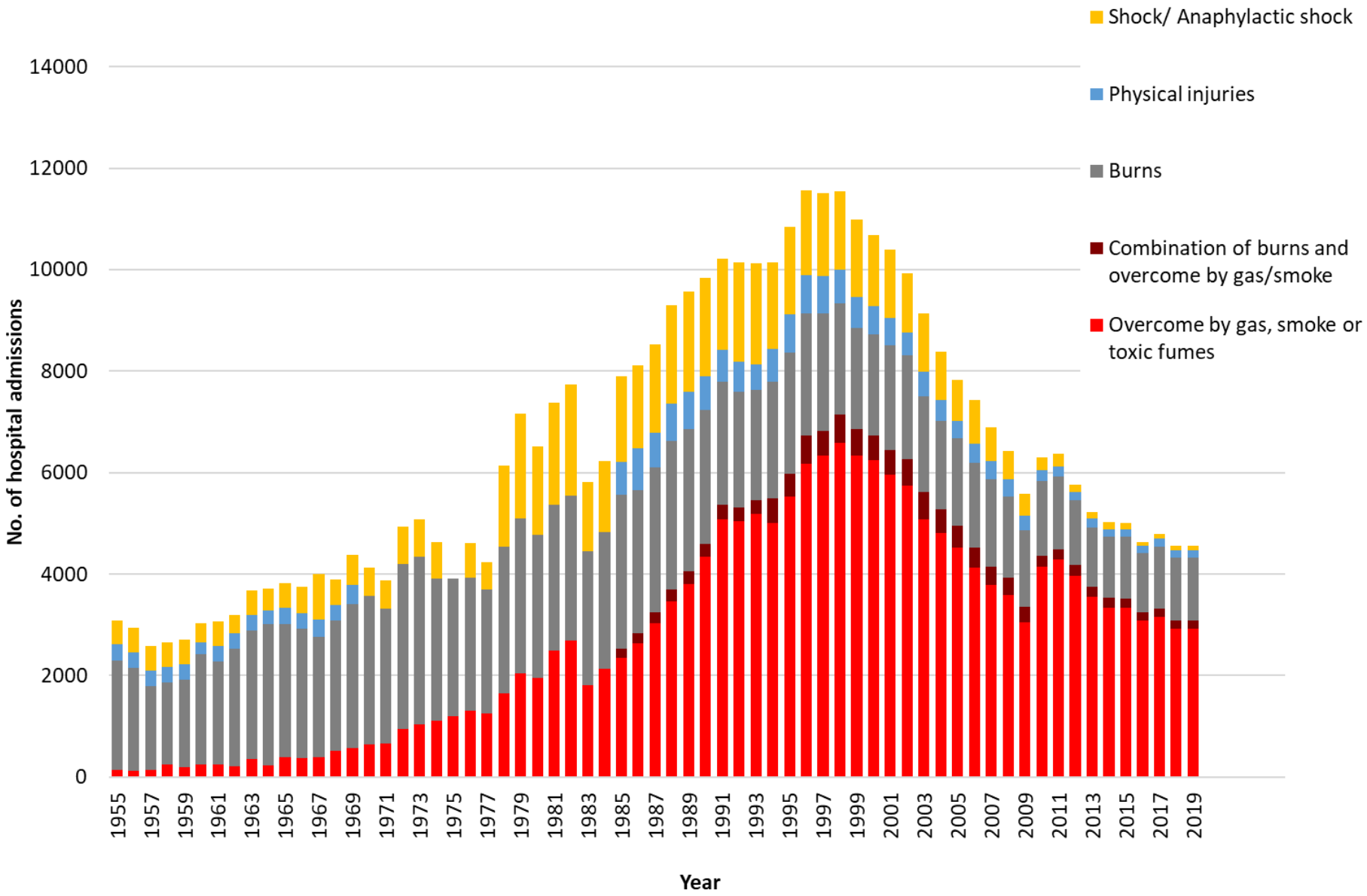
Smoke toxicity is the leading cause of death in fire.



- UK Gov. Statistics

UK Statistics: Non fatal injuries in fire



UK Gov. Statistics -

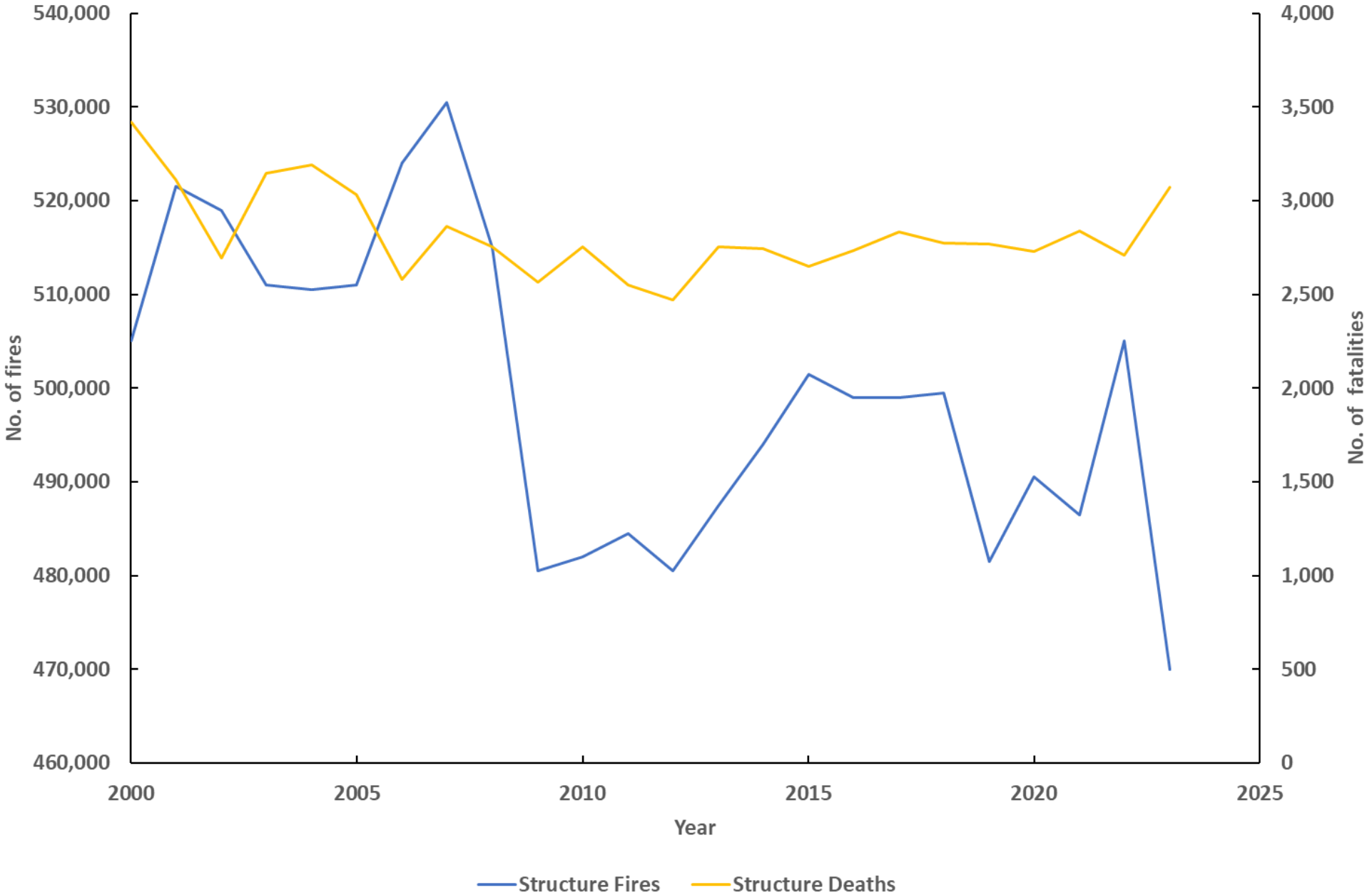
NFPA: USA Fire statistics
Structural fires & structural deaths
Definitions:

Structural deaths refer to civilian fatalities occurring in structure fires.

A structure fire is defined as any fire in or on a building or other structure, even if limited to contents.

These account for the majority of U.S. fire deaths, with home structure fires causing about 92% of them.

NFPA: USA Fire statistics
Structural fires & structural deaths



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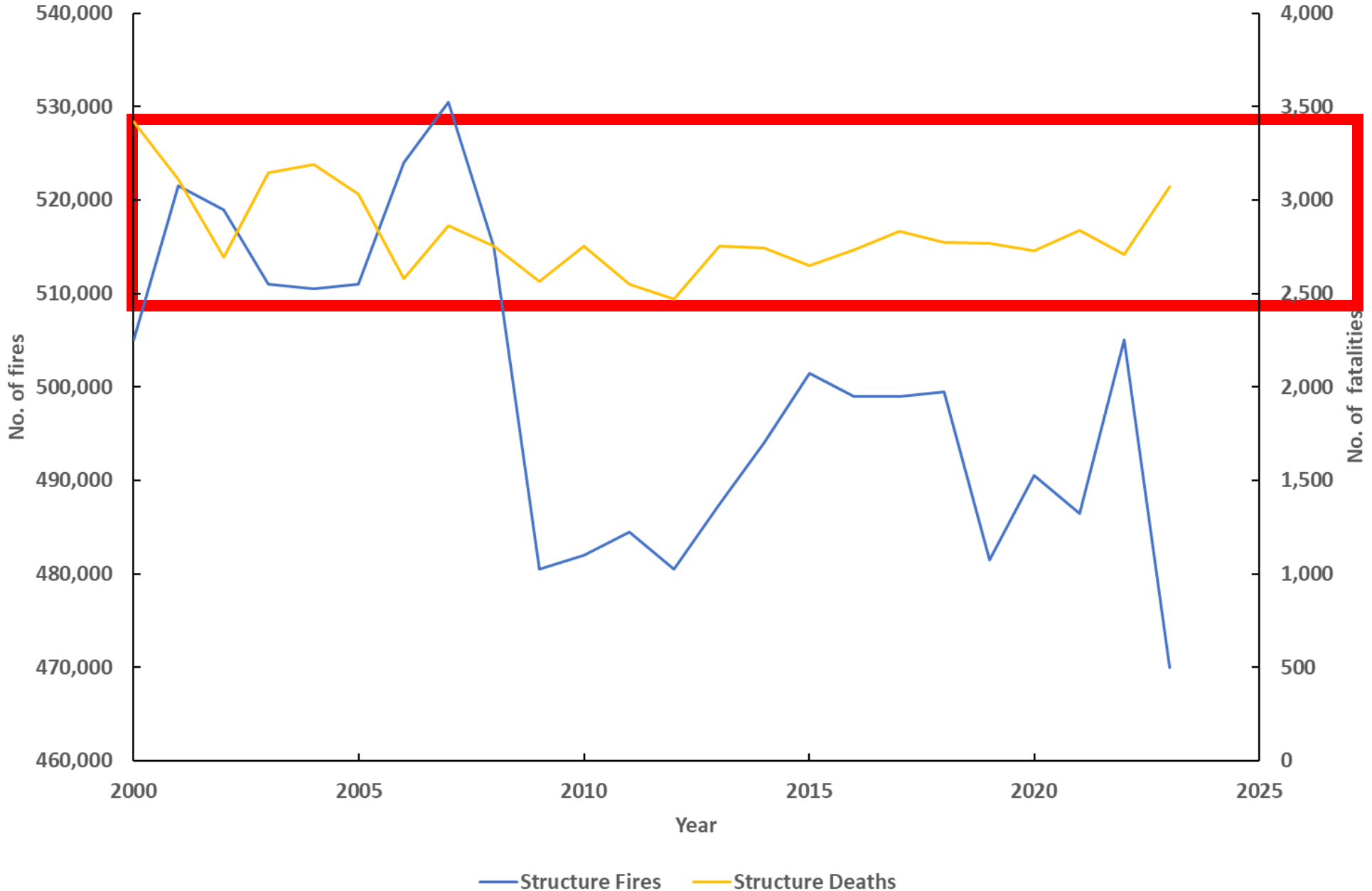

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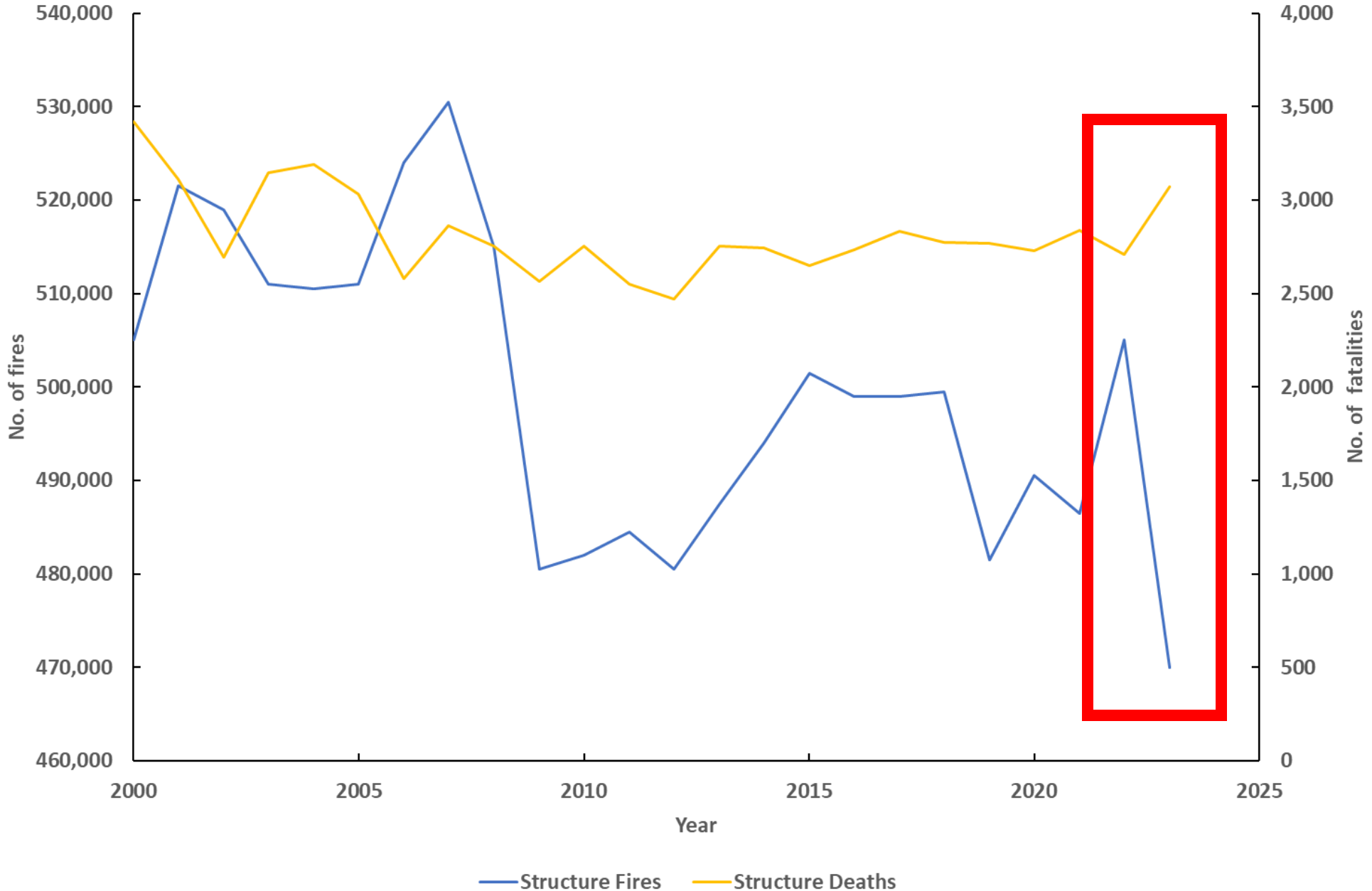

This isn’t a new problem...

Daeyeonggak Hotel Fire, Seoul, South Korea

25th Dec. 1971

Cause: Propane gas explosion in a second-floor coffee shop.

The blaze rapidly ascended the 22-story structure due to **combustible cladding** and **absent sprinklers; smoke infiltrated stairwells** and **upper-floor rooms**, causing asphyxiation far from the origin.

Evacuation was chaotic amid poor exits.

Casualties: 164 deaths (primarily smoke inhalation), 63 injured.

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No records to demonstrate inspection or compliance.

Siddharth Continental Hotel Fire, New Delhi, India

23rd Jan. 1986

Cause: Electrical short circuit in basement banquet hall.

Fire **propagated via service shafts** to upper levels; **toxic smoke permeated guest rooms and atriums**, suffocating occupants distant from flames.

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No records to demonstrate inspection or compliance
Investigation and government inquiry highlighted systemic lapses in fire safety enforcement.

Quakers Hill Nursing Home Fire, Sydney, Australia

18th Nov. 2011

Cause: Arson by a nurse using accelerant in two spots.

Early-morning fires **spread smoke across wards**; victims in **distant areas died** from inhalation while asleep or evacuating, **despite sprinklers activating.**

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No records to demonstrate pre-fire inspection or compliance.
Investigation showed:
-Poor design of passive elements.

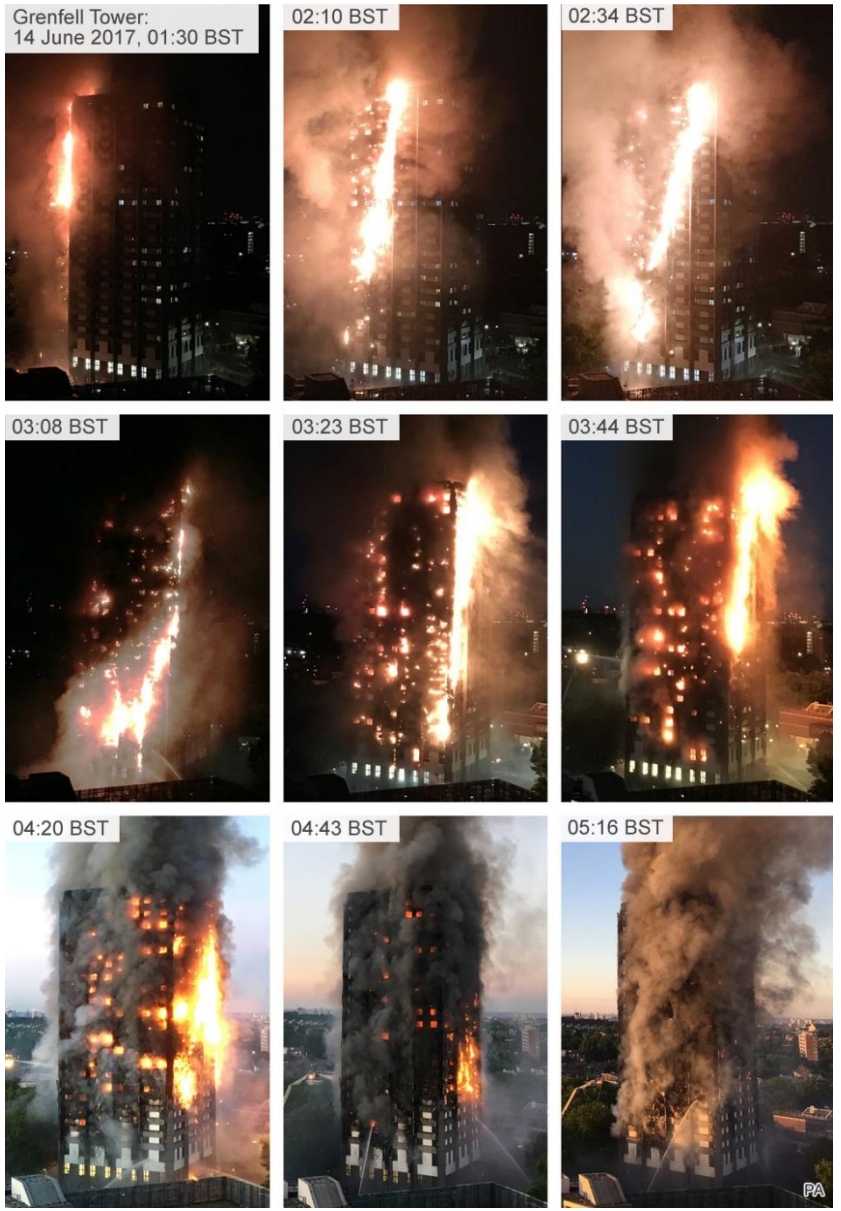
Grenfell Tower Fire, London, UK

14th June 2017

Cause: Faulty refrigerator ignition on the 4th floor.

Flames spread upward via combustible cladding; **toxic smoke filled the single stairwell** and infiltrated higher-floor apartments, **asphyxiating residents distant from the origin** before flames arrived.

Casualties: 72 deaths (primarily smoke inhalation), 70+ injured.



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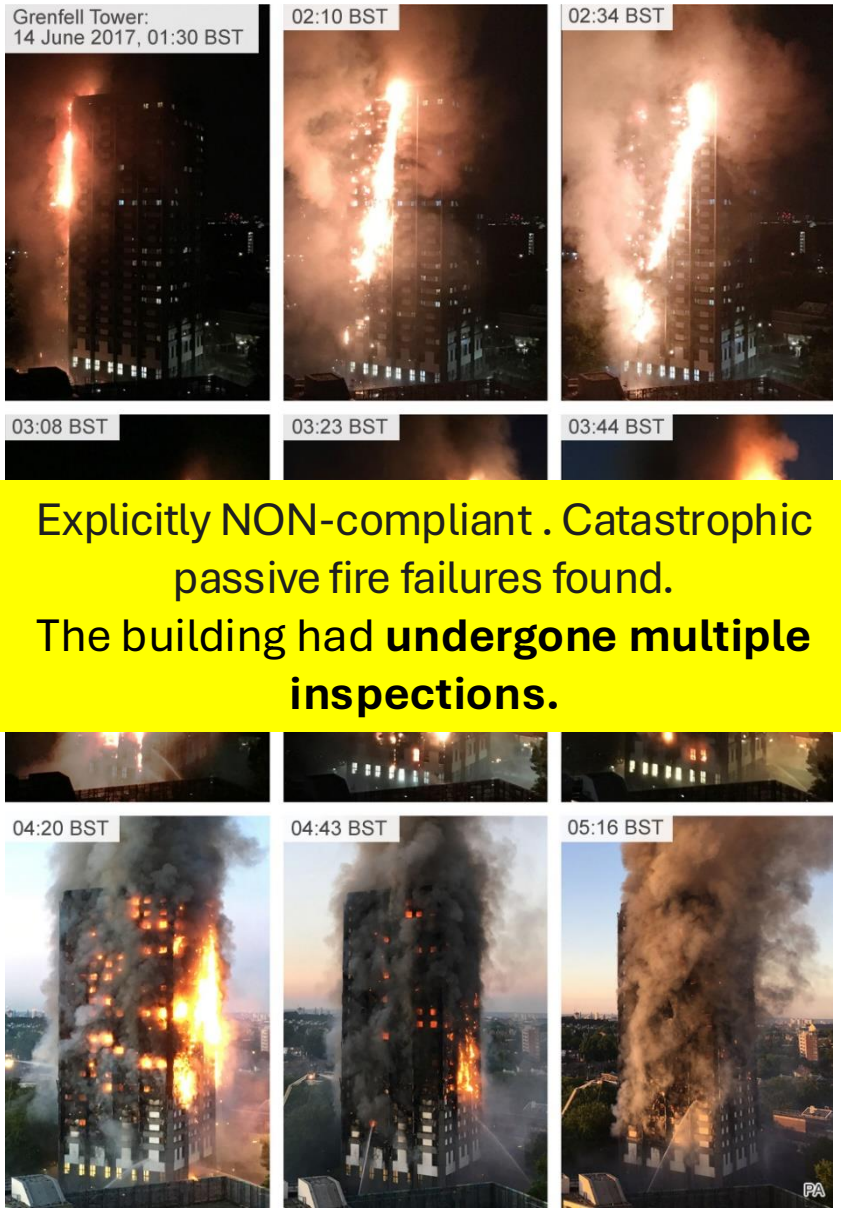

Explicitly NON-compliant . Catastrophic passive fire failures found.
The building had **undergone multiple inspections.**

Loafers Lodge Fire, Wellington, New Zealand

16th May 2023

Cause: Arson; resident with schizophrenia set two fires.

Blaze in 92-bed hostel **spread smoke via corridors**, **asphyxiating tenants in remote rooms** before flames reached them.

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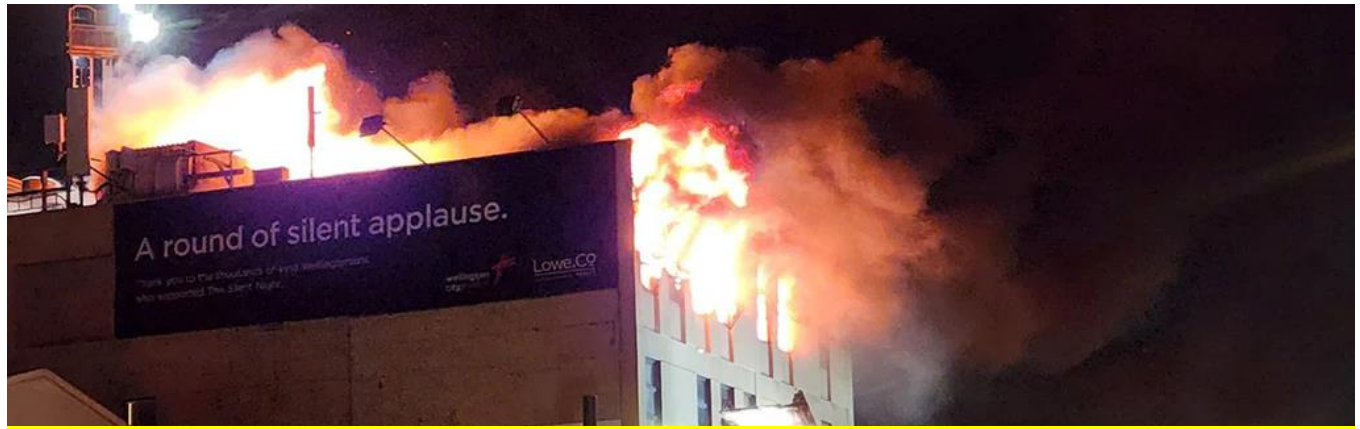

Under investigation

Had a BWoF

Valencia Residential Complex Fire, Valencia, Spain

22nd FEB. 2024

Cause: Electrical fault in basement transformer room.

Flames climbed via flammable cladding; **toxic smoke permeated all 14 stories**, causing fatalities on distant floors.

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Non-compliant cladding (PU)

Enforcement cited as a failure.

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Hotel Oriente in San José, Costa Rica

2nd Oct 2025

Cause: Under investigation. Serious safety failures revealed, including an emergency exit blocked with metal wire.

The fire started on the third floor of a three-story building in downtown San José. **Fire and smoke spread rapidly, trapping occupants due to the obstructed exit.**

Casualties: 5 deaths (3 men and 2 women, including an elderly couple found embracing); several injured from smoke inhalation, and 1 missing.

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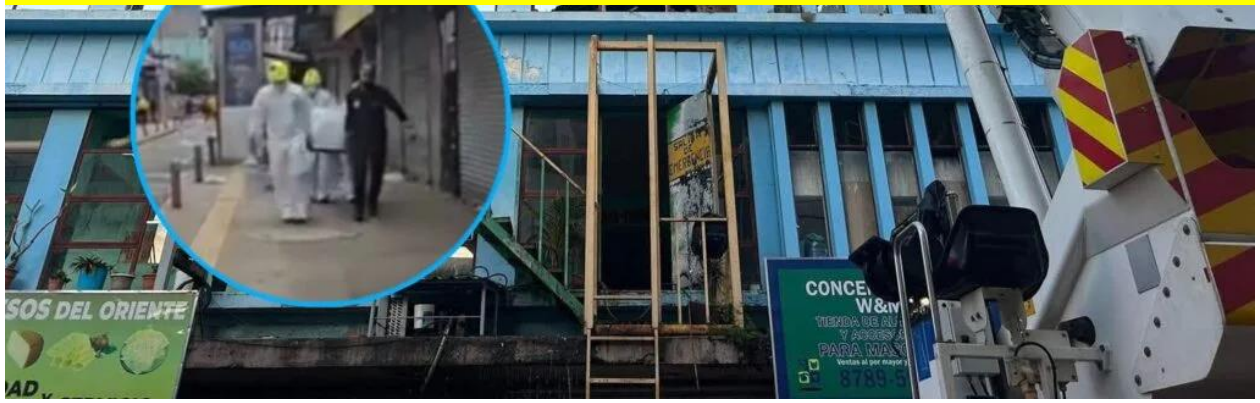

Tai Po, Hong Kong, 2025

November 26, 2025

Cause: Nylon netting on building caught fire. Renovation conditions inspected **16 times** in 1.5 years. Issued improvement notices, including:

- three prosecutions for safety violations
- fines up to HK$18,000.

Residents complained about safety conditions. Polystyrene used to seal windows. Fire spread to nearby towers.

Casualties: 161 fatalities (ages 1-97)

Mostly in apartments, stairwells, and corridors

In addition: 79 non-fatal injuries (over 40 initially critical).

What can we establish from these fires?

- Despite advancements, people are still dying in fires

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- Despite advancements, people are still dying from in fires
- Despite there being less fires, the risk level is just as high
- Inspection and Compliance is rarely enforced properly globally

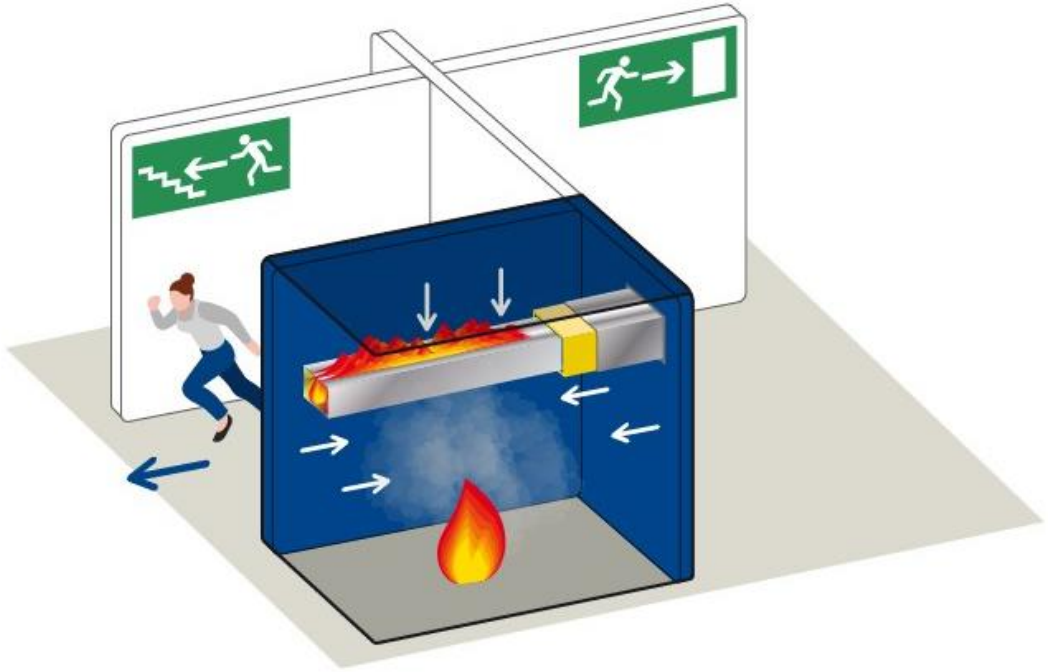
Back to basics

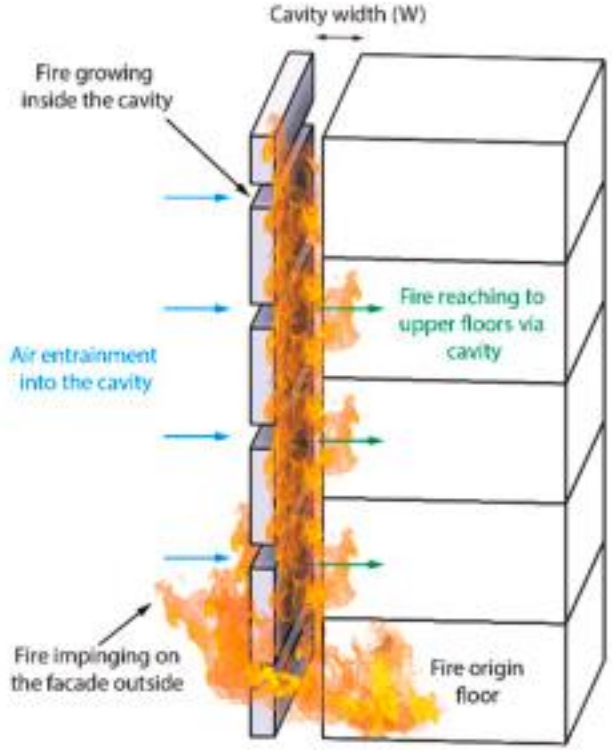
Key elements of a building

Passive fire protection (PFP) relies on integral building elements to:

- **resist fire spread**
- **maintain structural stability**
- **control smoke spread**

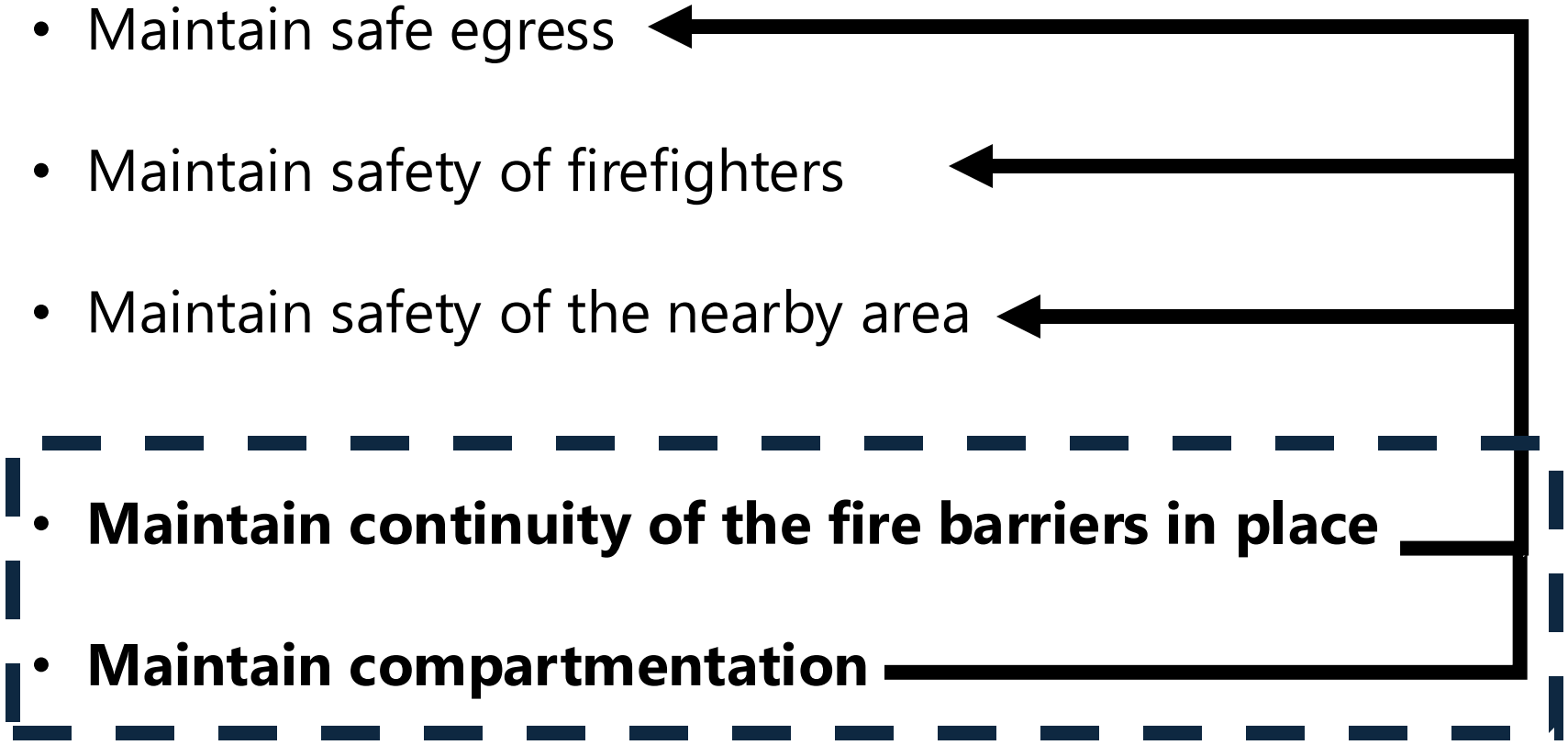
- **Structural Framework**
- **Compartmentation Barriers**
- **External Envelope**
- **Service Integrations**





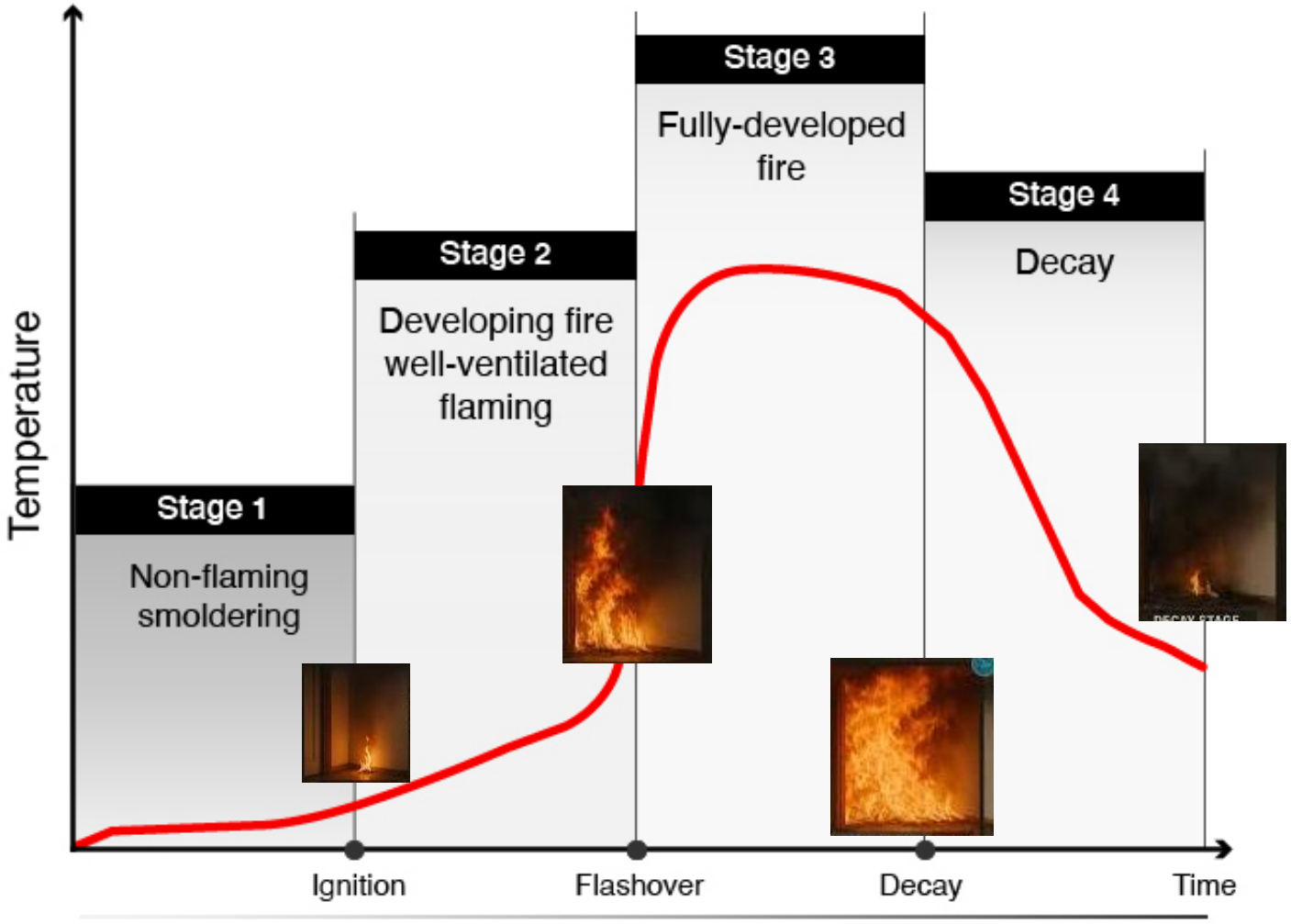
We rely on the structure remaining stable so that we can:

- Maintain safe egress
- Maintain safety of firefighters
- Maintain safety of the nearby area
- **Maintain continuity of the fire barriers in place**
- **Maintain compartmentation**

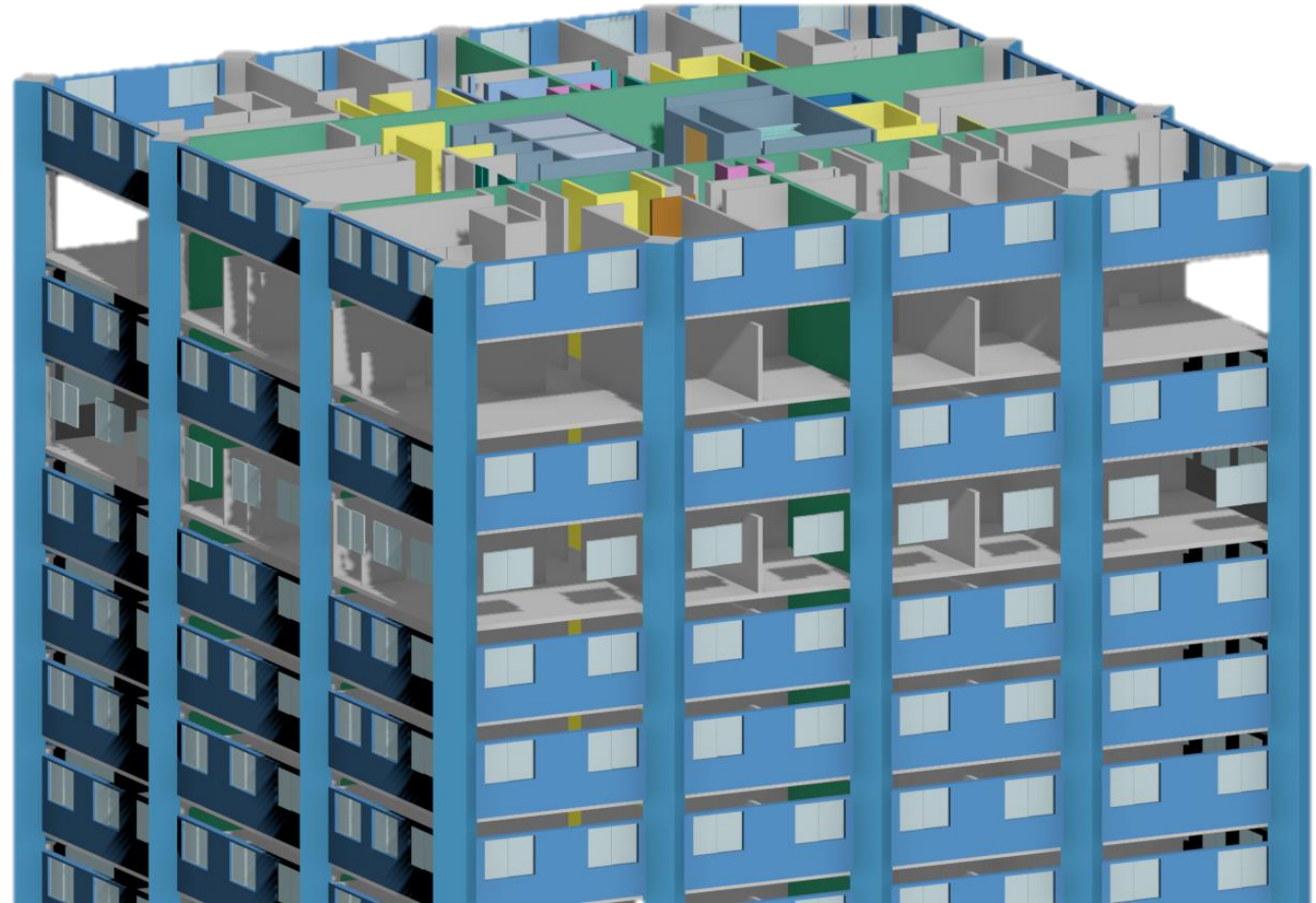


What would happen if an unprotected building caught fire?

Fire stages and development

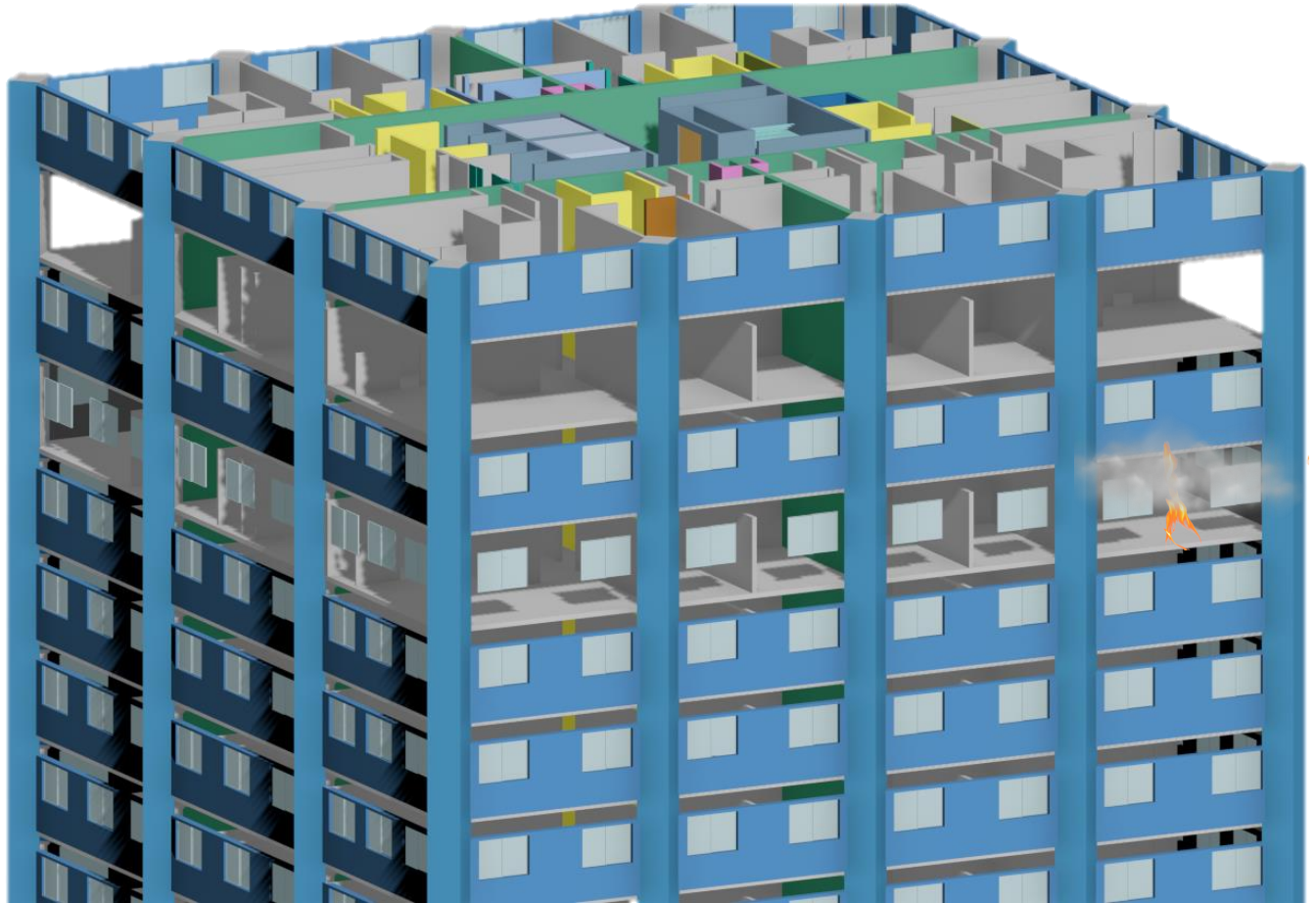


- Flashover is the rapid transition in a fire where all combustible materials in an enclosed space ignite nearly simultaneously due to intense heat, typically occurring when temperatures reach 500–600°C (932–1112°F), causing a sudden spread of flames and extreme danger.



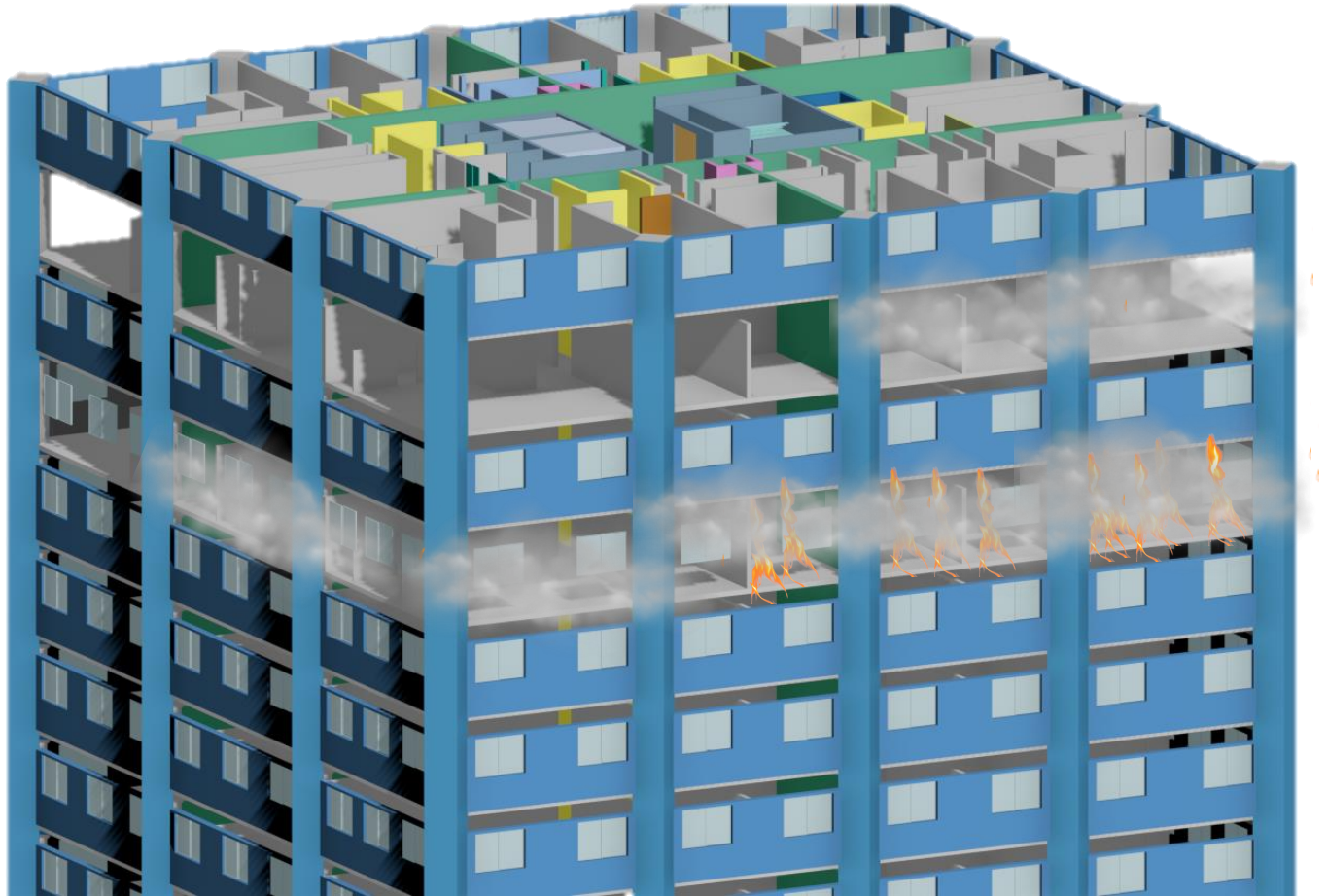
0 to 5 mins

A small fire in a room begins.

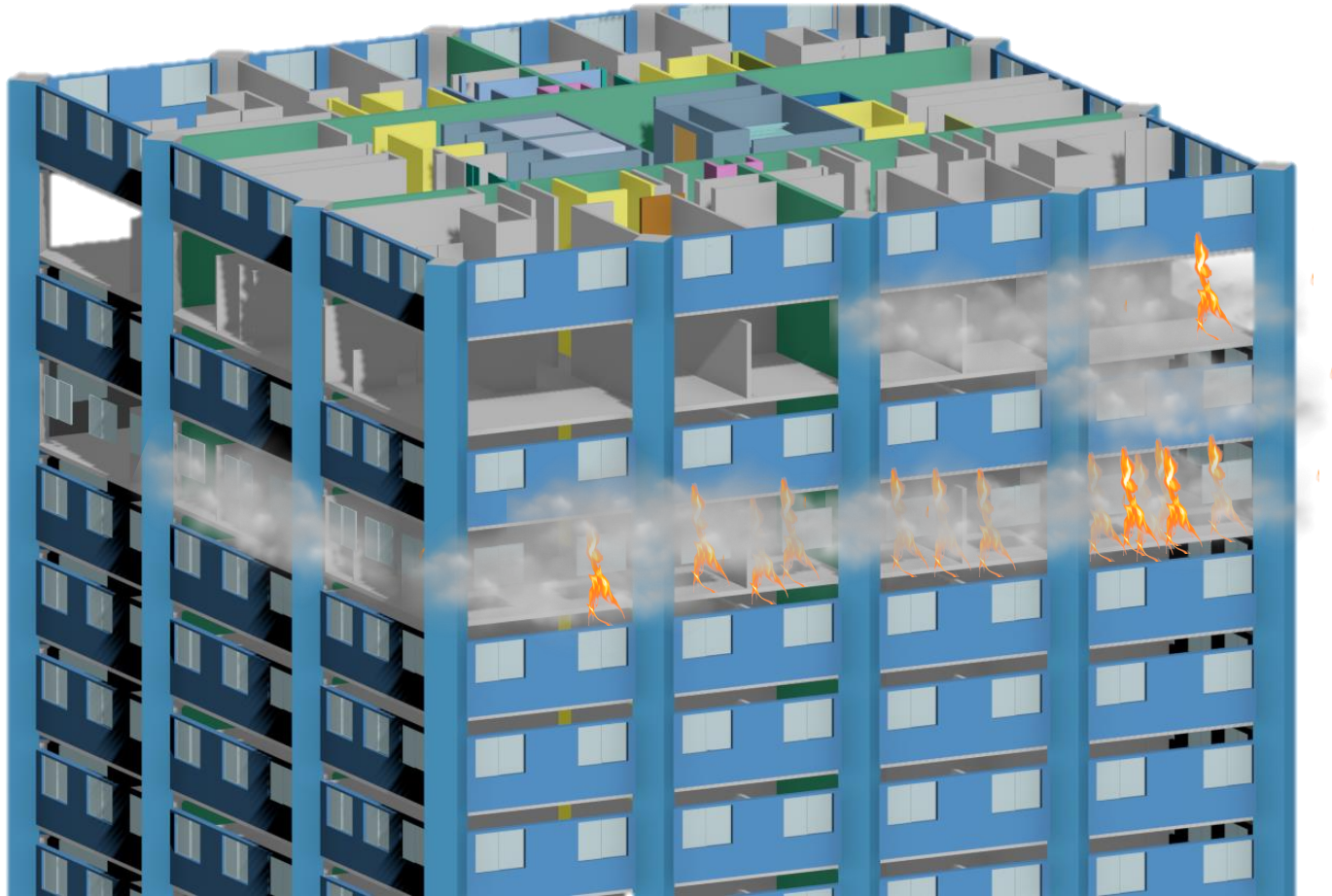


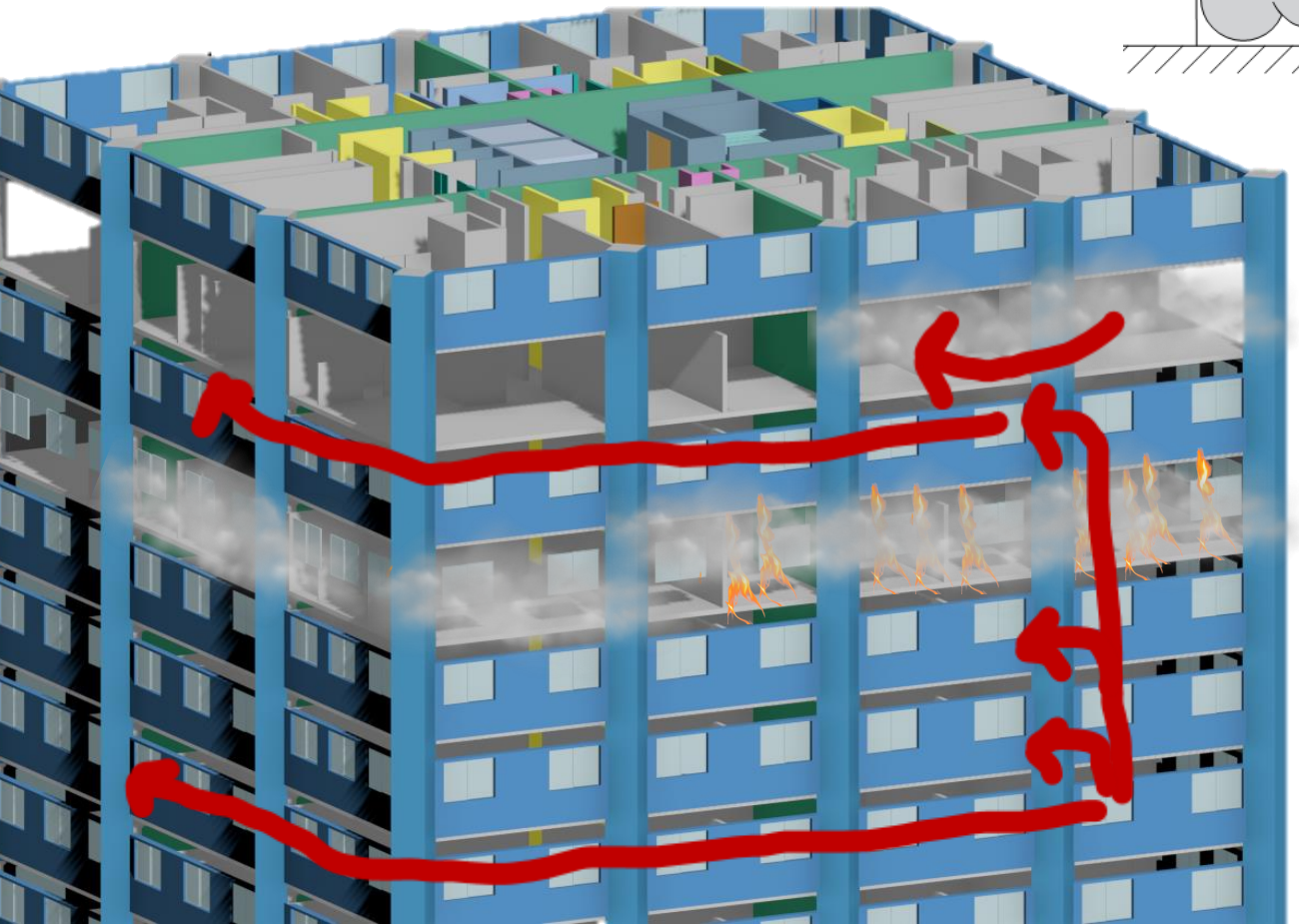
5-15 mins

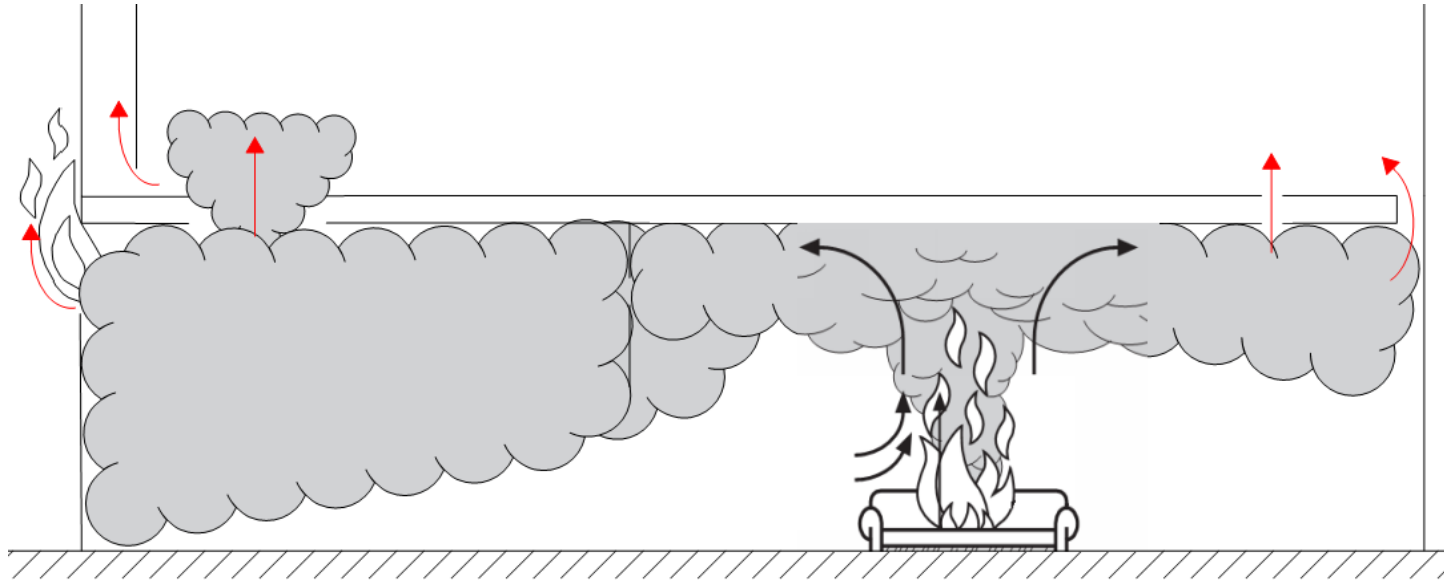
The fire will continue to grow…



15-20 mins

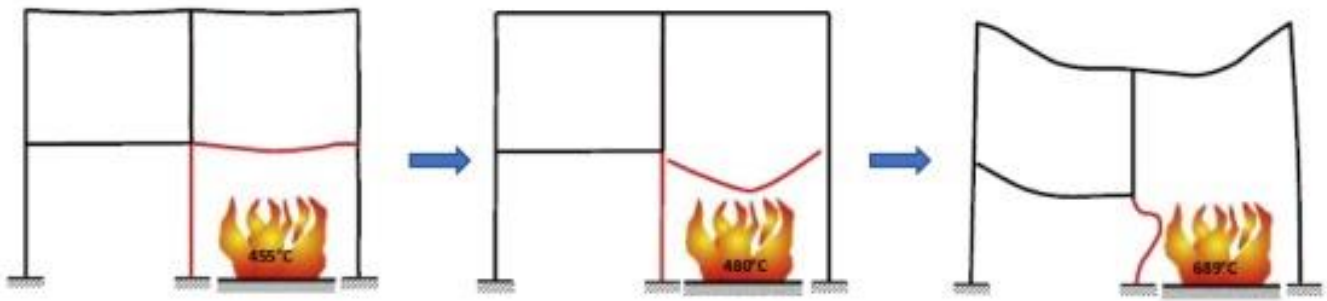


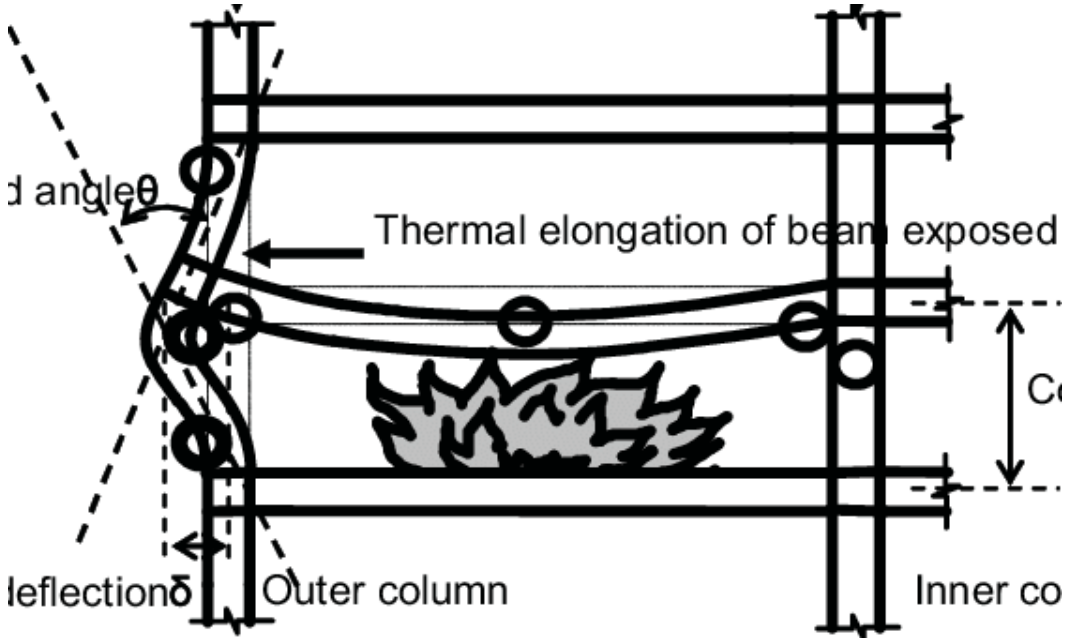




Structural Instability begins (20-30 min).

20-45 mins


455°C
480°C
689°C


d angleθ
Thermal elongation of beam exposed
C
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9
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C1
C2
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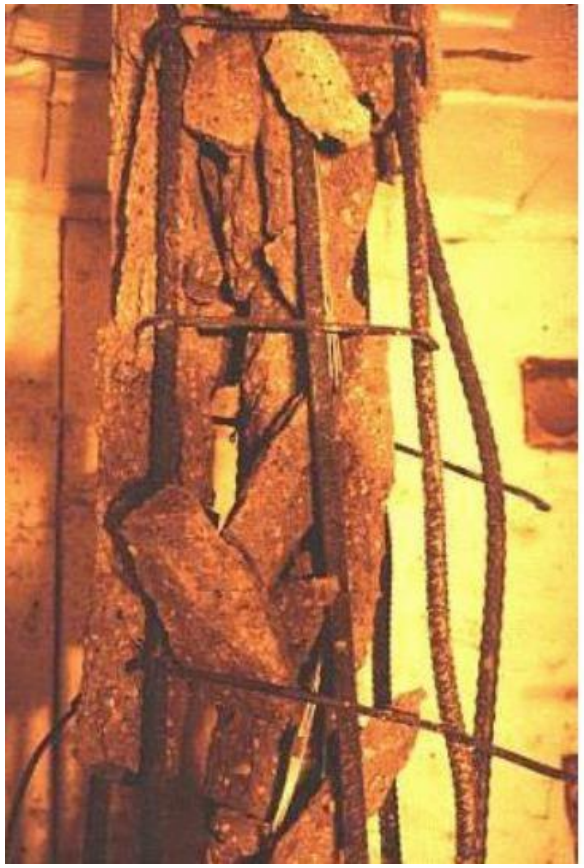
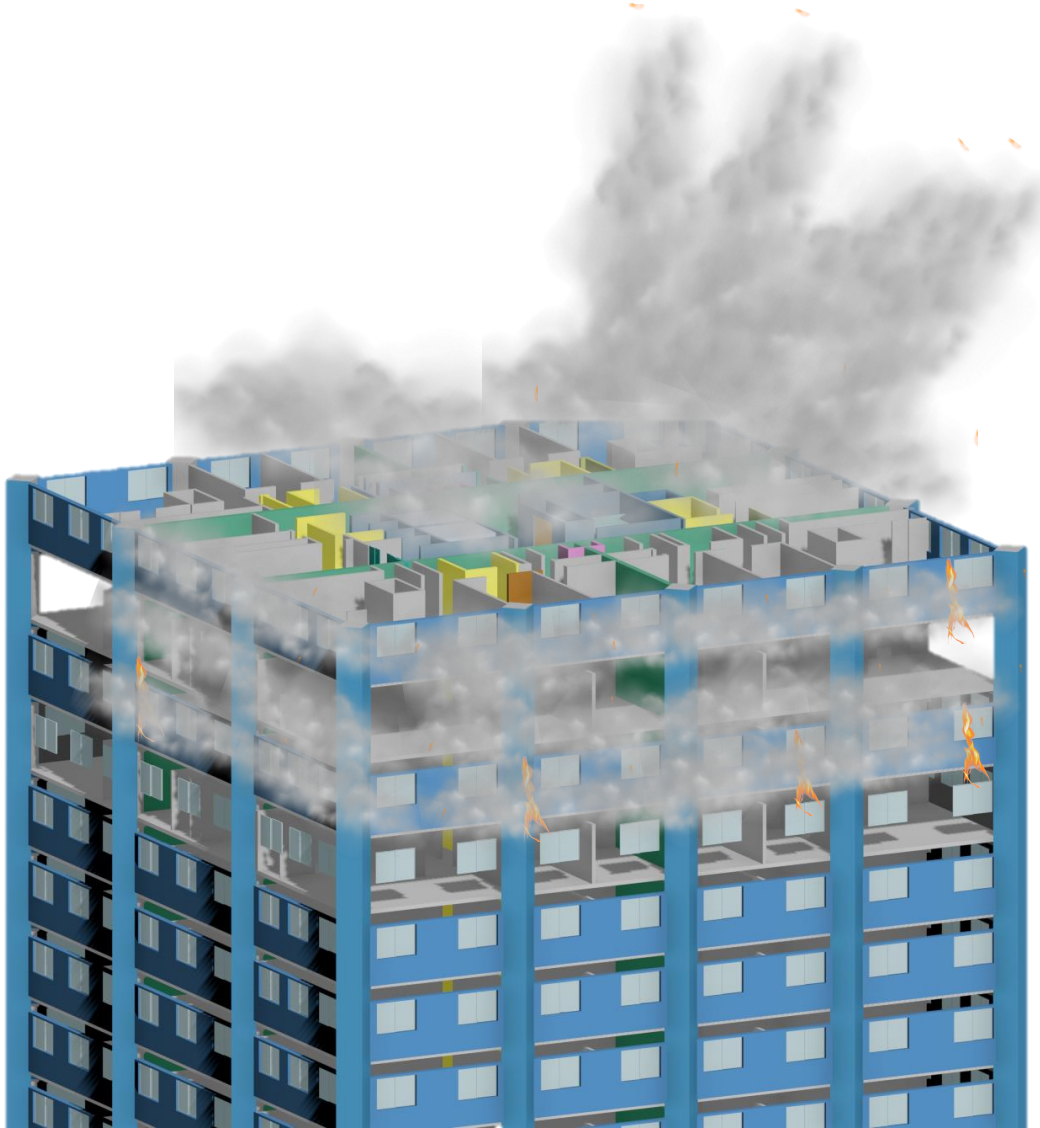
E2
E2
F
2-3

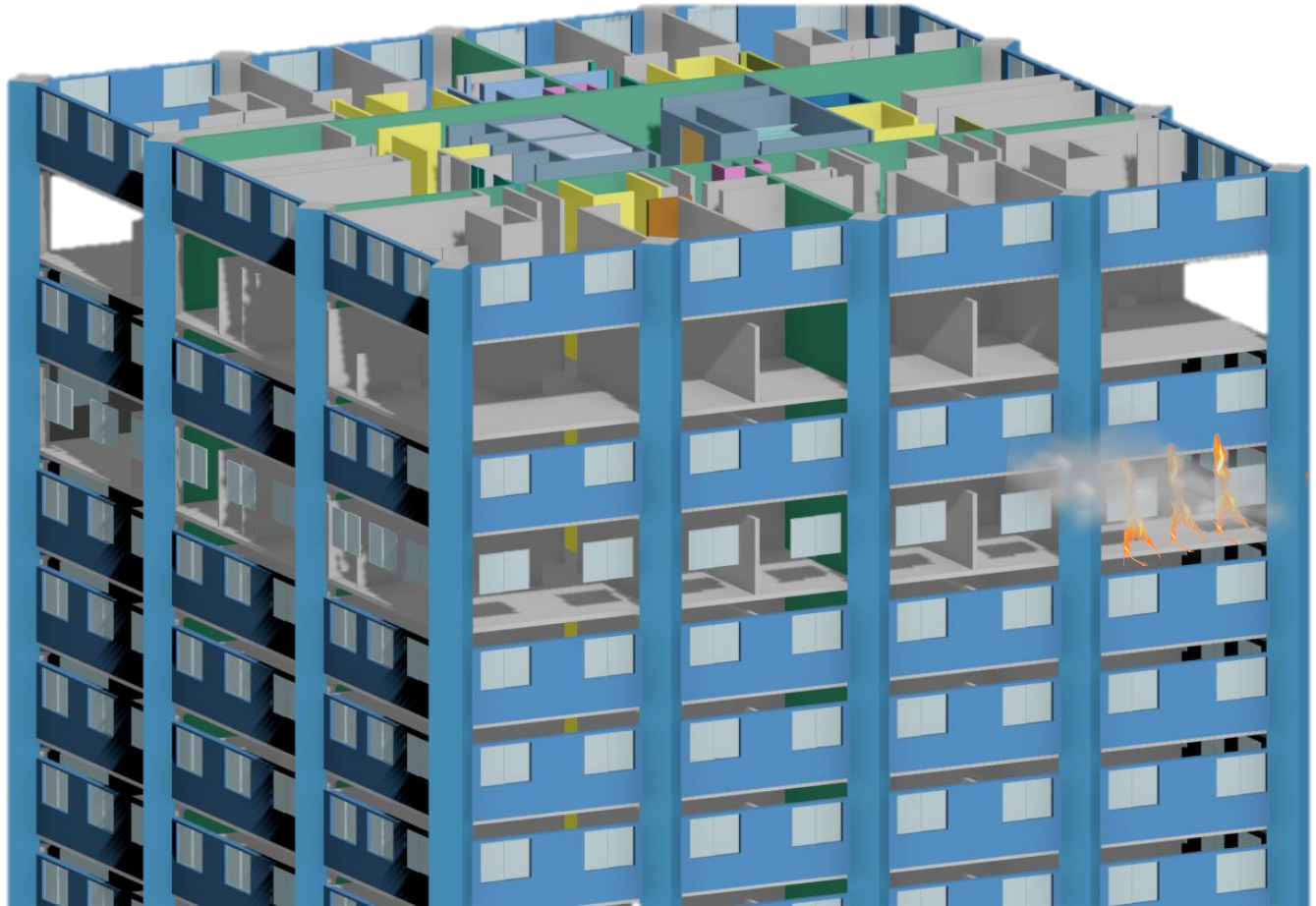


Decay (>45 min)



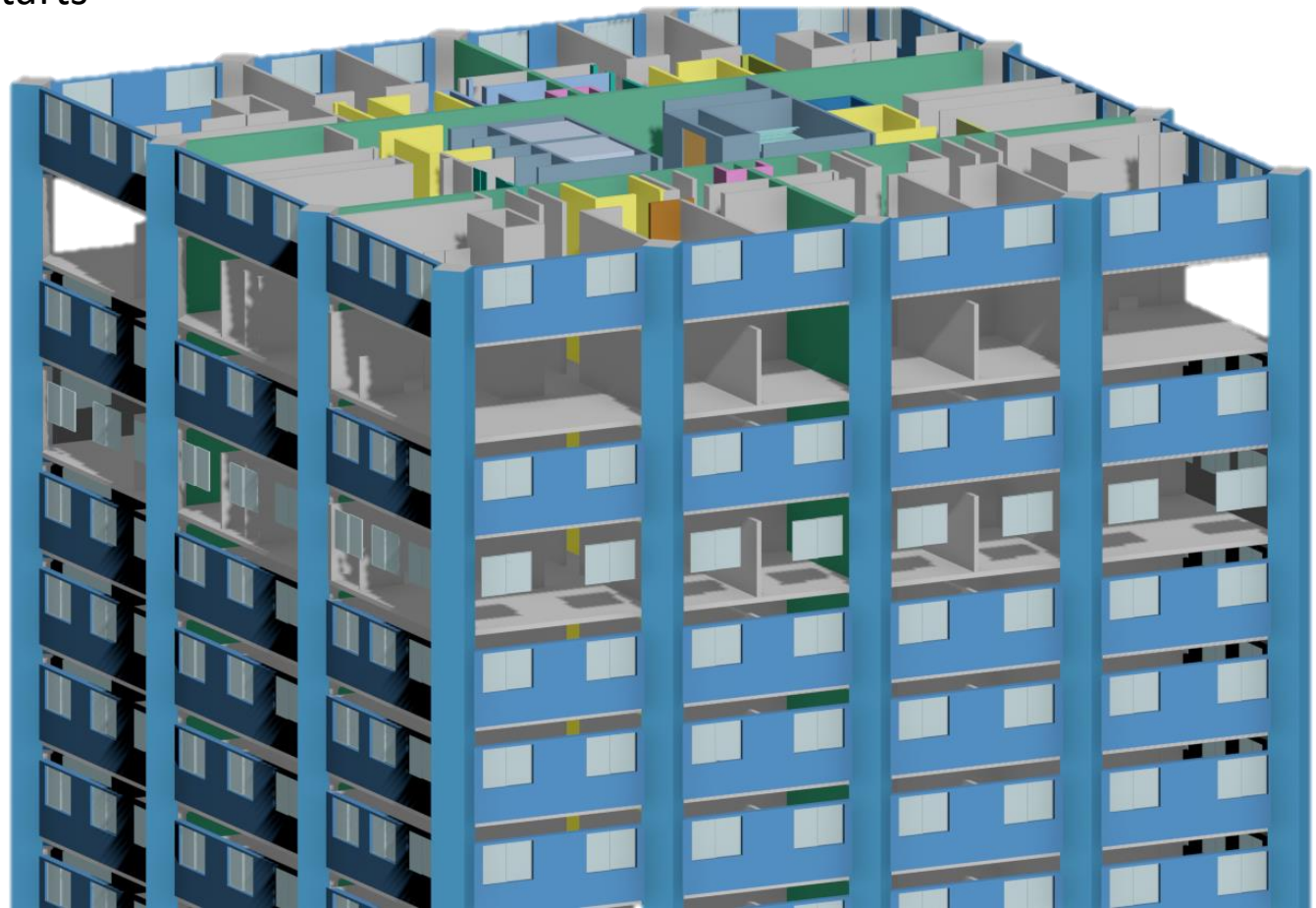
No protection causes 3 key problems:

- **Smoke spread**
- **Flame spread**
- **Risk of structural collapse**



“It’s OK- we don’t need passive fire protection if we have sprinklers…”

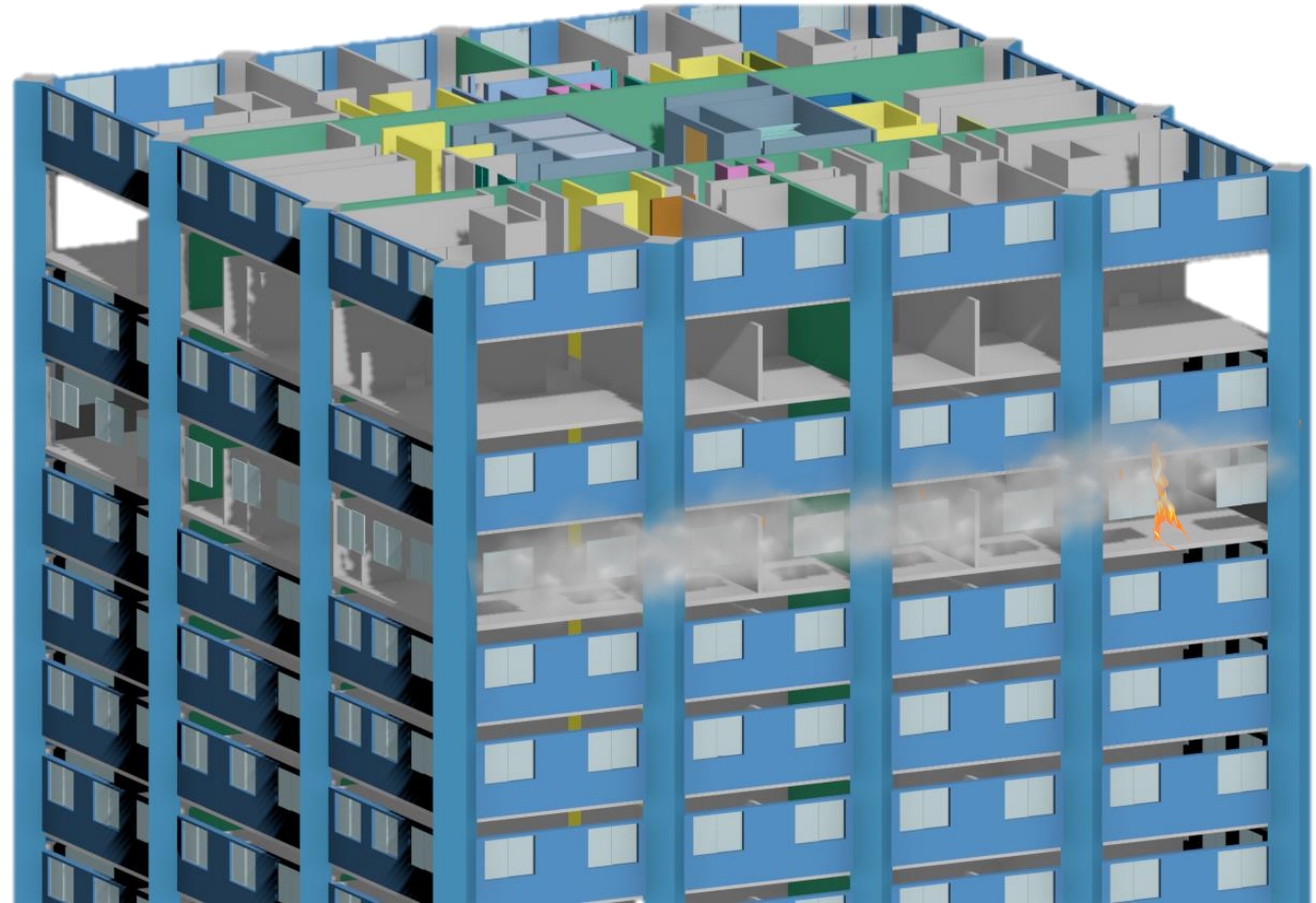
Ignition (0-5 min): Flame sparks and a small fire starts



Detectors sense 60°C rise and the alarms start. Evacuation begins, but smoke still spreads and rises.

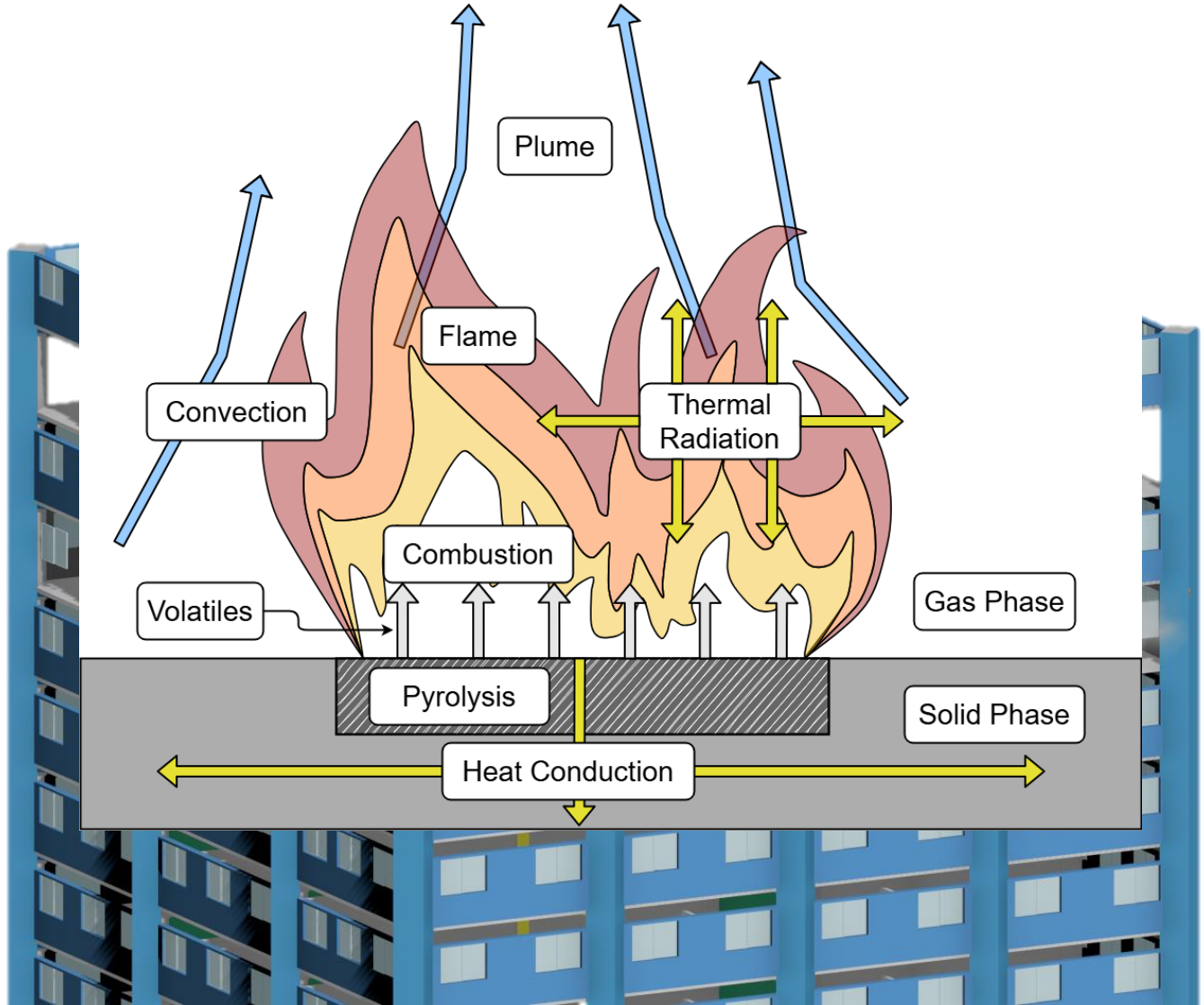
If the fire is small, and located near the sprinklers- the fire will be put out by the sprinklers. Water mist also aerosolizes smoke, aiding smoke spread

……But what if the fire is large, or if it is fast growing?



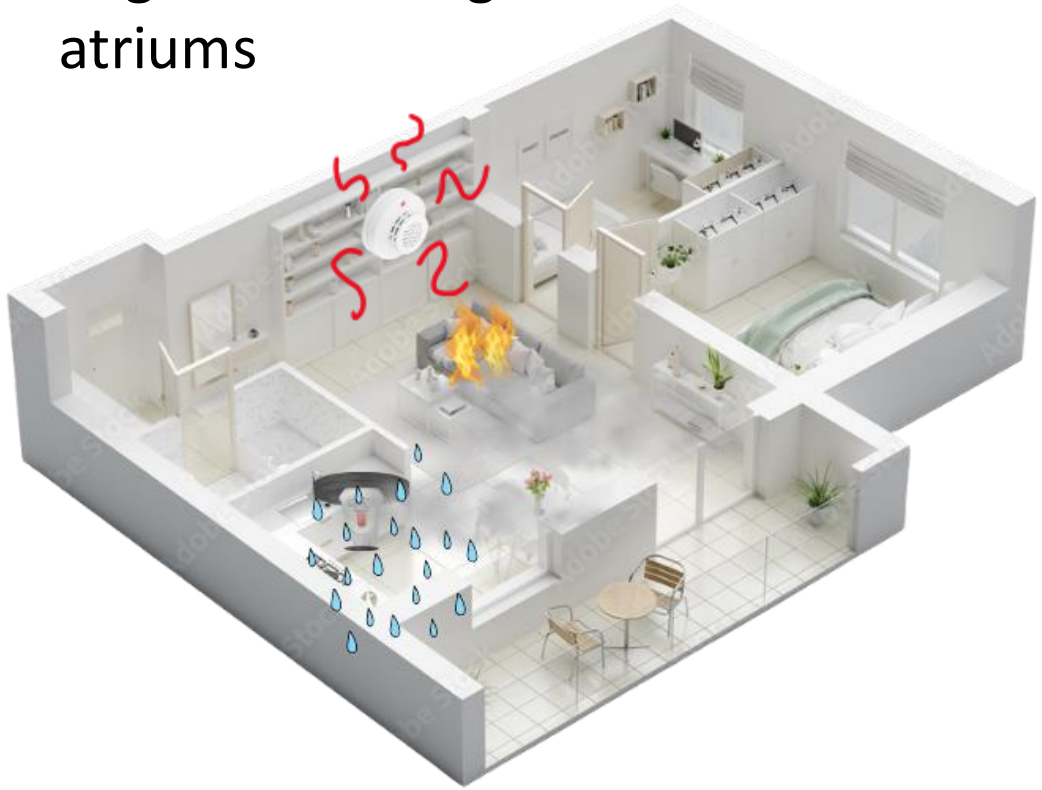
For very large fires or rapidly growing fires, sprinklers **may activate but become overwhelmed.**

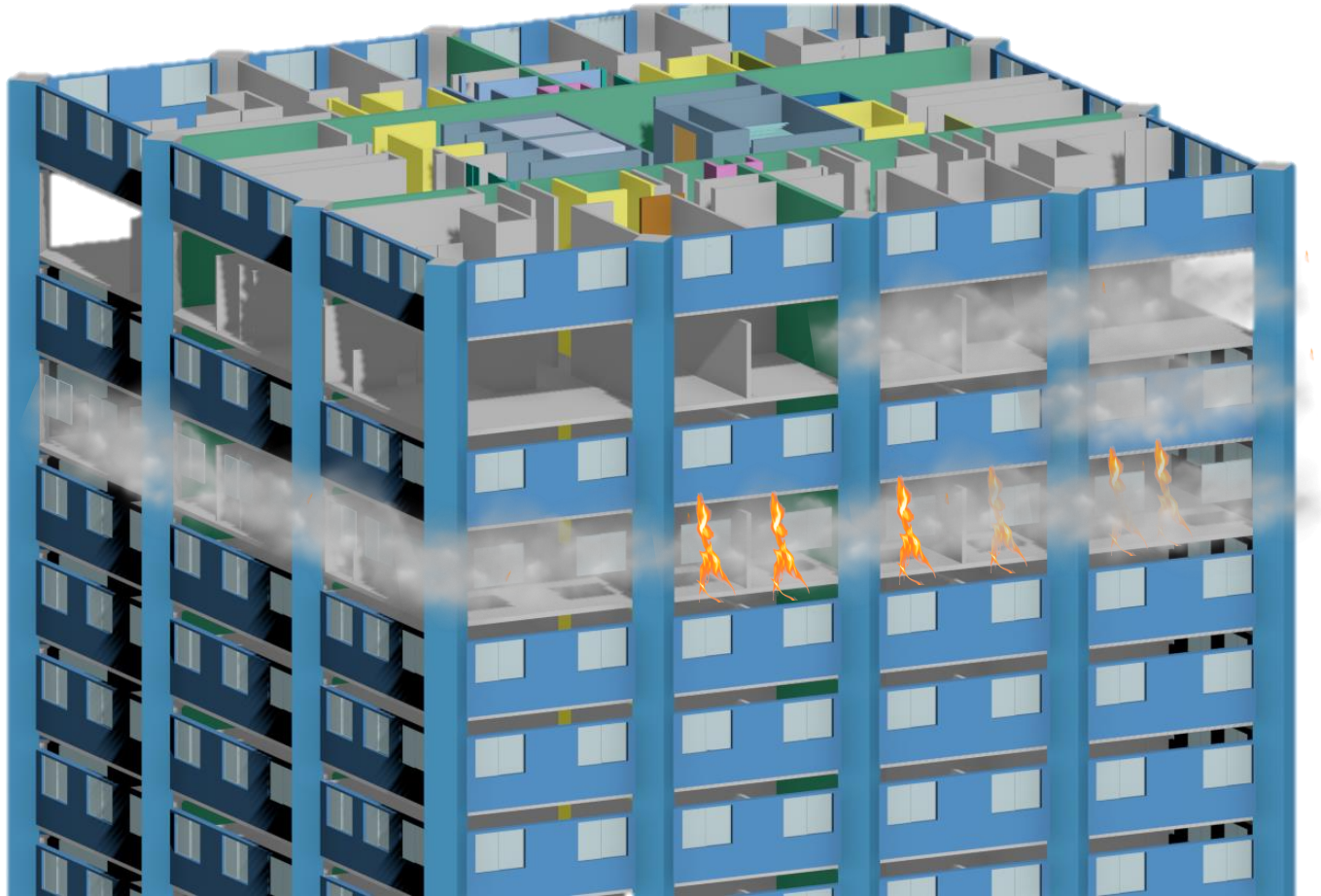
Water mist can further aerosolize smoke, exacerbating toxicity and visibility issues.



5-15 mins

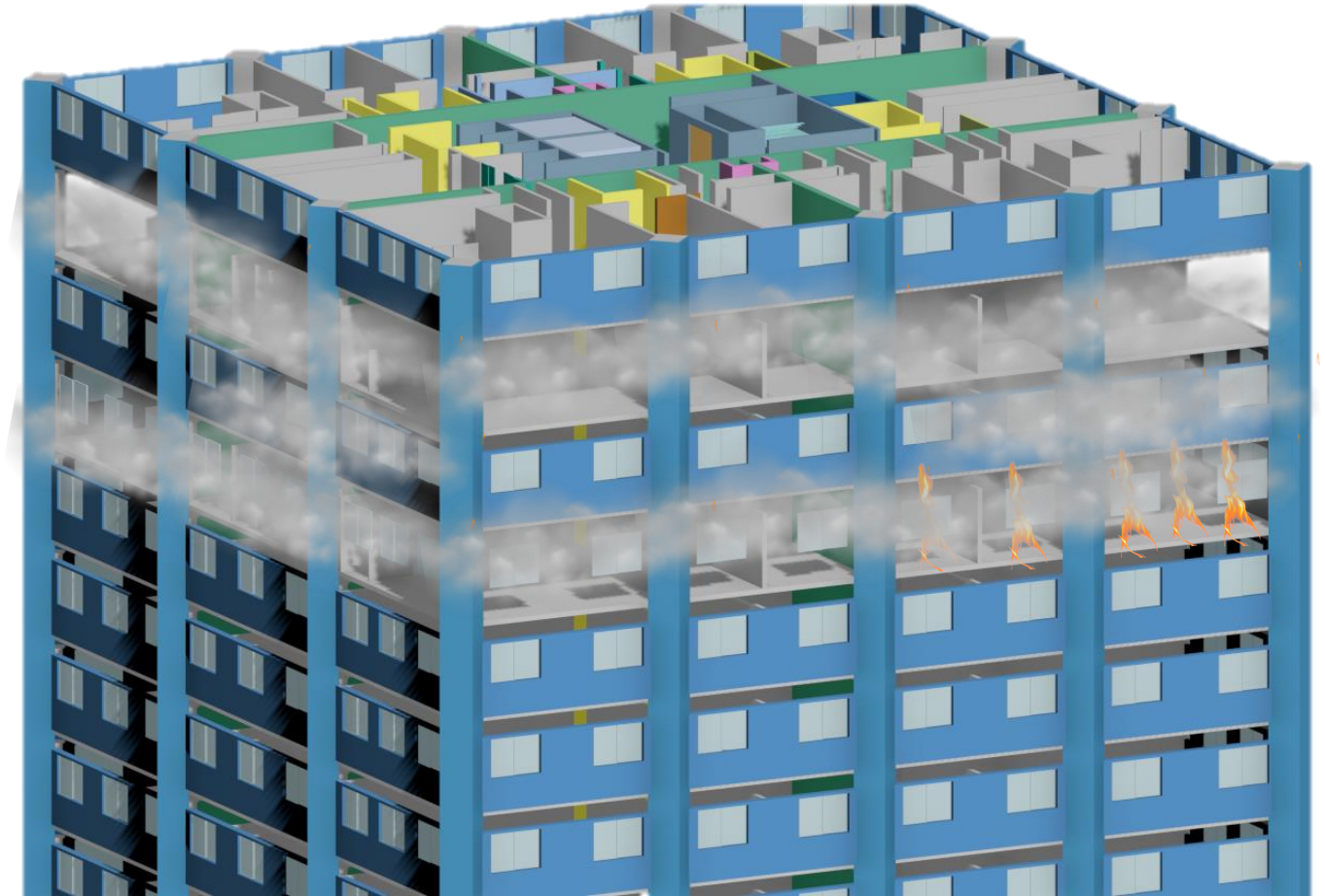
sprinklers activate at 68°C, discharging water, capping fire growth. Flames recede, but water mist aerosolizes smoke**, aiding spread**. Horizontal smoke migration through unsealed doors fills atriums





15-20 mins

Flashover is mitigated (15-20 min): sprinklers prevent uniform ignition. BUT vertical shaft convection propels unconfined smoke upward, infiltrating vents.



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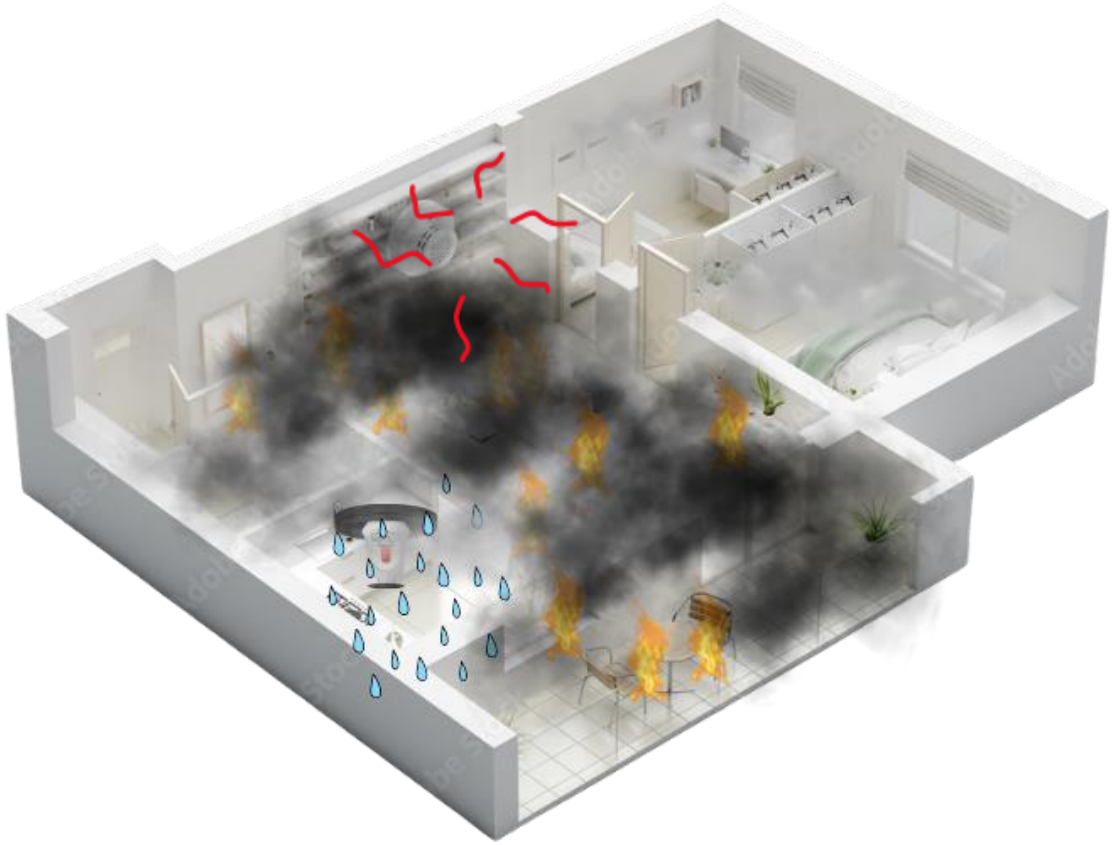
Early-morning fires **spread smoke across wards**; victims in **distant areas died** from inhalation while asleep or evacuating, **despite sprinklers activating.**

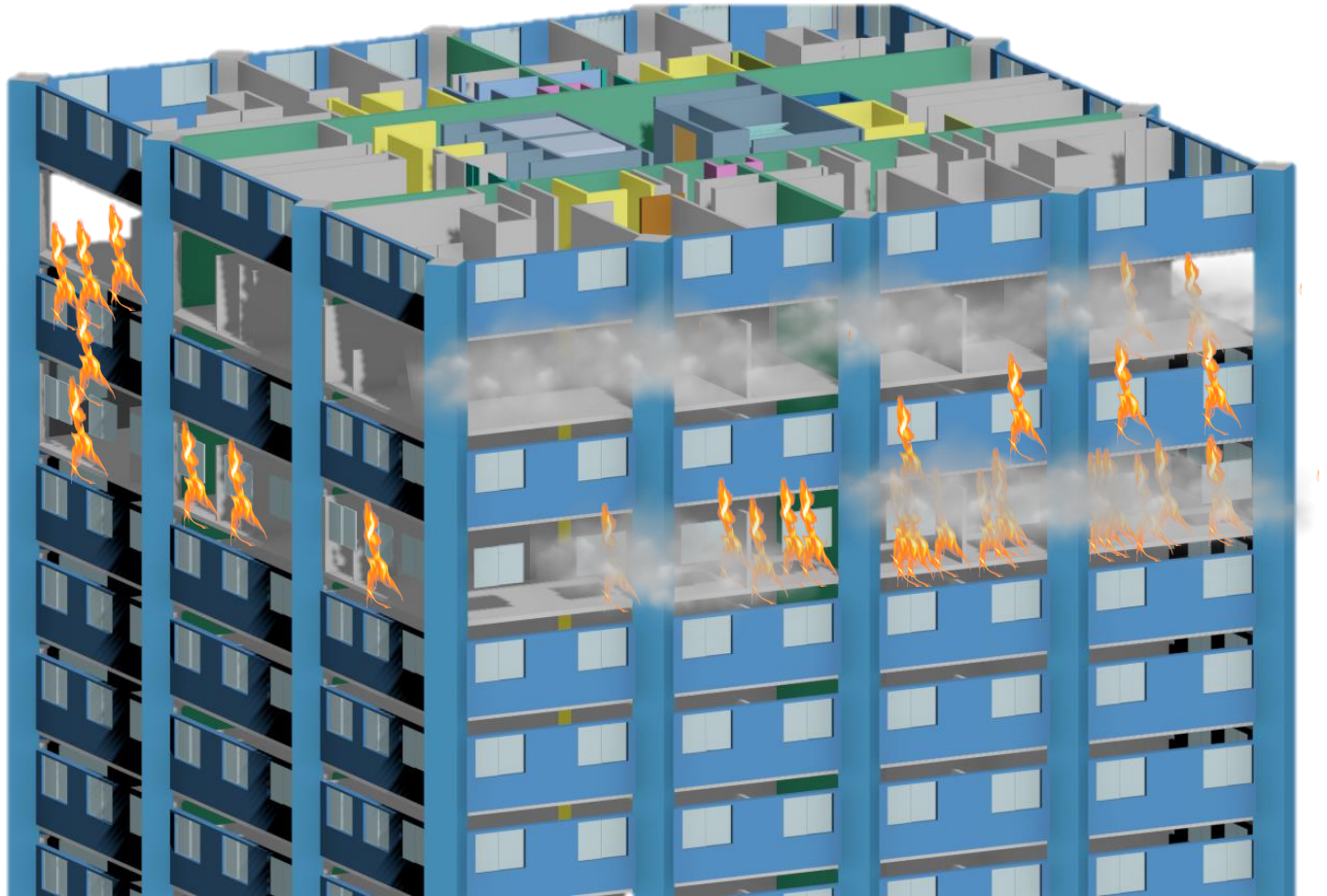
Casualties: **14 deaths (smoke and burns), 32 hospitalized for inhalation**.

Fully Developed (20-45 min)

Localized to origin room, **heat begins to warp steel columns (concrete may spaul).**

No collapse imminent, but smoke permeates floors of the building and oxygen dips to 12%. Sprinklers wet distant areas, BUT occupants ARE STILL AT RISK from inhalation. Smoke flood exit ways, making escape difficult.



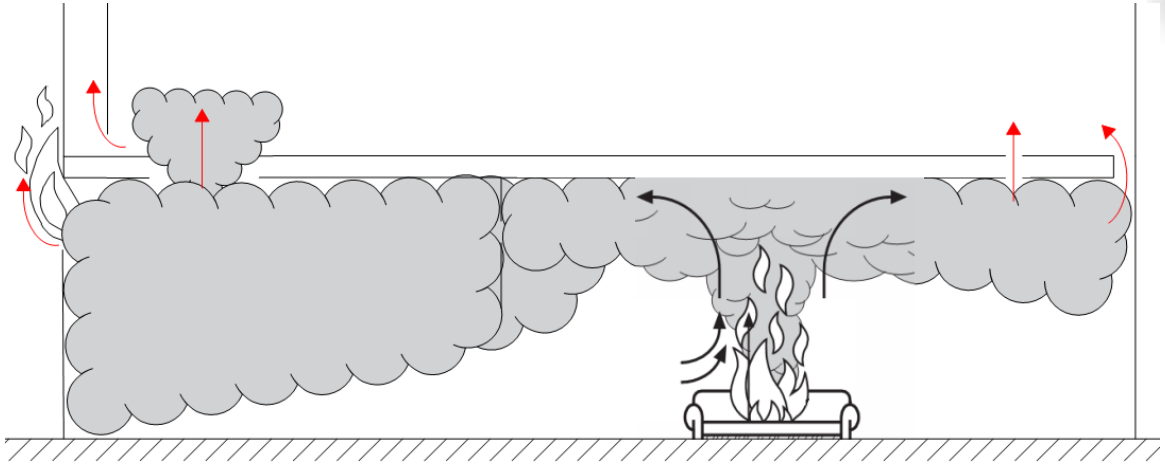


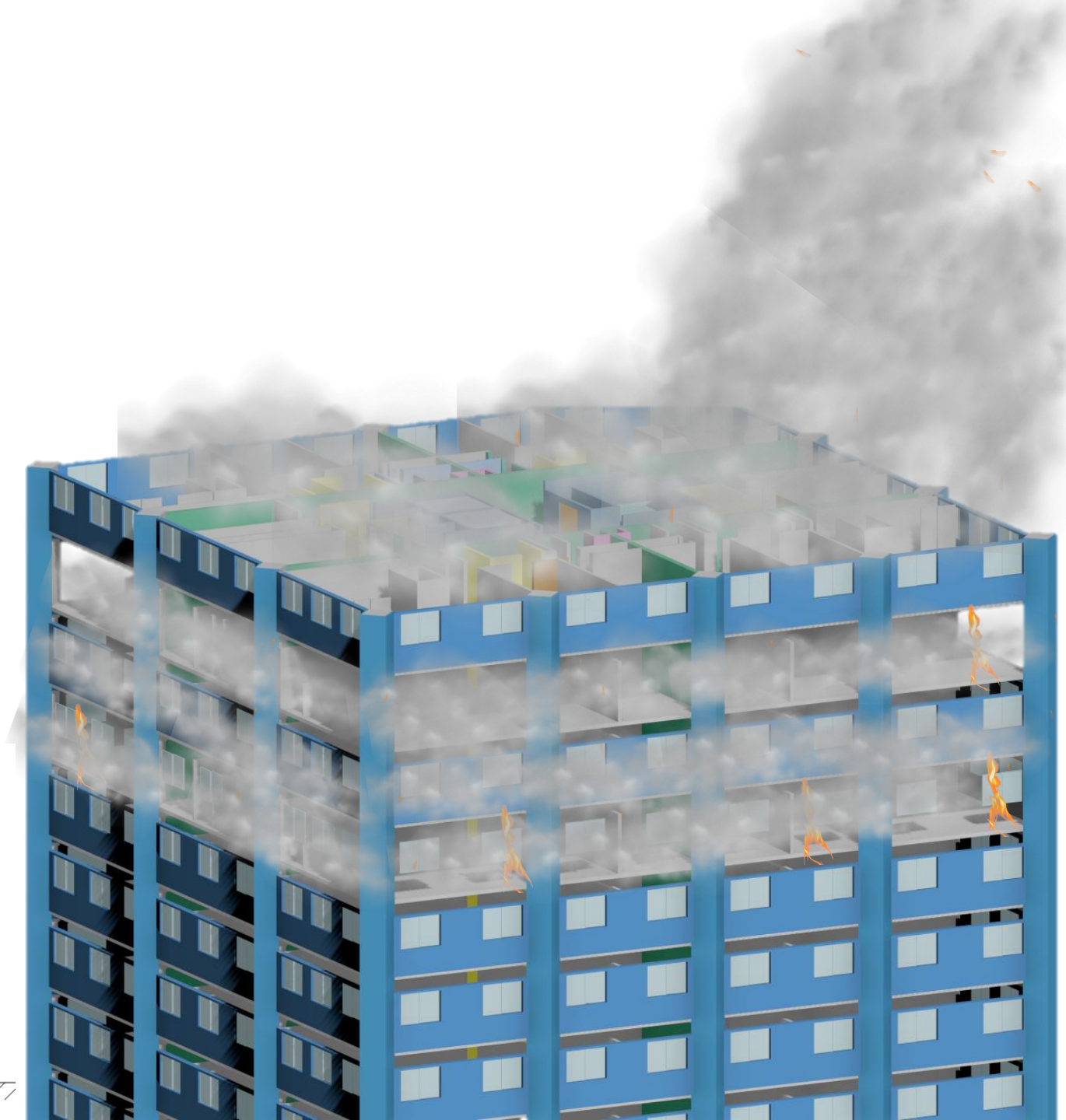
>45 mins

Water suppression douses embers.

Large volumes of smoke are produced. As there is no compartmentation, smoke travels through the building, flooding egress routes.

Those unable to escape unassisted are at risk of incapacitation and are reliant on rescue from firefighters.





Sprinklers

The statistics

Sprinklers are effective 89% of the time

Key cause of failure:

-Delayed onset

-Failed onset (7%)

-Fire grew too large too fast, and the sprinklers **failed to contain fire**

The other 11% of the time....?

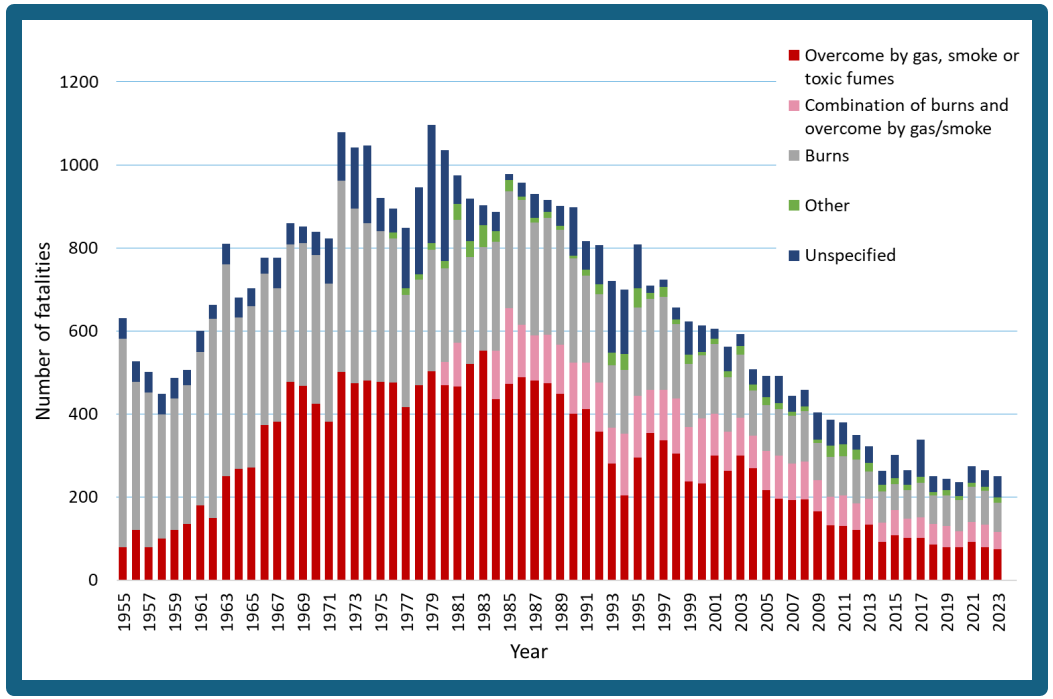
NFPA Research | Fire Protection Systems: U.S. Experience with Sprinklers

By Tucker McGree 01-Apr-2024

No protection causes 3 key problems:

- **Smoke spread**
- **Flame spread**
- **Risk of structural collapse**

Reduced risk but still a problem if the fire develops rapidly or is large.



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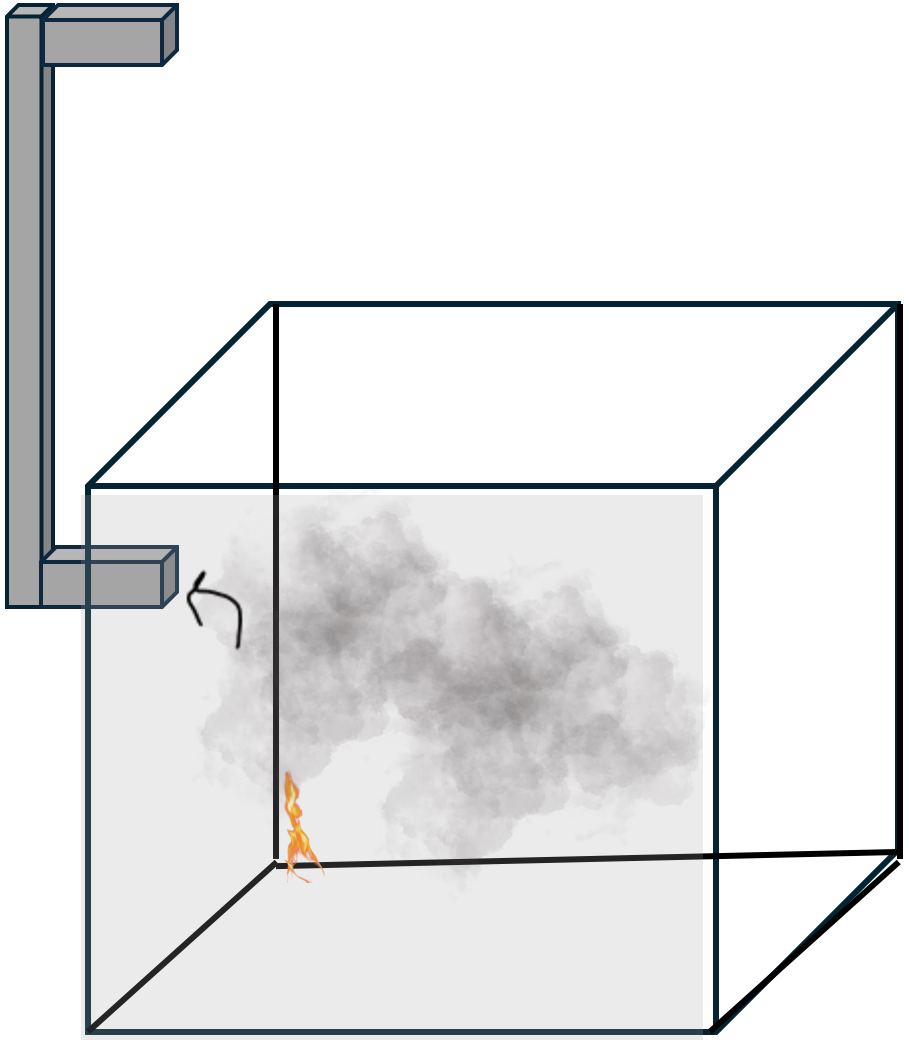
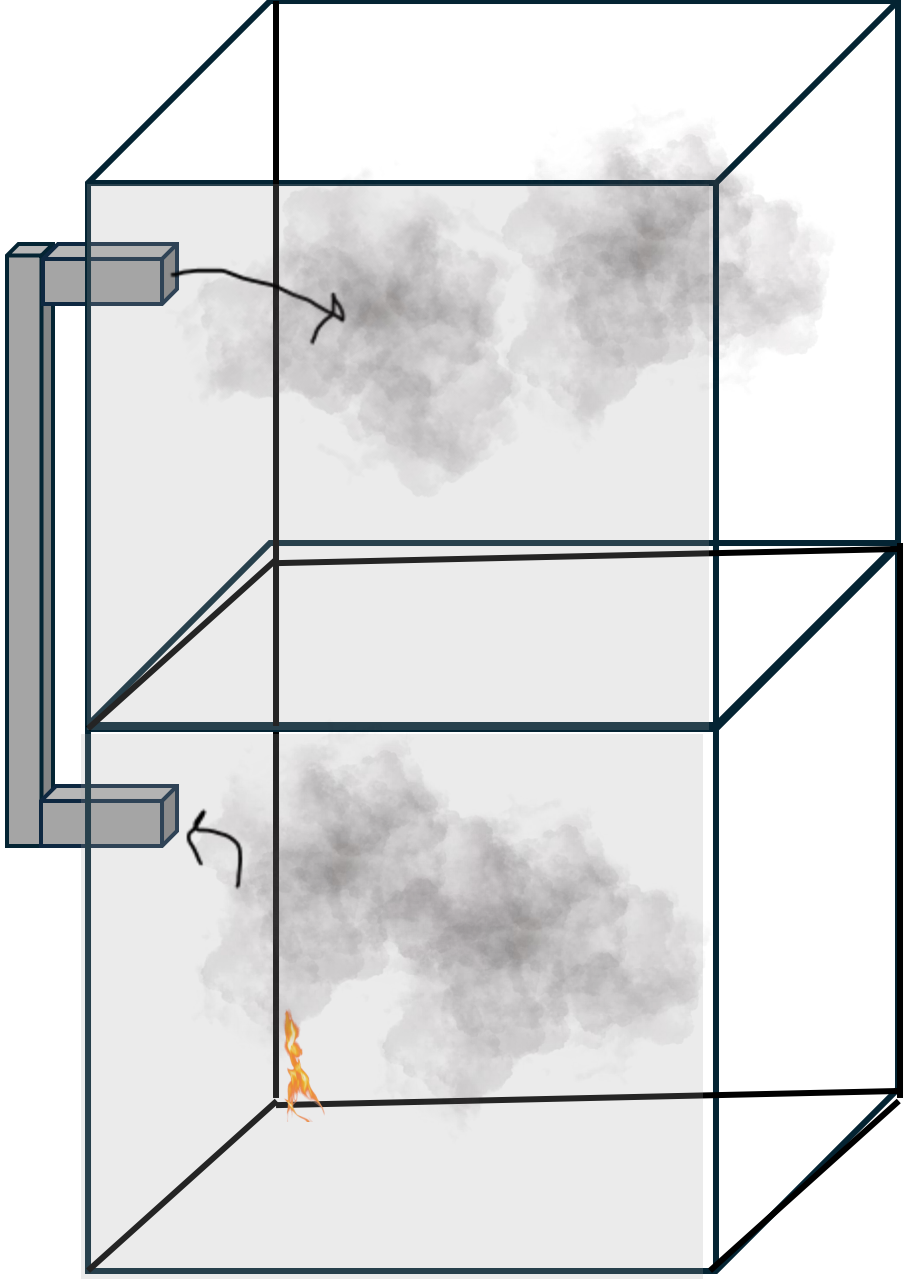
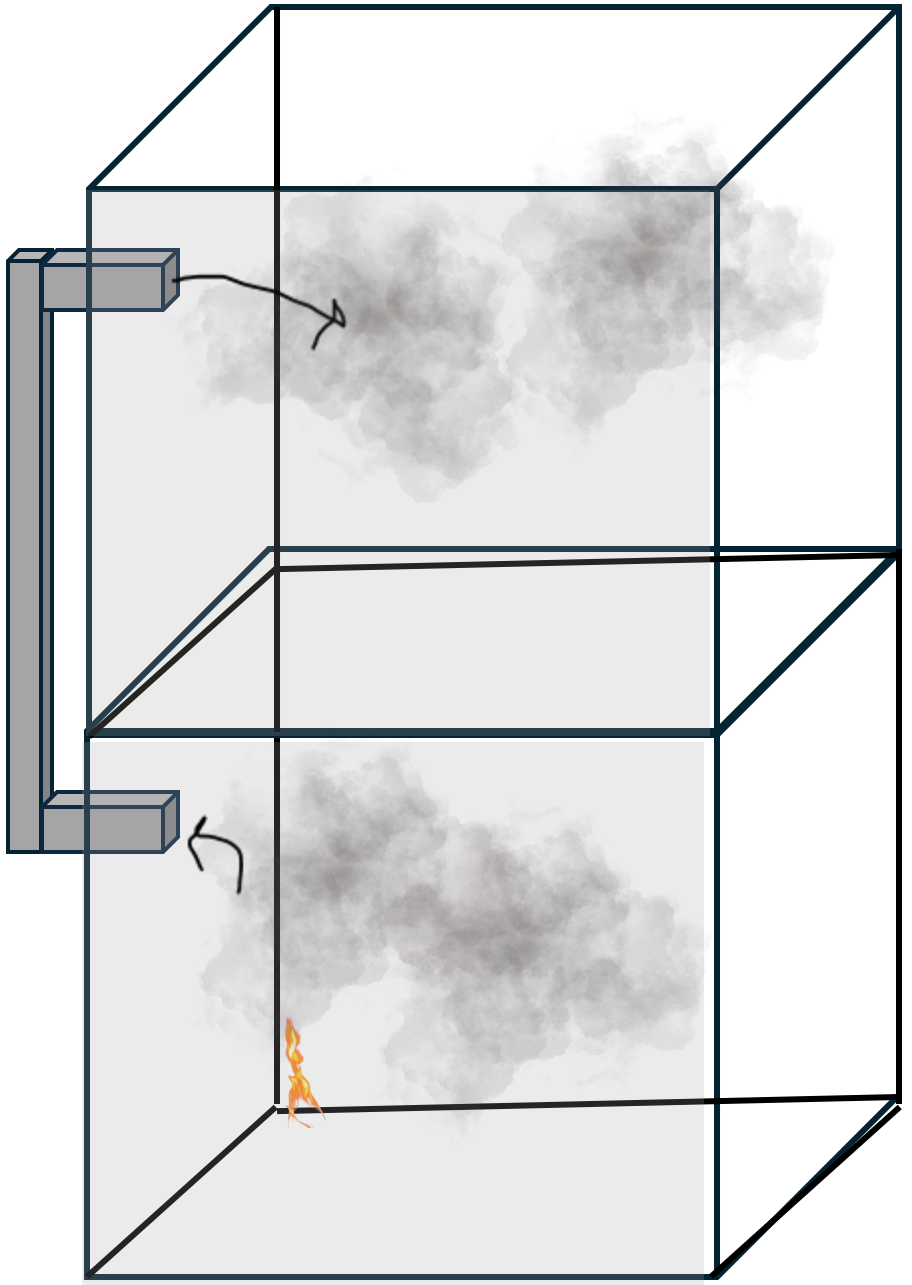
Active fire protection (sprinklers and alarms) stops the fire growing too large;

Passive fire protection stops the fire and smoke spreading around the building

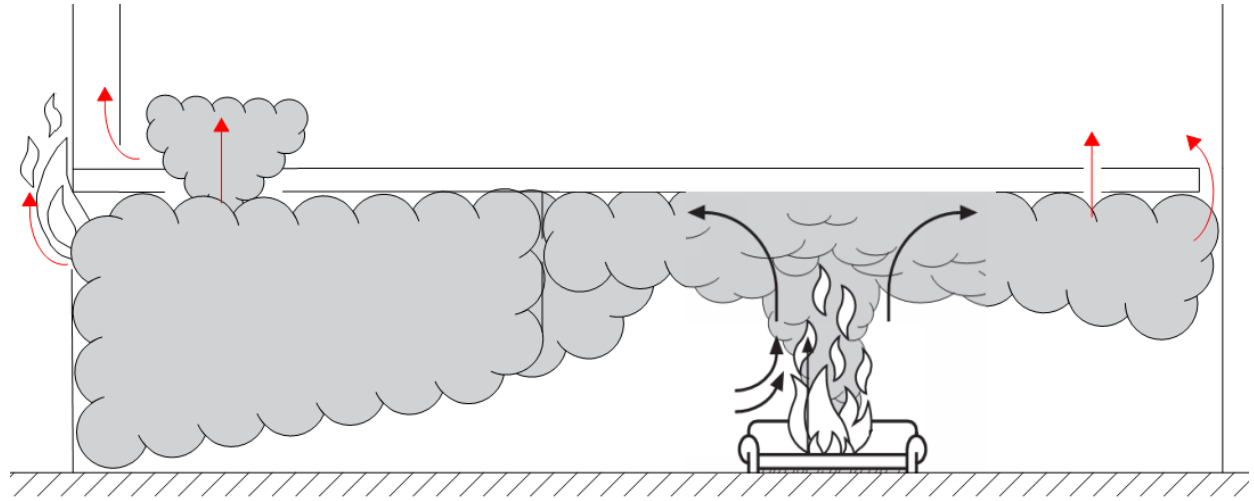


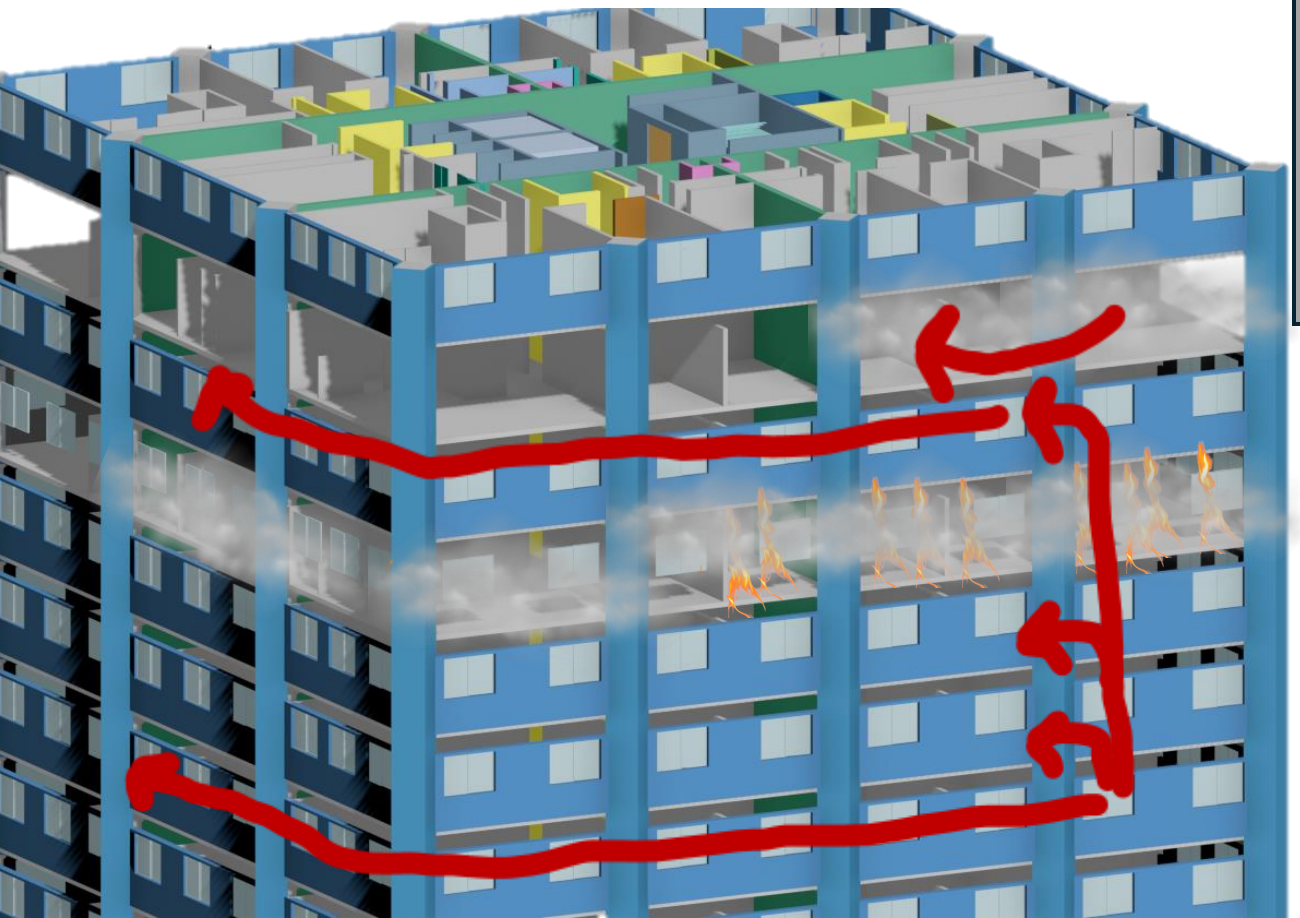
Smoke spread still occurs with sprinklers and alarms!



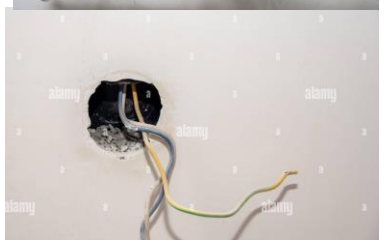


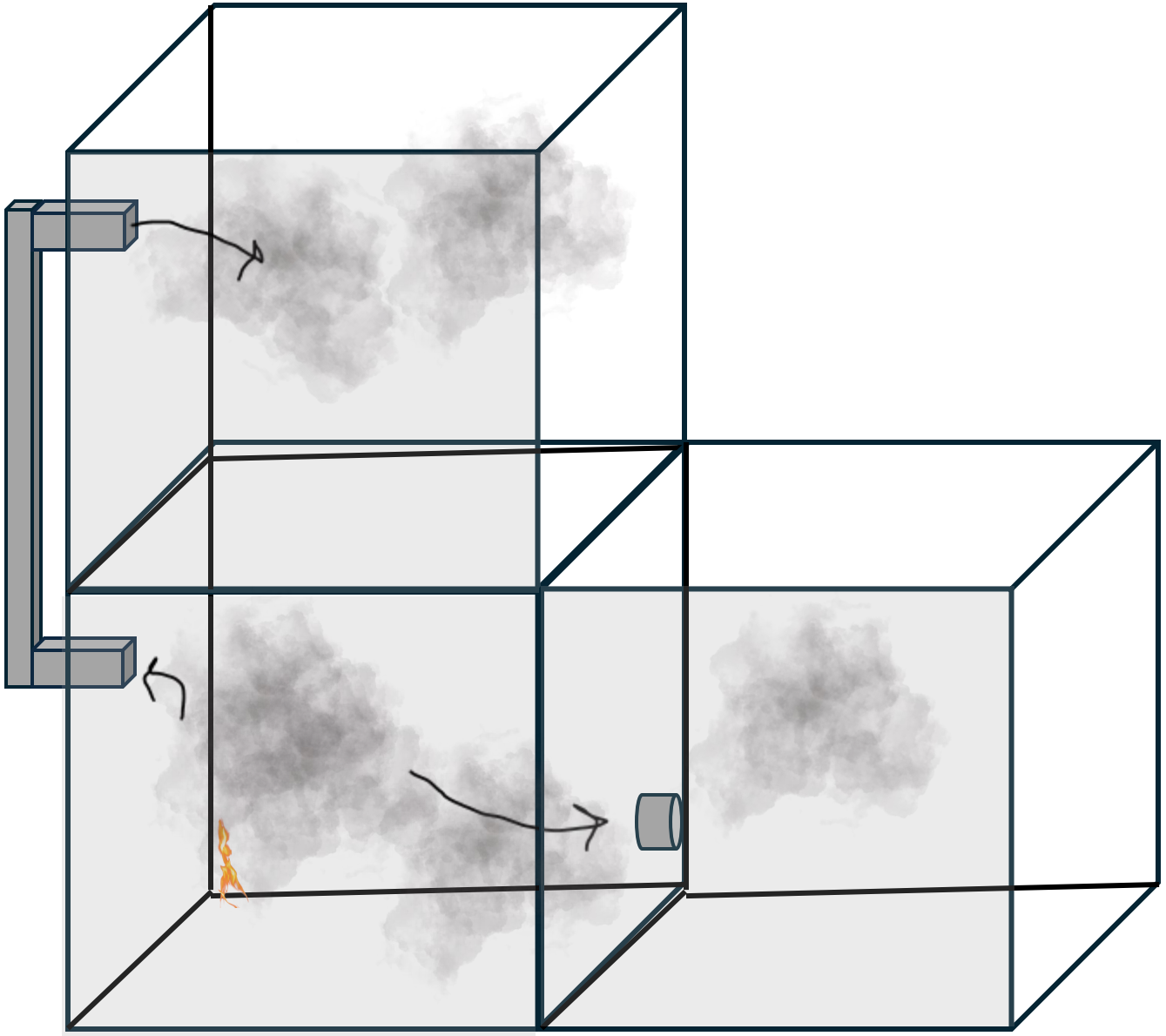
Smoke will move through openings to other parts of the building.
This is how occupants die in fires despite not being near the room of the fire.






WESTLAND-LR 6" SCH 10





HVAC systems, Plastic pipes, metal pipes, cables etc..

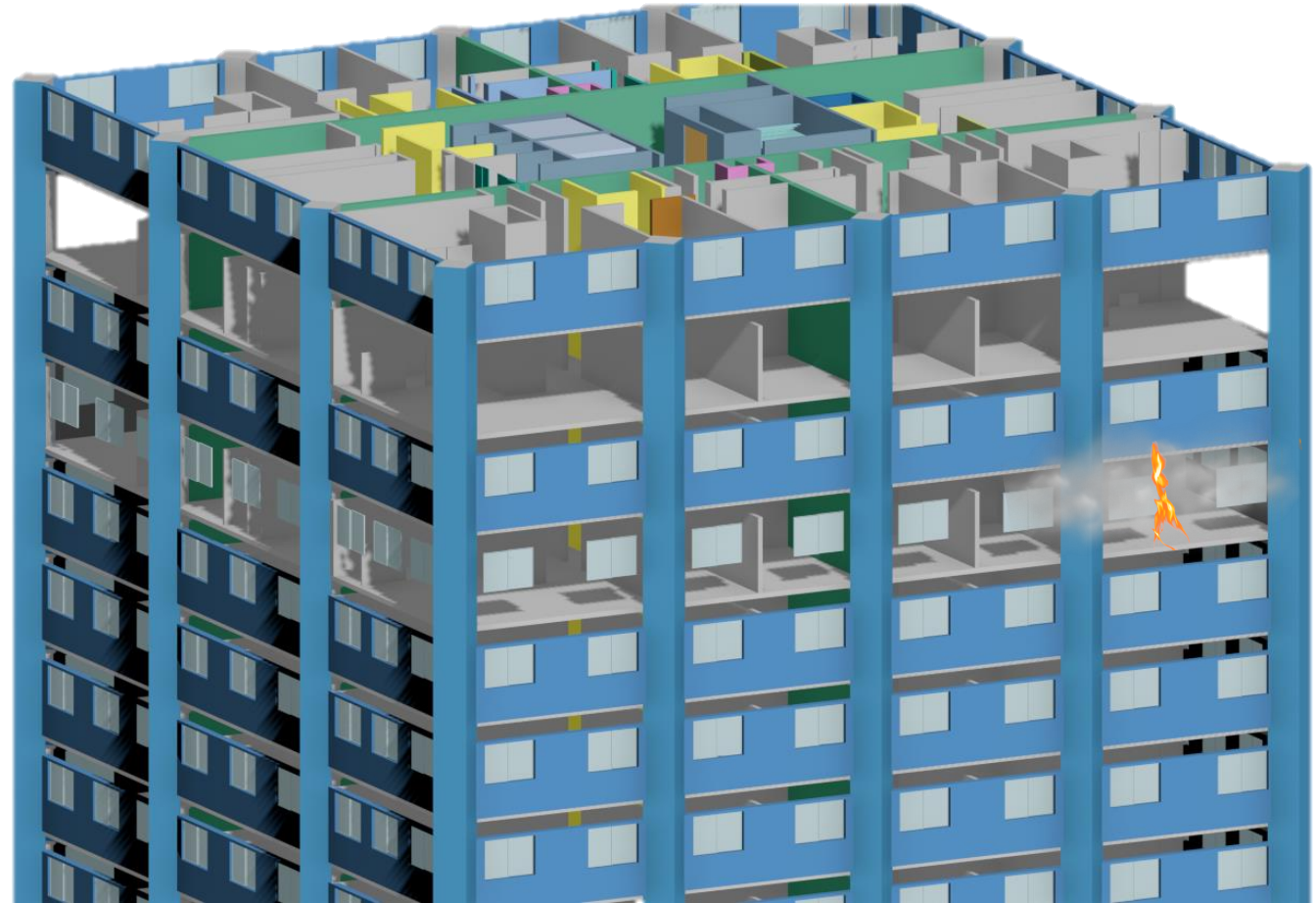
Solving the problem

Ignition 0-5 mins

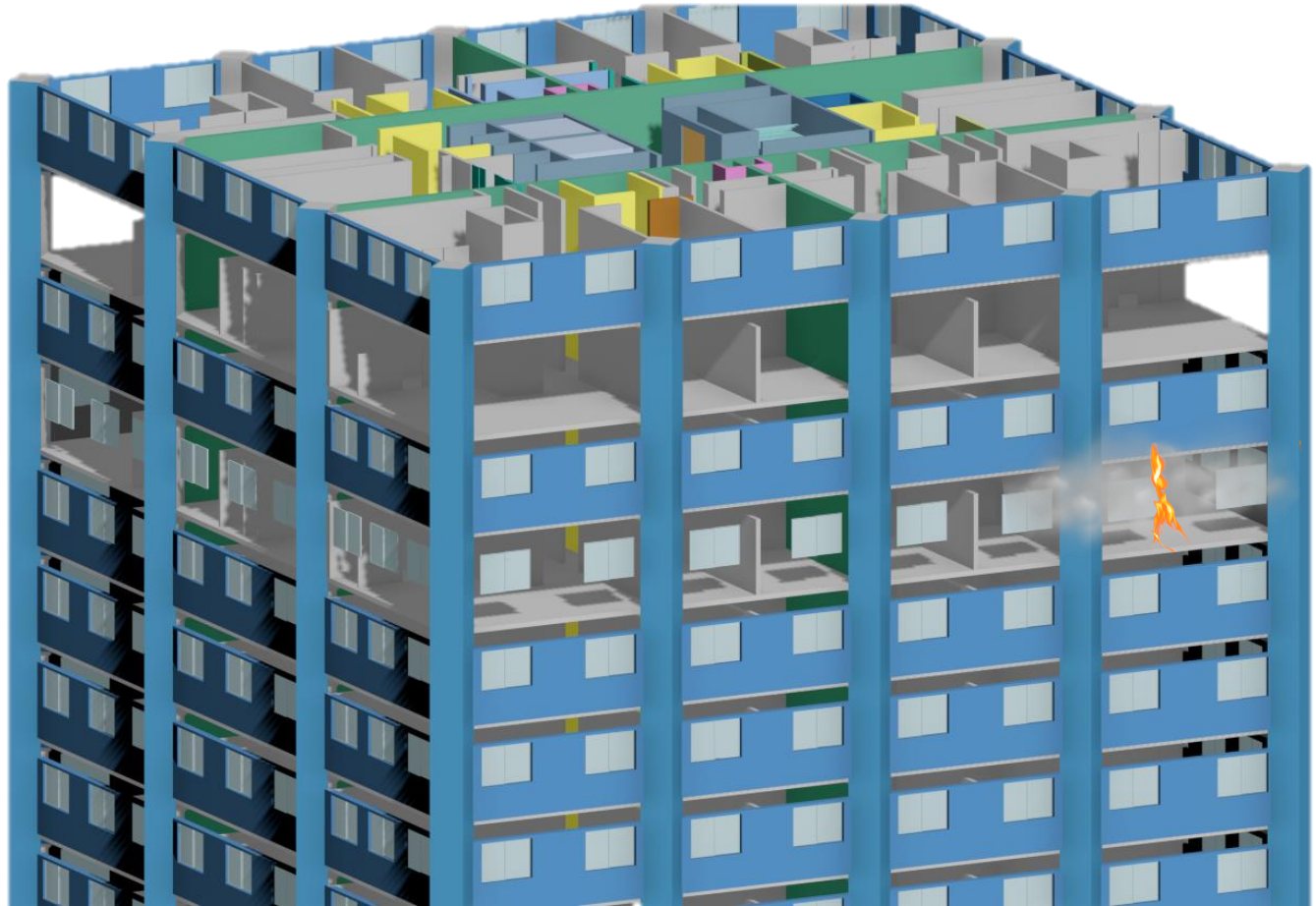
Flame sparks and a small fire starts

Ignition (0-5 min)

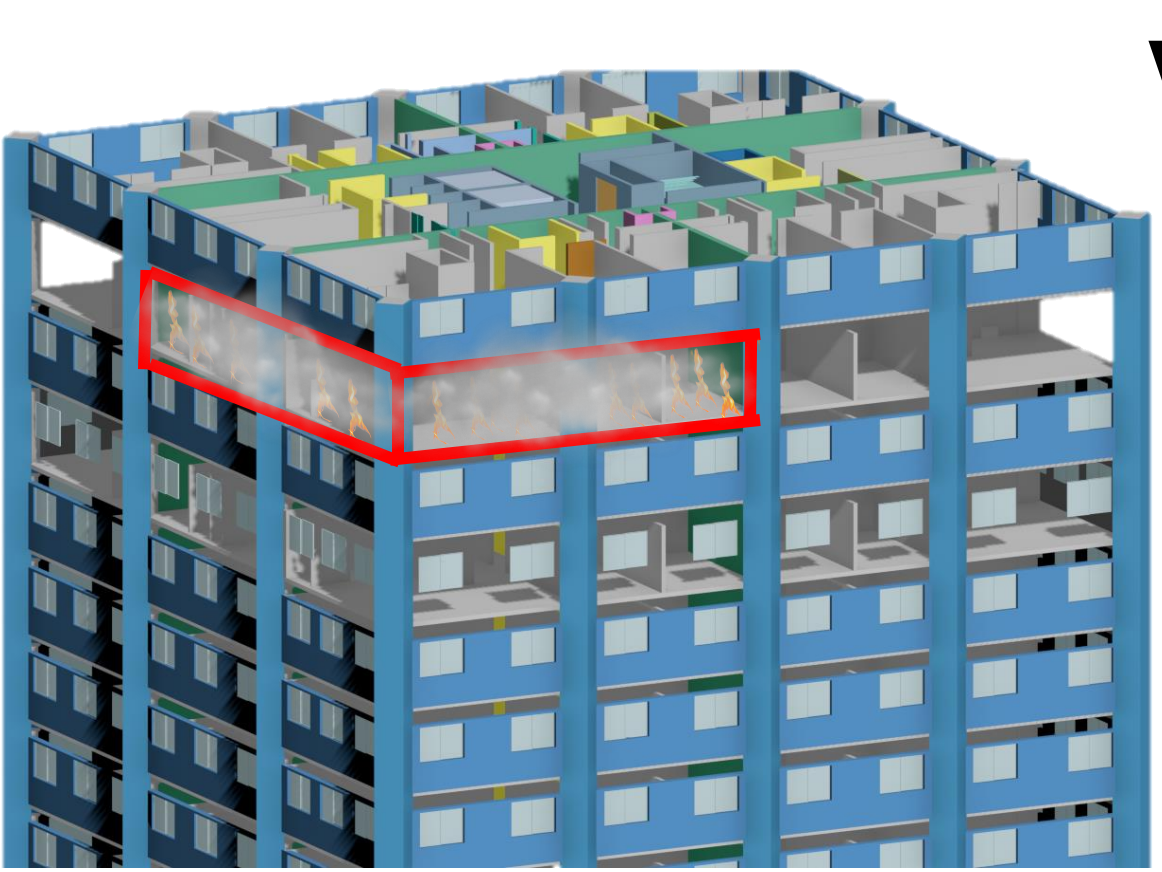
The detectors activate at 60 °C and the alarms activate. Evacuation commences.



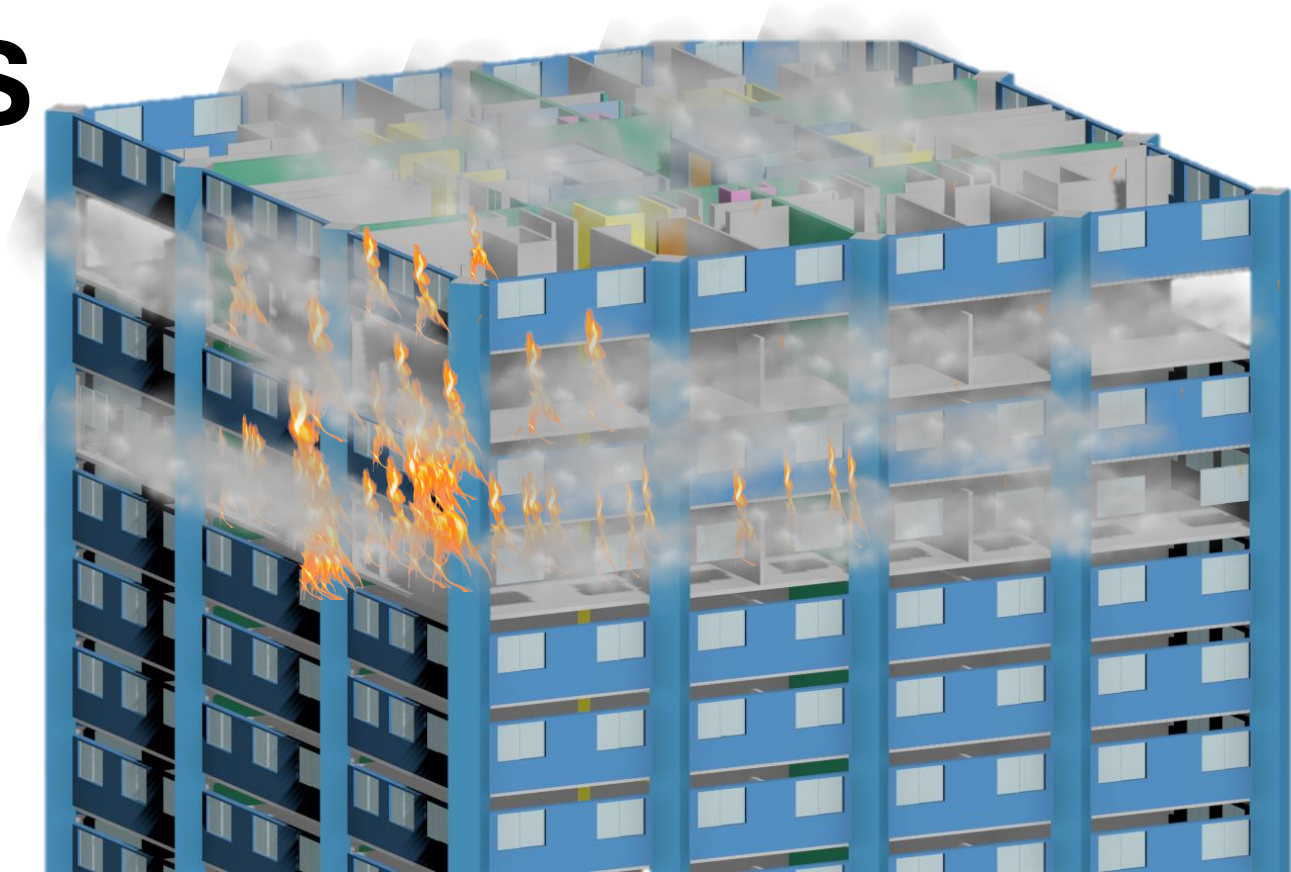
Preventing smoke and flame spread…



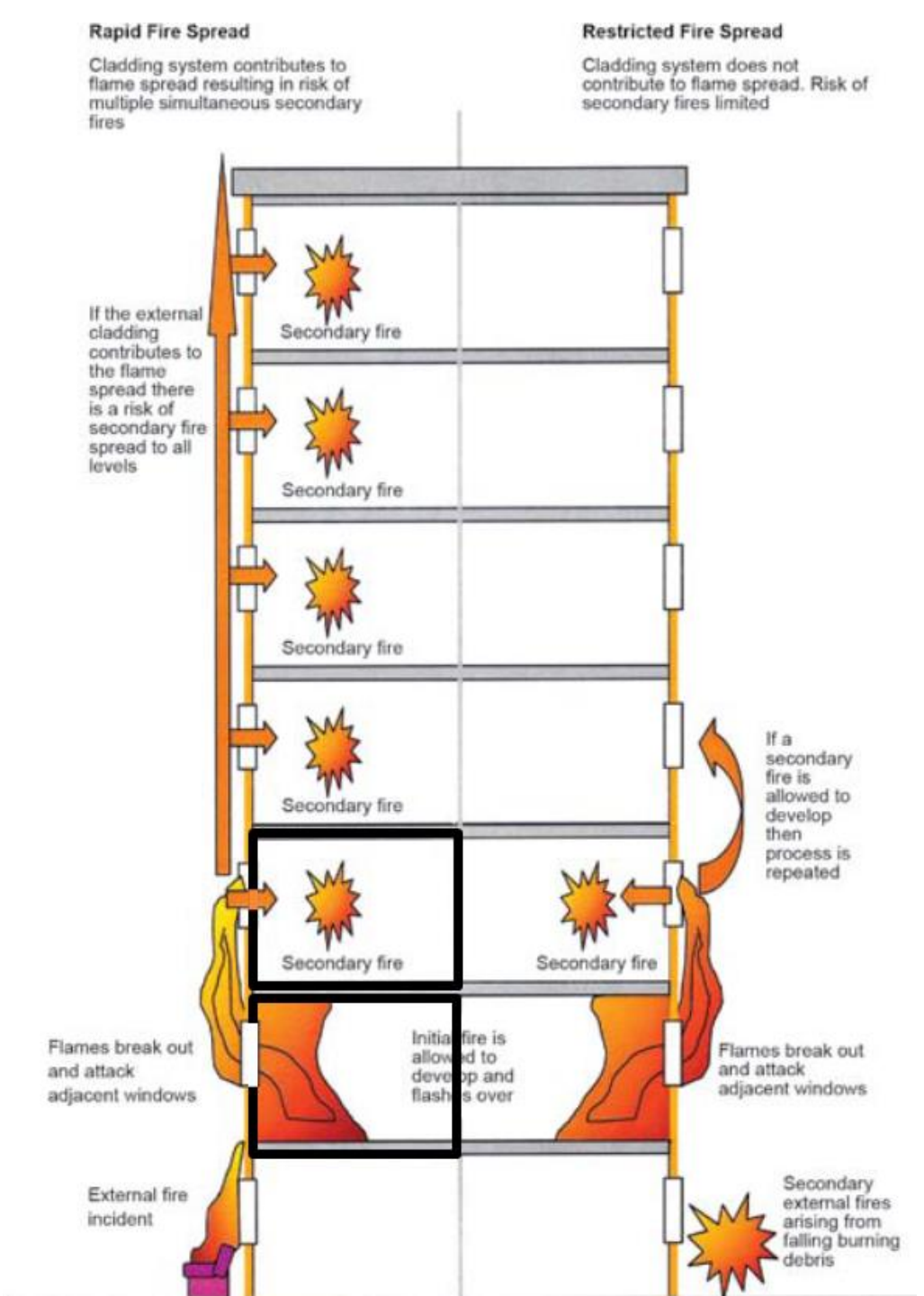
Concept of compartmentation

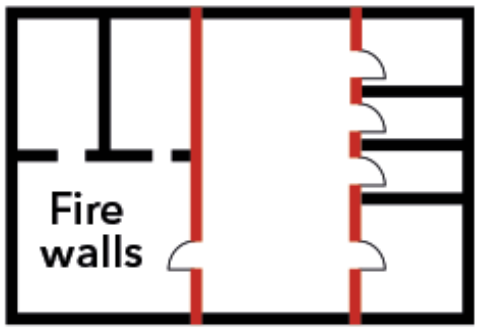


VS

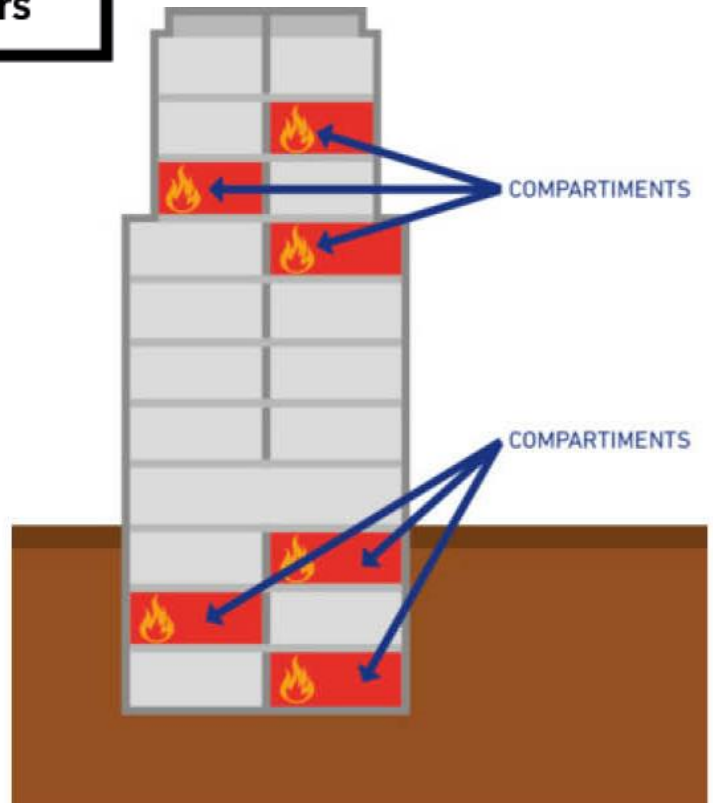


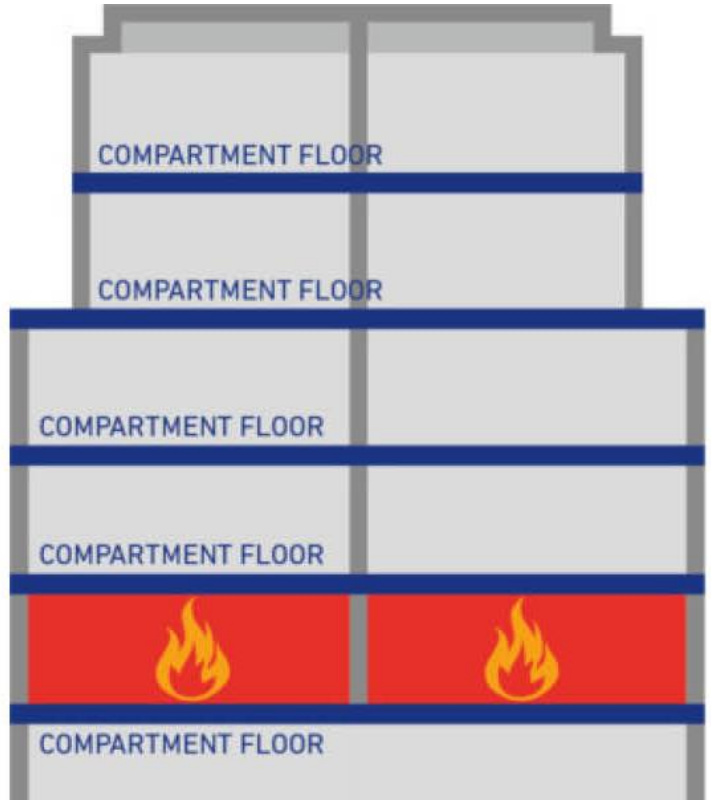
- Compartmentation should isolate each apartment or designated area – making it as safe as a 2 storey house.
- **This prevents flame spread, and smoke spread**.




Fire
walls


Fire floors


COMPARTIMENTS
COMPARTIMENTS


COMPARTMENT FLOOR
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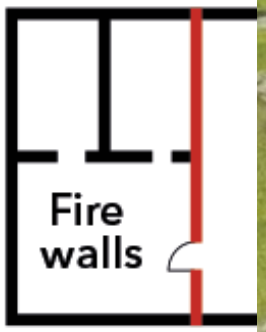
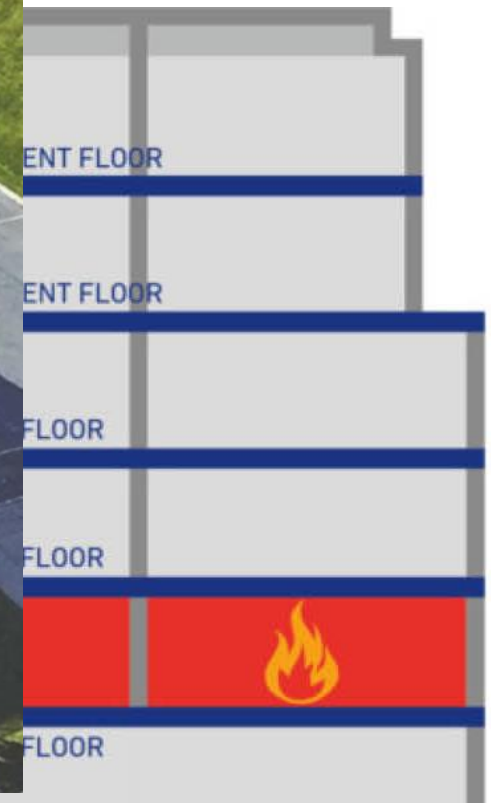

Fire
walls

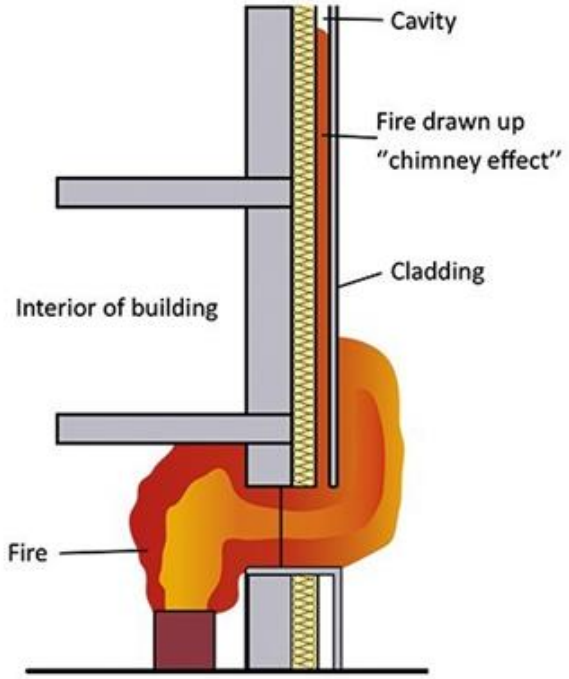

ENT FLOOR
ENT FLOOR
FLOOR
FLOOR
FLOOR

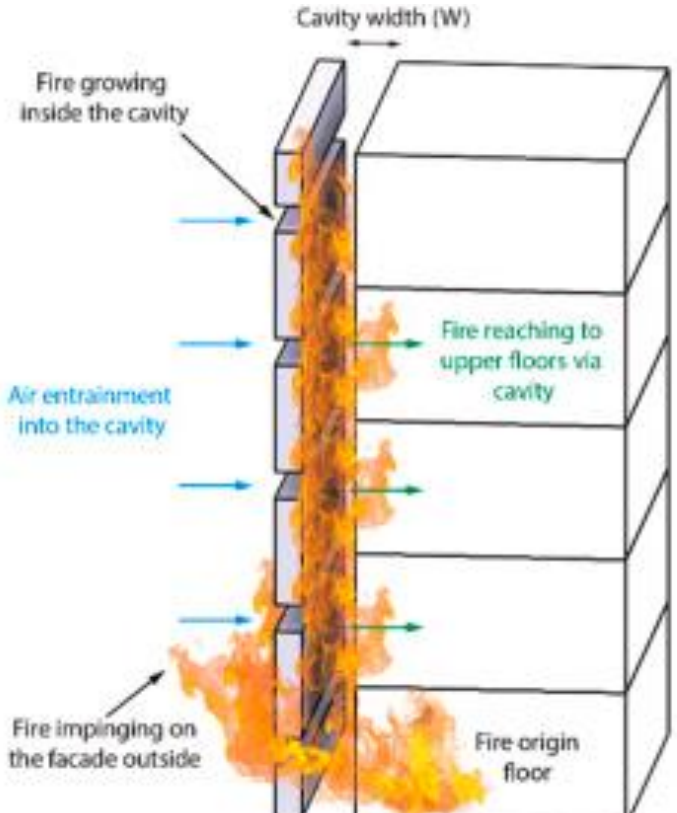
These buildings will have services that will disrupt compartmentation:

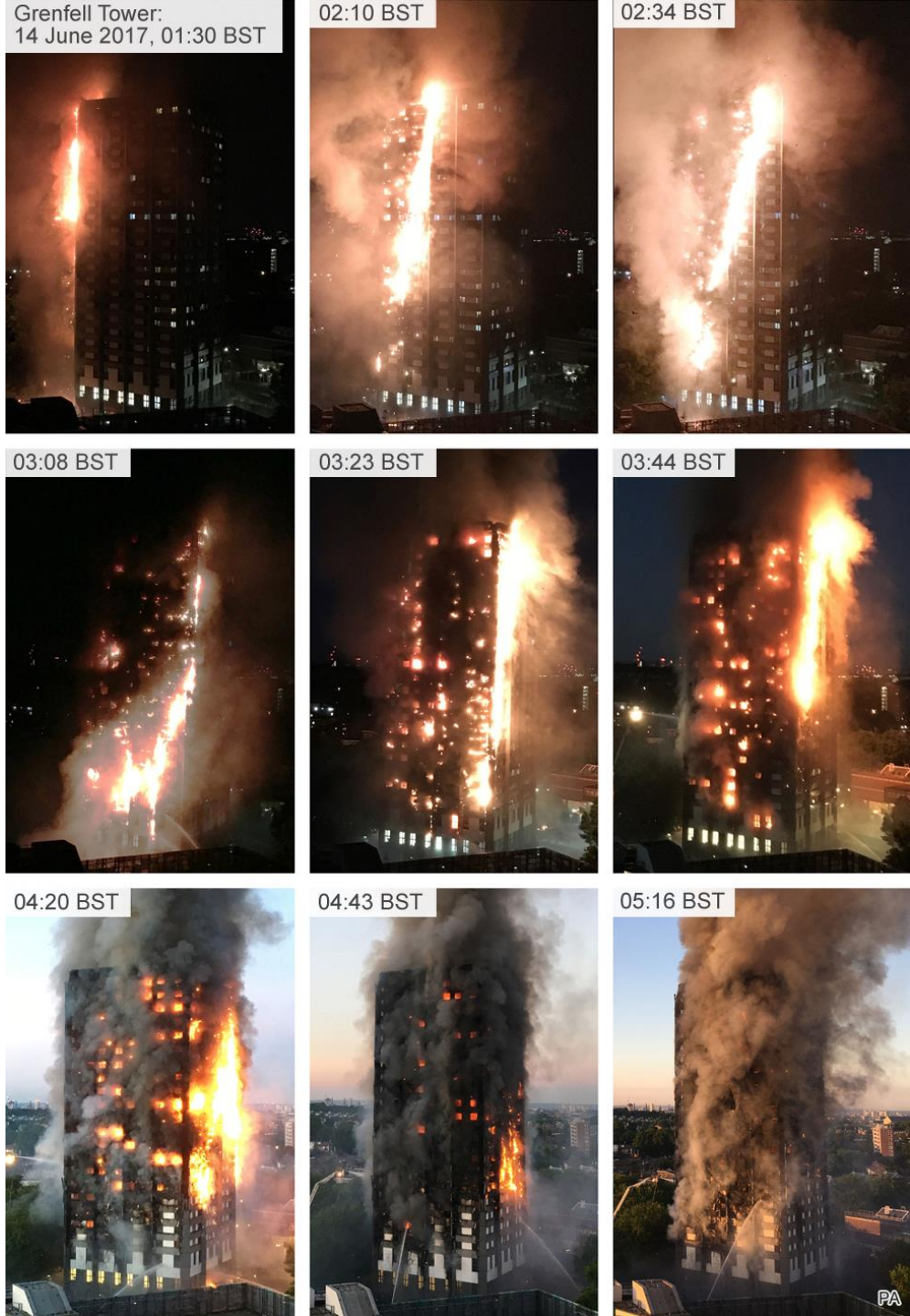
- Plumbing pipes through the floor and walls
- Electric cables through walls, floors, ceilings etc..

How do we maintain compartmentation when the wall has holes in for services?

- In façade structures, if the fire reaches the external cladding, an unprotected combustible façade will allow the fire to spread to other floors of a building externally.







Solving the problem:
Products and Fire rated systems

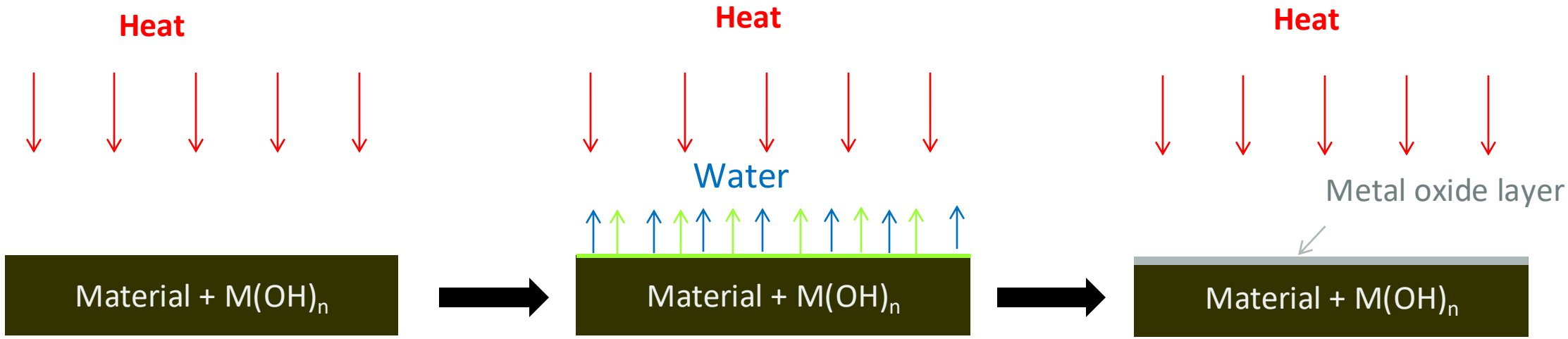
IBC

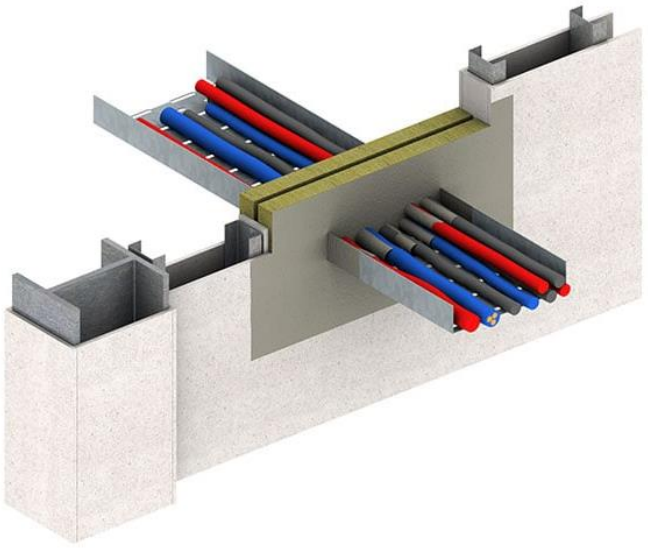
FIRE RESISTANCE

That property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases or flames under conditions of use.

How do we achieve this?

Endothermic materials





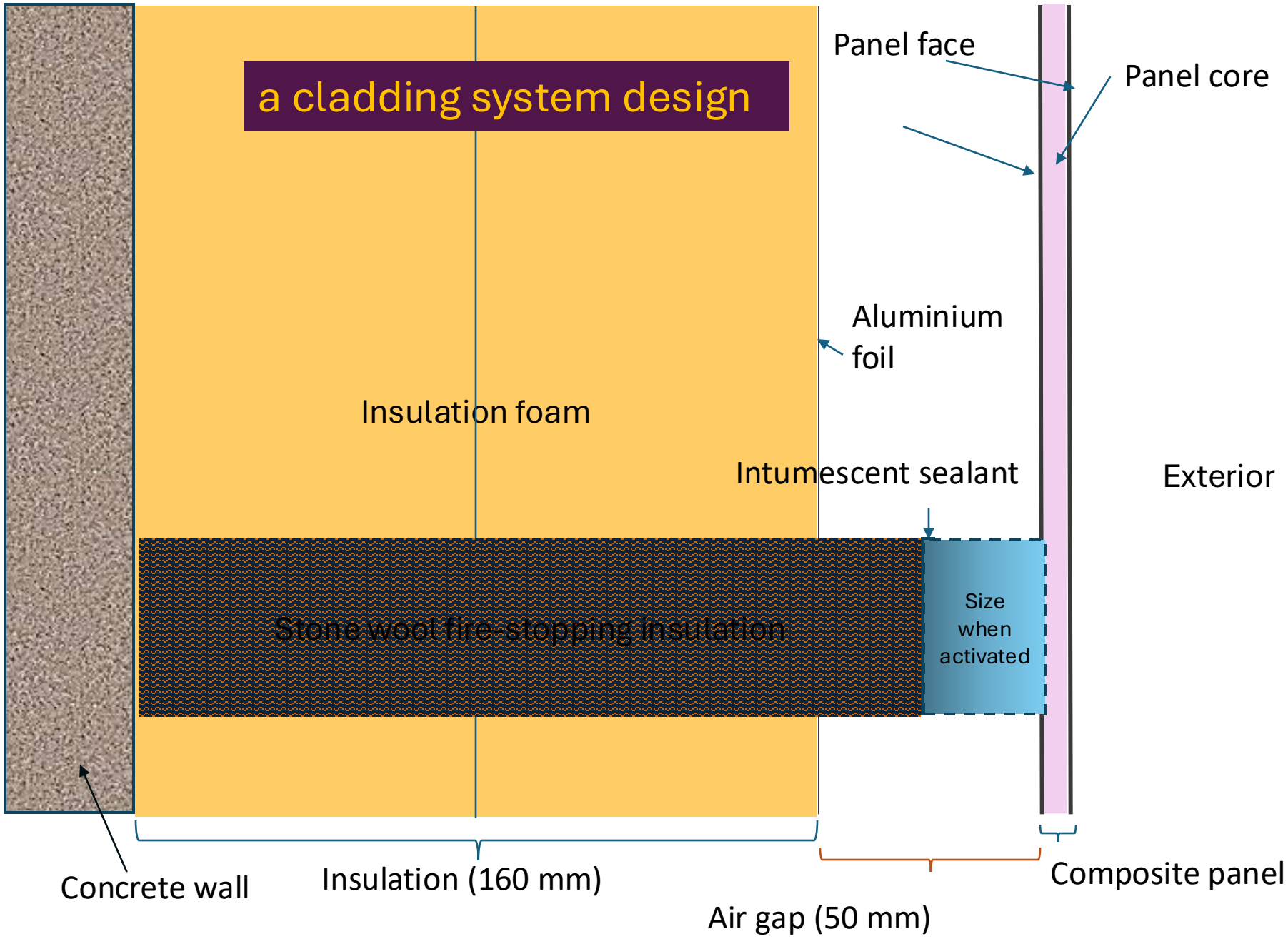
(Material decomposes to fuel)

$$M(OH)_n \xrightarrow{\text{heat}} MO + H_2O(g)$$

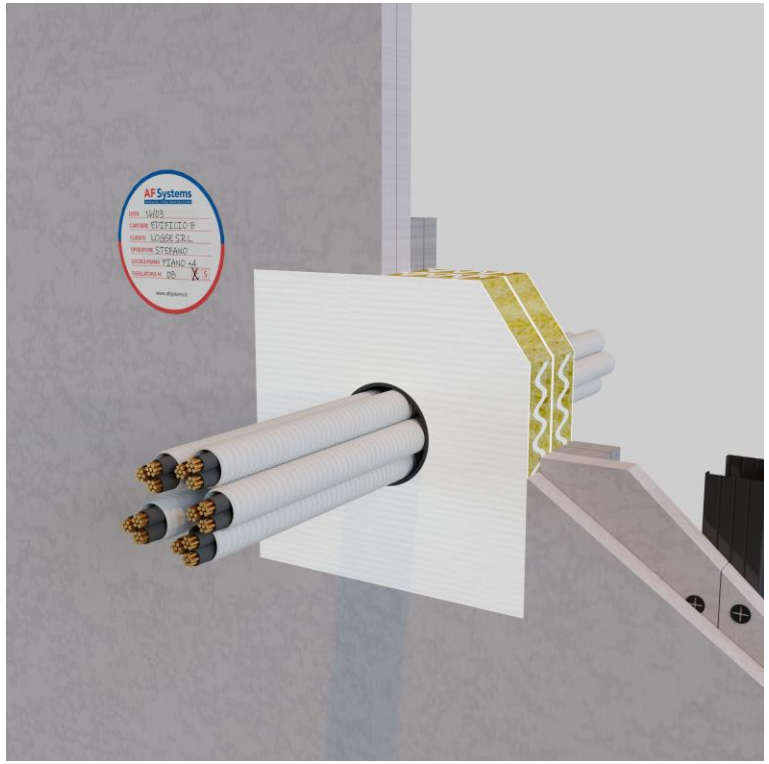
- **Heat absorbed**
- Water released

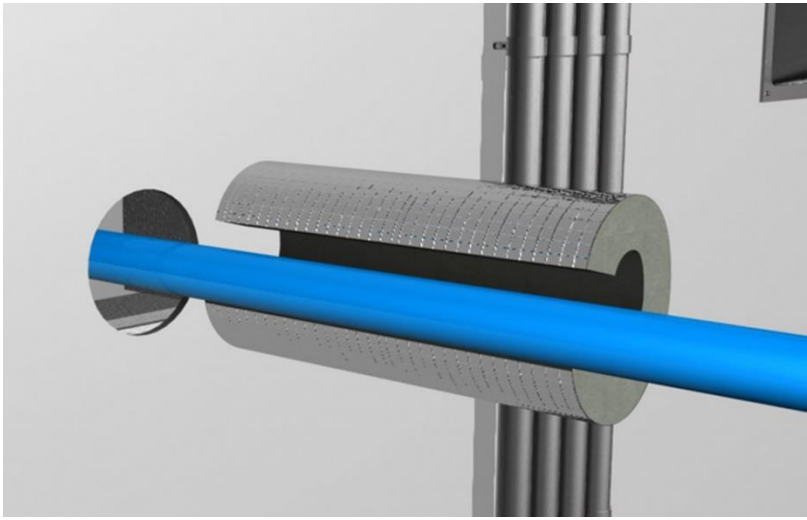
Layer of MO on surface :

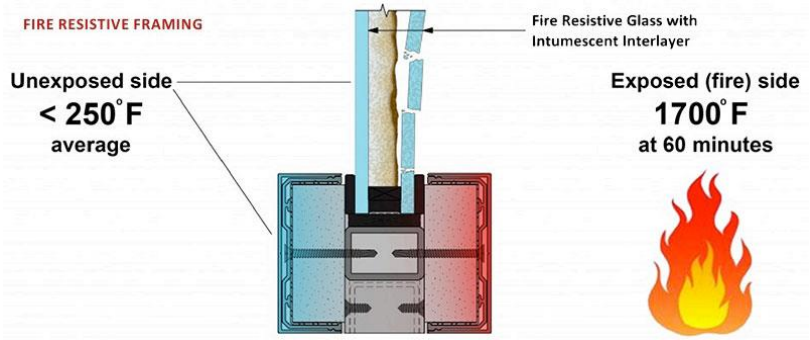
- **Radiation shield**
- Cotinuous barrier to fuel and oxygen

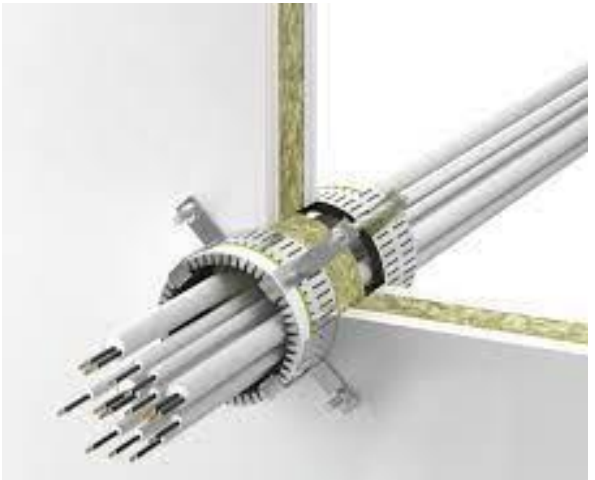

a cladding system design
Panel face
Panel core
Aluminium foil
Insulation foam
Intumescent sealant
Exterior
Stone wool fire-stopping insulation
Size when activated
Concrete wall
Insulation (160 mm)
Air gap (50 mm)
Composite panel

And many other types of products, all with different applications!



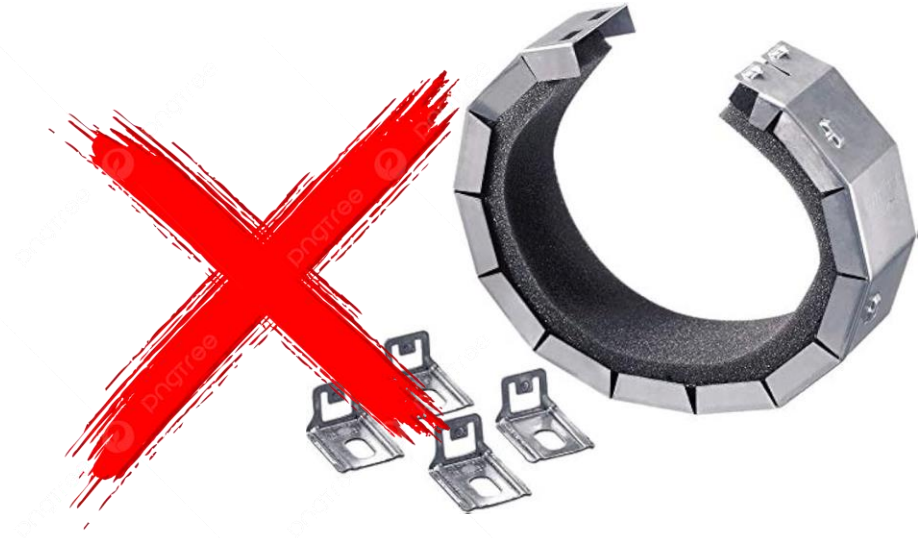






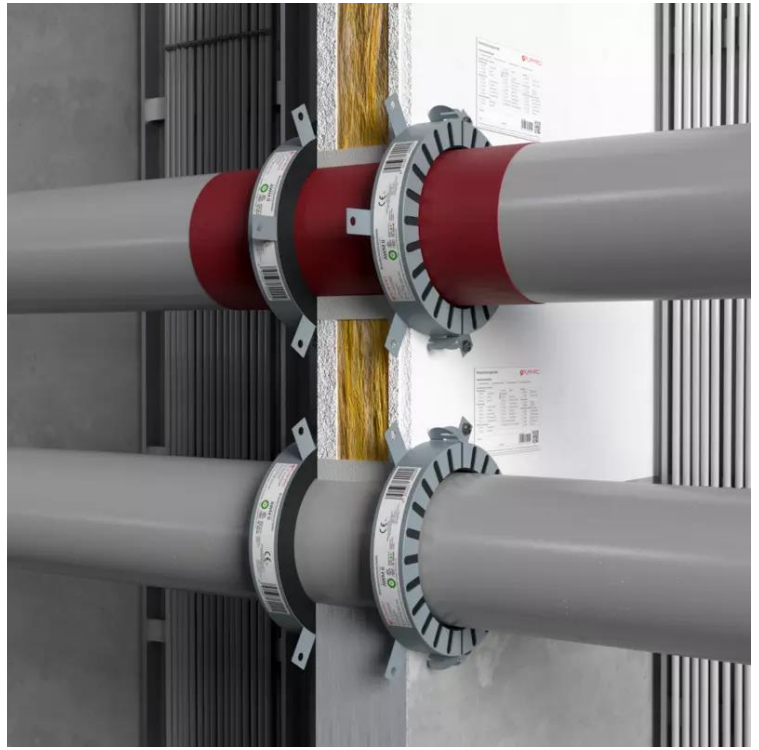
Products & systems

- Ratings quantify a **system's performance** against fire, heat, smoke, and movement.
- A product CAN NOT have a rating. Only a SYSTEM can get rated.



Can not be rated

Can be rated



SYSTEM Testing = Suitability Statement

Fire Resistance Continuity = SYSTEMS

- **Structural – SFRM, IFRM, Boards, Wraps….ASTM E119/UL263**
- **Walls/Floors - Fire & Smoke Barriers – Fire Separations**
  - ASTM E119, UL 263
- **Firestopping** – Standards are Based on E119, UL 263
  - UL 1479, ASTM E814, FM 4990, UL 2079, E1966, E2307, E2837, E3037…test methods…"
- **Swinging/Rolling Fire Doors** – UL 10B & UL 10C….NFPA 252
- **Fire Rated Glazing** – UL 9, NFPA 257, UL 263, ASTM E119
- **Fire/Smoke Dampers** – UL 555, UL 555S, UL 555C

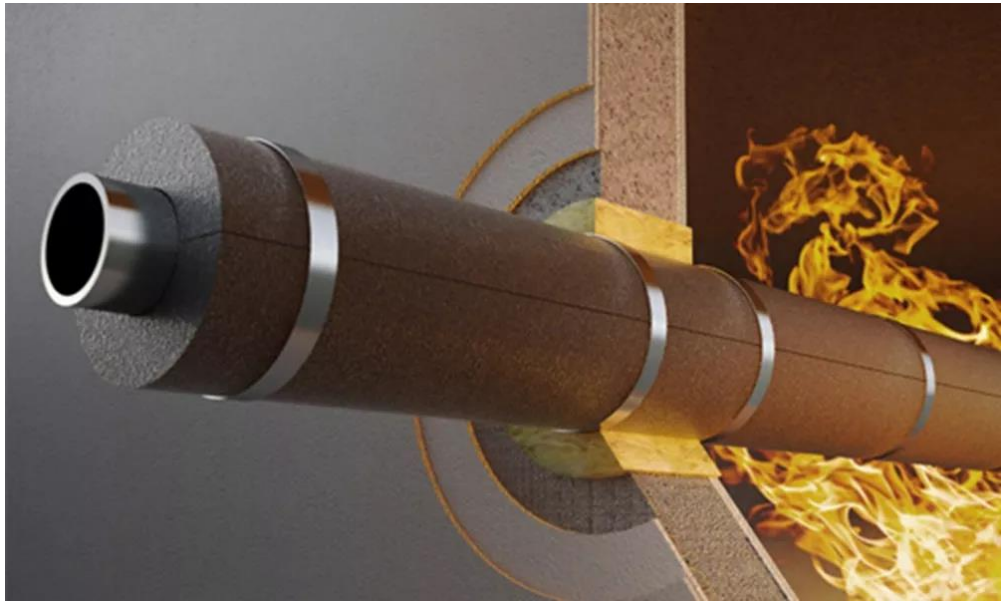
What do we assess and why?

Products are applied to an assembly, and THEN tested.

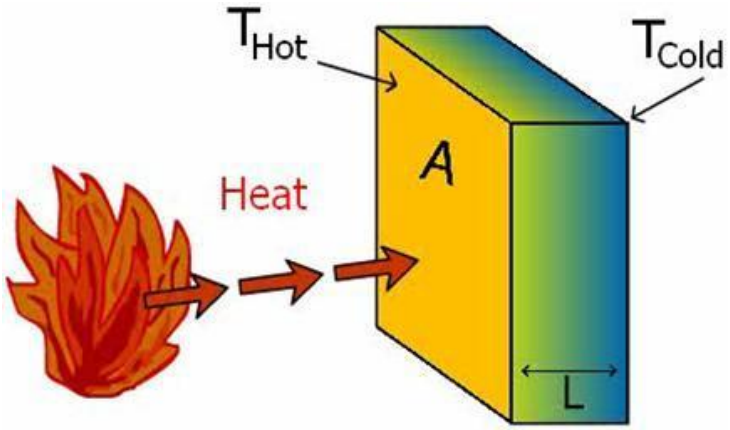
SYSTEM Testing = Suitability Statement

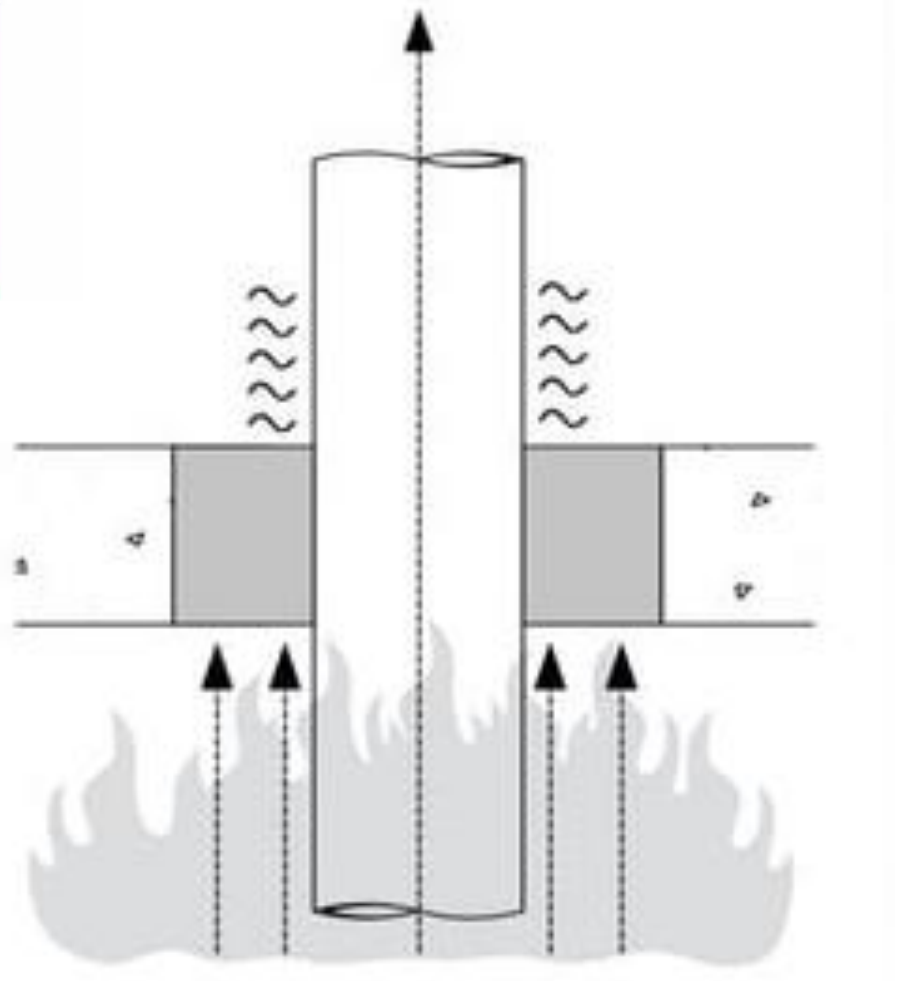
F- rating

- This certifies a firestop's **ability to block flame passage**.
- **This is defined as the Time (in hours) a system prevents flame passage to the unexposed side.**
- Requirements: **Field installs must mirror lab test set up** (e.g., exact fill depth);
- **A 2-hour F means ≥2 hours before breakthrough.**
- Chosen to match barrier rating (e.g., 2-hr wall requires 2-hr F)



T-Rating



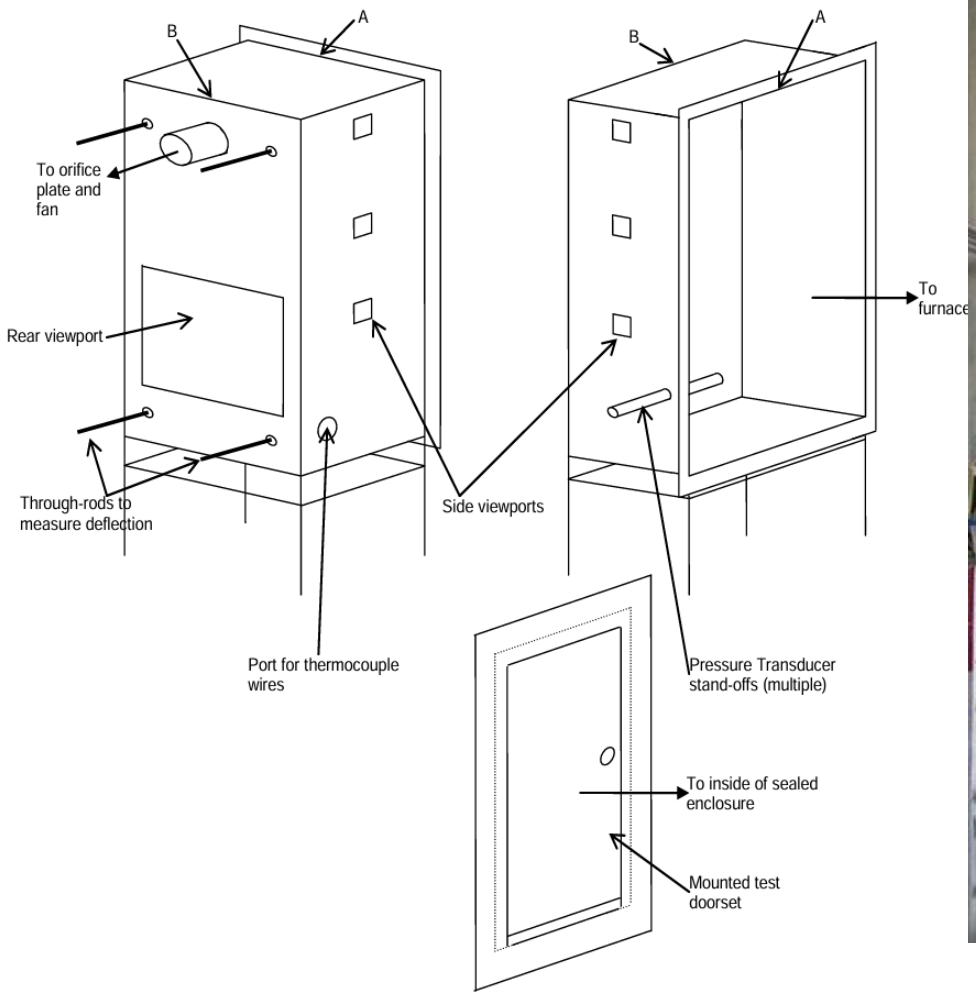


- The time before unexposed side temperature rises 325°F (163°C) above ambient, plus no flame.
- Selected for occupant protection in escape paths (NFPA 101).
- T-Rating limits heat conduction through the firestop, preventing auto-ignition on the unexposed side (e.g., cables melting, sparking secondary fires).

L-Rating

- L-Rating: Air leakage rates for smoke seal assess how much smoke will pass through the system.
- It is determined post-fire via blower door test; required for smoke barriers (NFPA 105).
- L-Rating measures air/smoke leakage
- Even F/T-rated systems leak if unsealed—L ensures tenable air for escape.
- Steps:
- (1) Fire test first
- (2) Cool, seal chamber
- (3) Apply pressure, measure flow.
- UL 1479 Annex
- E/ASTM E814 Annex A

L-Rating



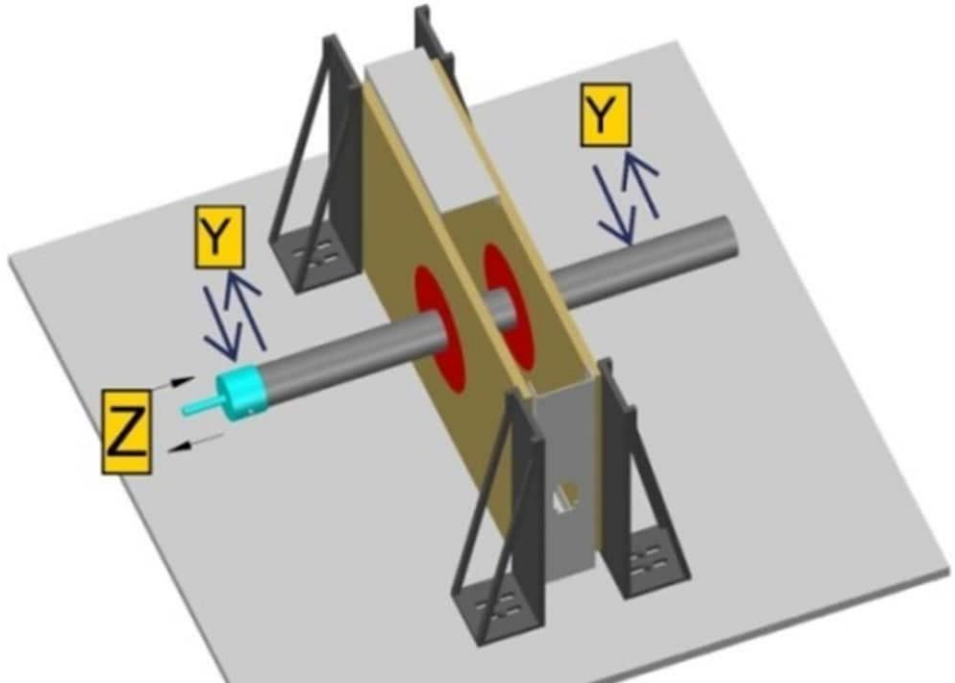
- L-Rating: Air leakage rates for smoke seal

- E/ASTM E814 Annex A

M-Rating

Movement: Maximum displacement (mm) in axial/lateral directions while maintaining integrity.

- Tested under cyclic movement; chosen for seismic/dynamic joints (e.g., IBC Table 715.3).
- Selection depends on hazard (e.g., occupancy, penetration type) and codes; e.g., high-rises mandate 2-3 hr F/T.
- M-Rating assesses firestop resilience to building movement (thermal expansion, seismic), preventing cracks that breach seals.
- M=25% means handles 25% annular space shift.



Choosing a solution…

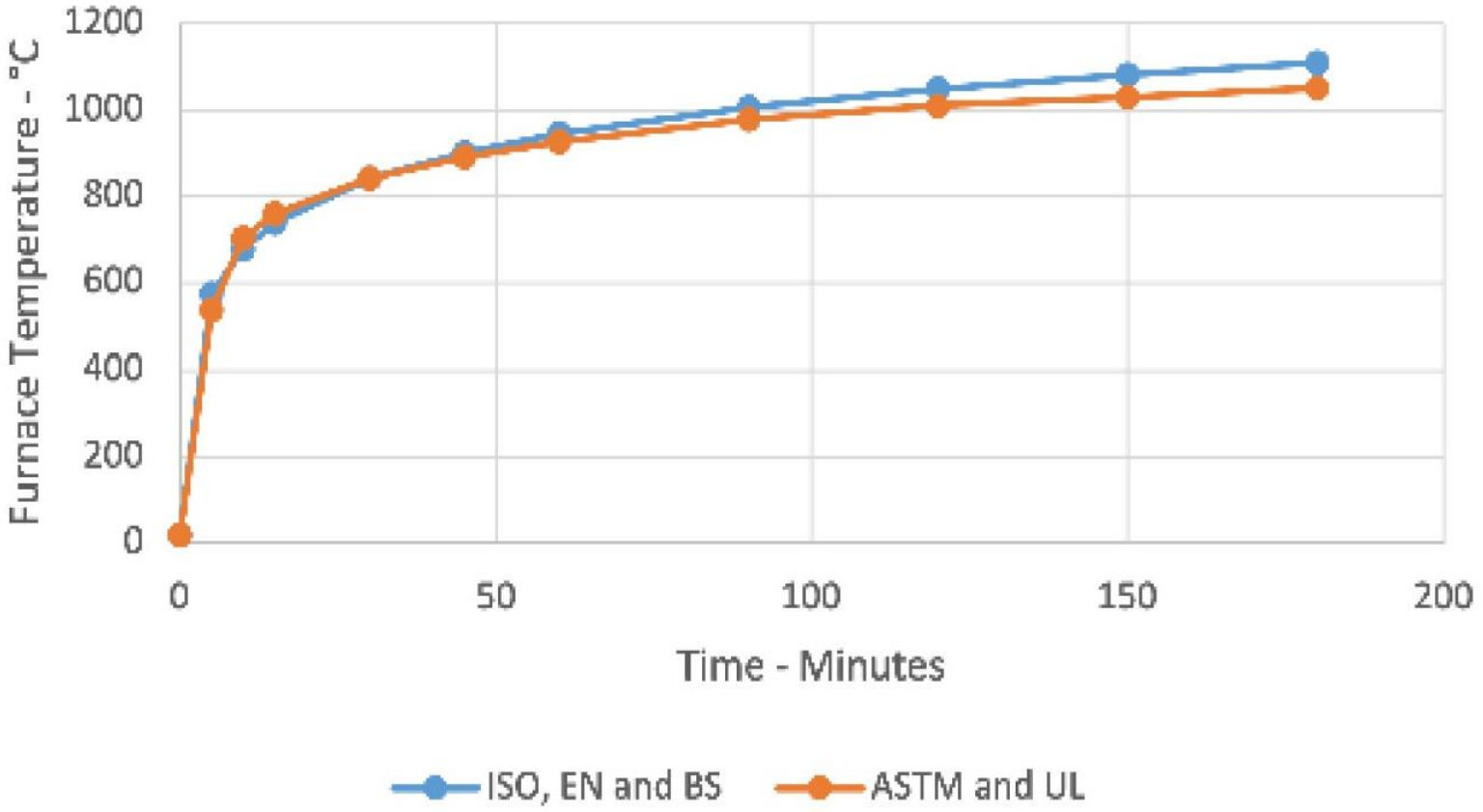
- The way you pick a solution is dependant on your countries building code and processes.
- Performance based design
- Prescriptive based design
- Objective based
- Hybrid approaches

Standard Tests Establish Fire-Resistance

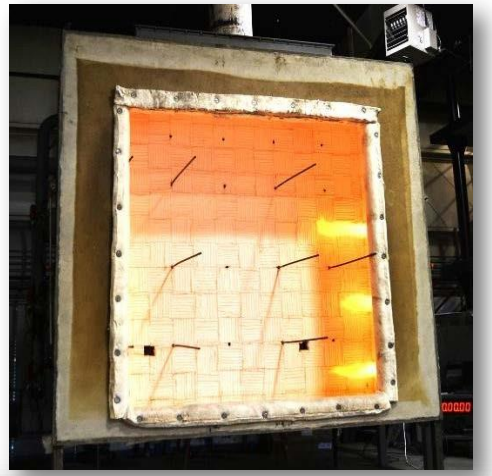
- USA, and North America
  - ASTM E119
  - UL 263
- Canada
  - ULC-S101
- Euro
- ISO 834
  - BS 476/EN 1363

UL Image

Time Temperature Curve
Structural, Compartmentation, Breach



UL 555
Fire, Smoke, Combination, Radiation Damper - UL 555Standards



- **UL 555** - standard for Fire dampers
- **UL 555S** - standard for Smoke dampers
- **UL 555C** - standard for Ceiling Radiation dampers
- CAN/ULC-S112, 112.1 (Smoke Control)

Greenheck Image

Fire Dampers

"A device, installed in an air distribution system, designed to close automatically upon detection of heat, to interrupt migratory airflow, and to **restrict the passage of flame**." (NFPA 80) –IBC 2024 Section 717

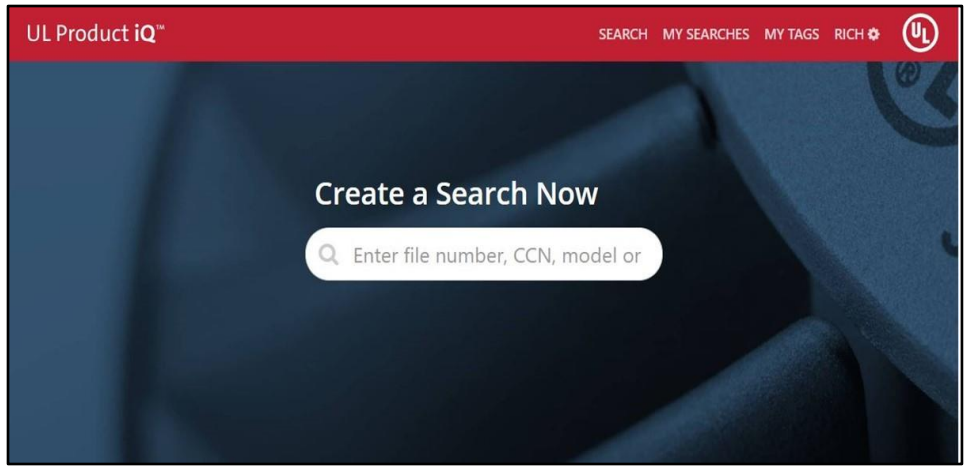
Curtain Fire Damper

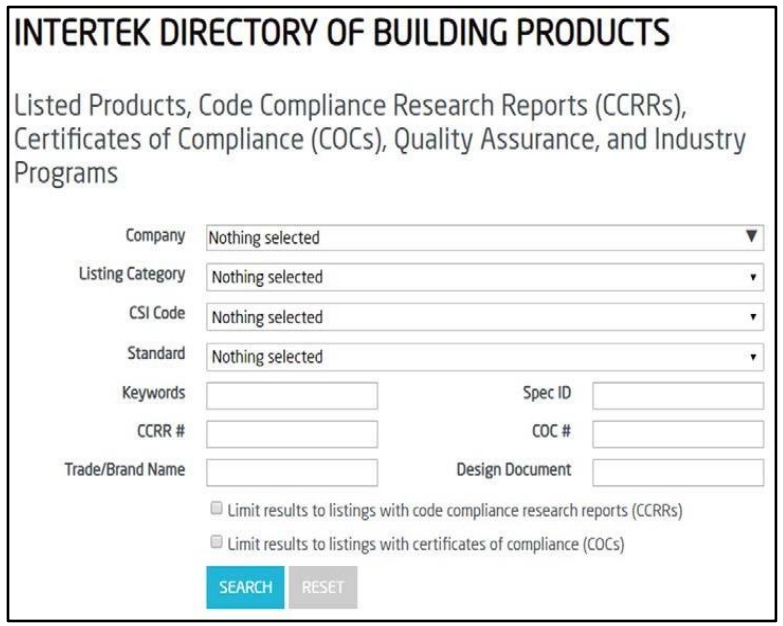
True Round Fire Damper

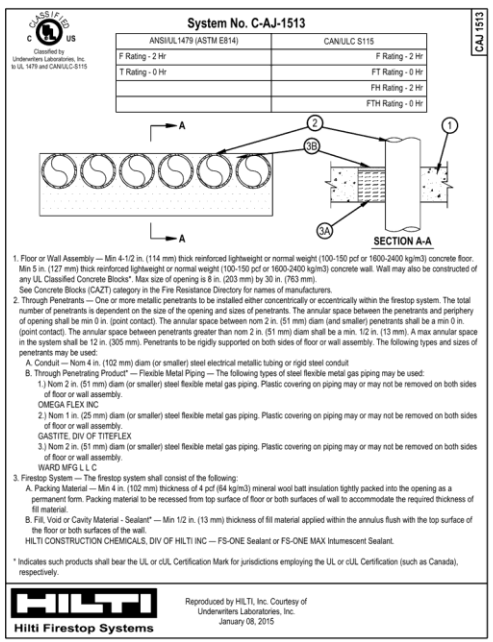
Multi-blade Fire Damper

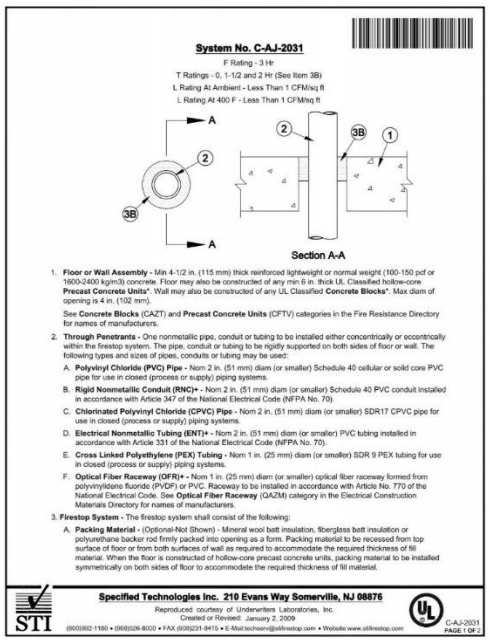
Greenheck Image

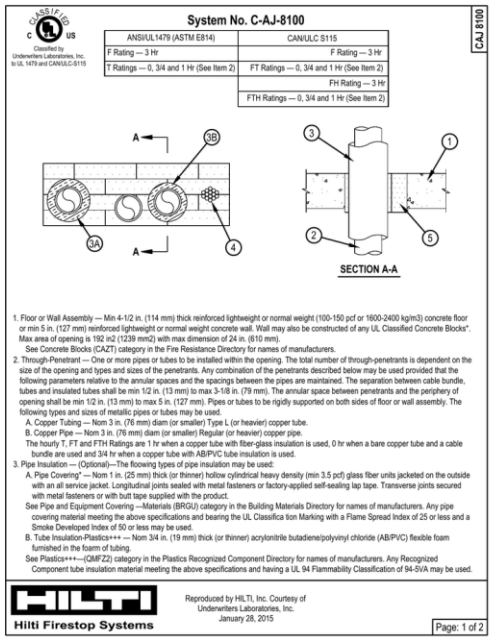
Tested listed systems.







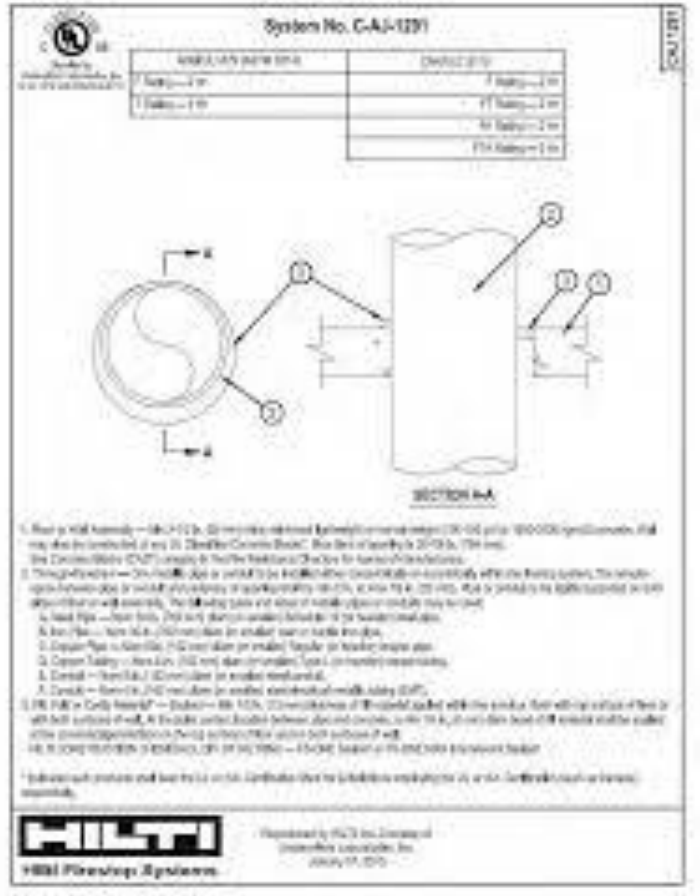




C-AJ-1291: During a fire

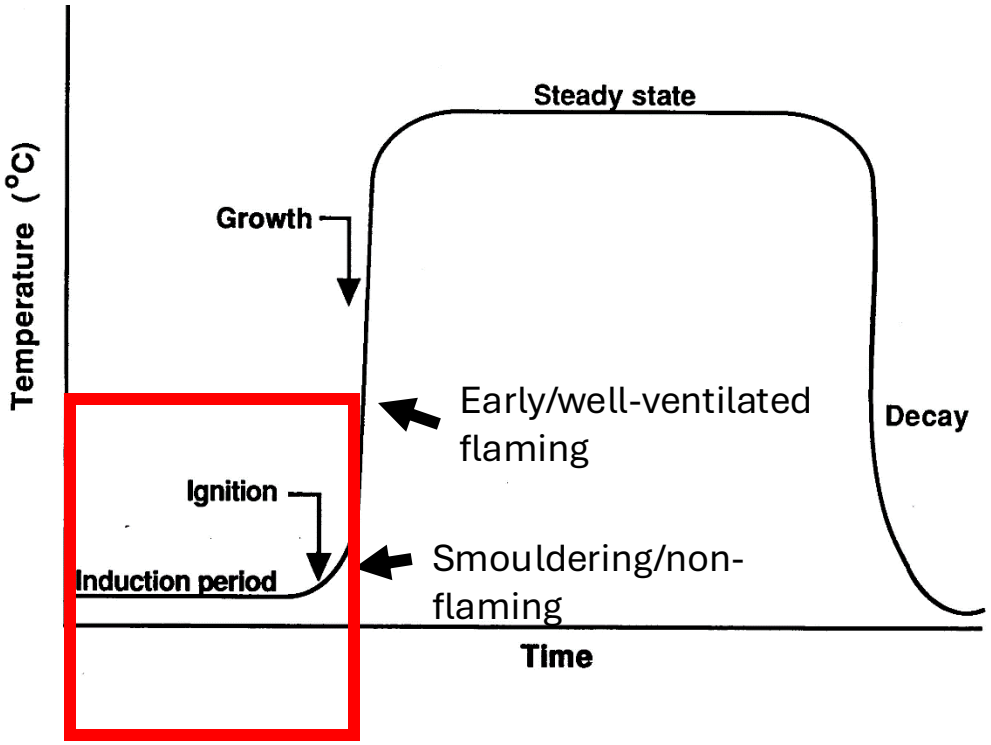
Through-penetration firestop system for one metallic pipe (EMT or rigid steel conduit, max 4 in. diameter) in concrete floors or walls, achieving 2-hour F/T ratings per ASTM E814/UL 1479.

Assembly:
•Min 4-1/2 in. (114 mm) thick reinforced lightweight or normal weight (100-150 pcf) concrete floor, or min 5-1/2 in. (140 mm) thick concrete wall.
•Max opening diameter: 4 in. (101.6 mm); max area: 12.6 sq in. (0.0081 m²); max dimension: 4 in. (101.6 mm).
•Penetrant: One EMT or rigid steel conduit, rigidly supported on both sides, with annular space 0 to 7/8 in. (22 mm).
Firestop Materials:
•**Fill, Void, or Cavity Material — Packing**: Mineral wool batt (min 4 pcf), 4 in. (102 mm) thick, firmly packed into the annular space. Recessed 1/2 in. (13 mm) from the top surface of the floor or both surfaces of the wall. HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — CP 767 or CP 777 Mineral Wool.
•**Fill, Void, or Cavity Material — Sealant**: Min 1/2 in. (13 mm) thick intumescent sealant applied flush with the top surface of the floor or both surfaces of the wall, overlapping 1/2 in. (13 mm) beyond the perimeter of the opening. HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — FS-ONE MAX or CP 606 Firestop Sealant.
Certification: UL Classified for 2-hour F and T ratings.
Reference: UL Directory



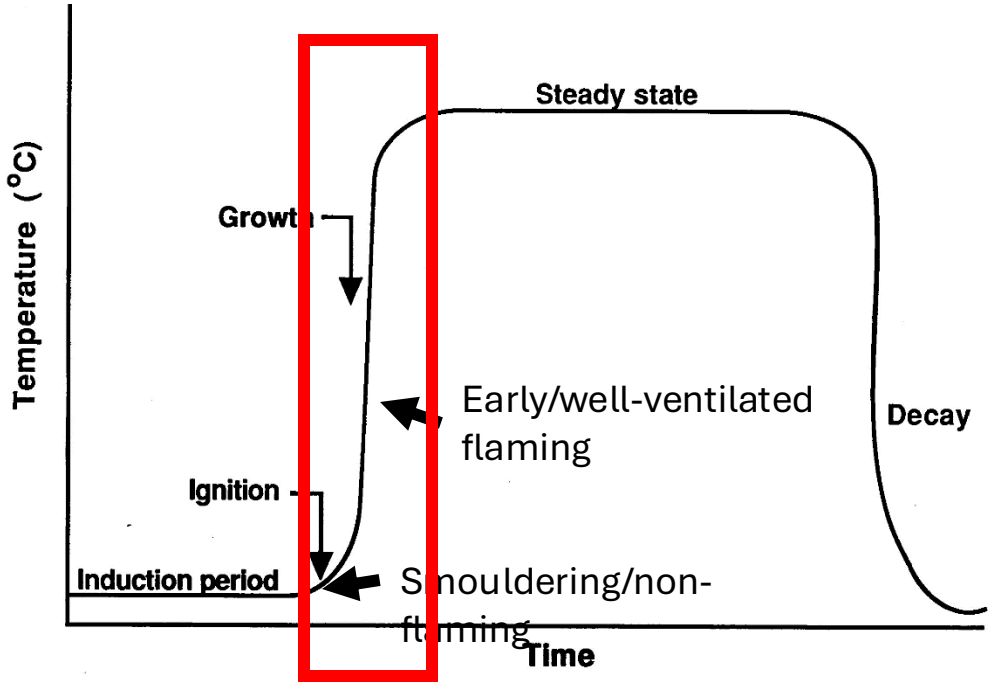
C-AJ-1291: During a fire

- **Stage 1: Ignition (0-5 min)**
- A localized flame heats the steel pipe, raising its temperature to approx. 200°C (392°F).
- The mineral wool has low thermal conductivity, limiting heat transfer.
- The fire plume rises, producing smoke, but the annular space confinement keeps the unexposed side temperature rise below 140°C (284°F).



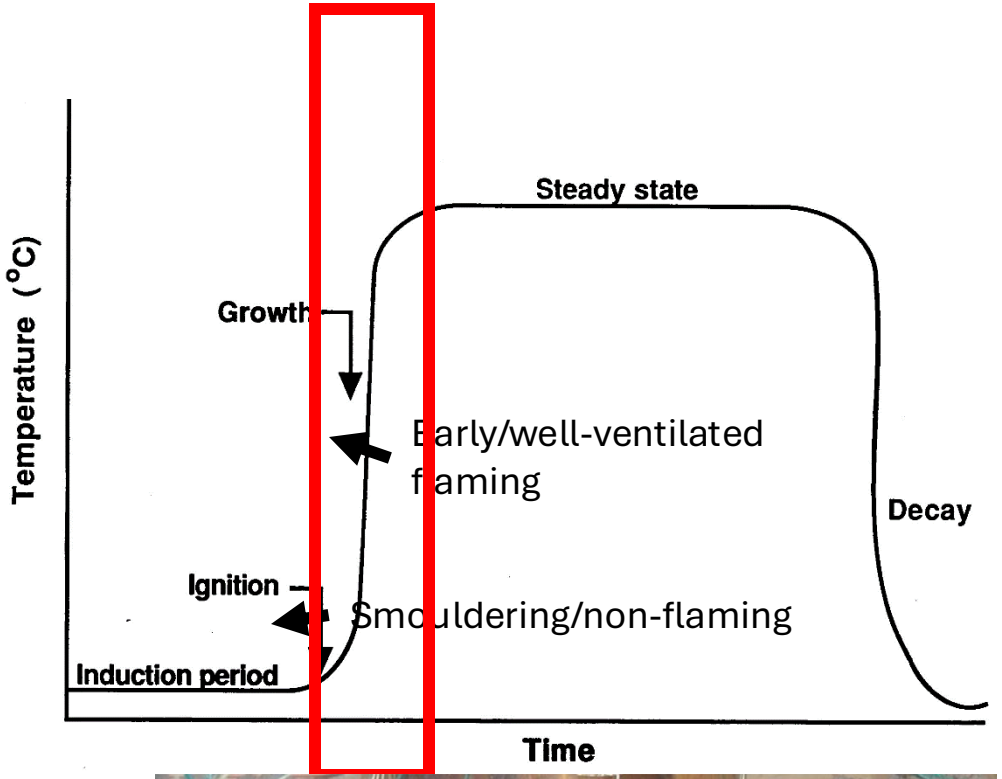
C-AJ-1291: During a fire

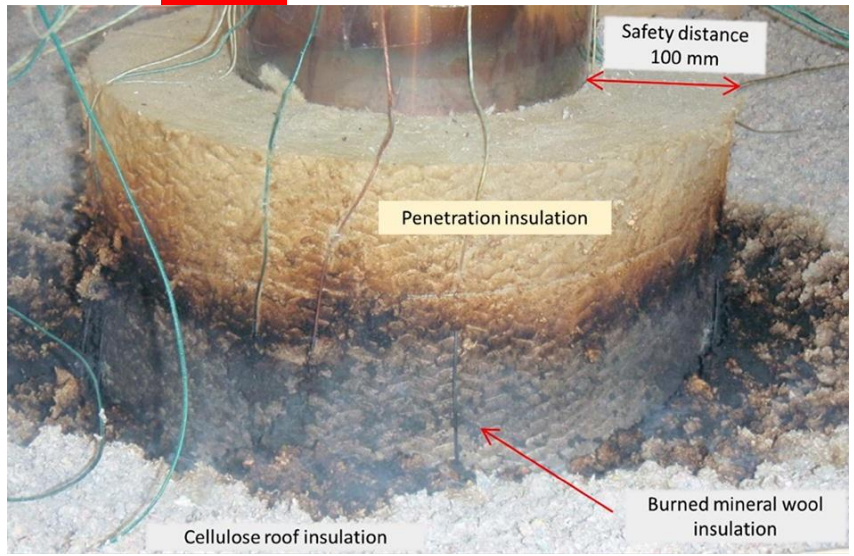
- **Stage 2: Growth (5-15 min)**
- Heat increases (approx. 2 MW HRR).
- The mineral wool's ceramic matrix dehydrates endothermically, absorbing heat and releasing water vapor, insulating the pipe (surface typically below 400°C or 752°F).
- No flame passage occurs, maintaining the F-rating.
- The intumescent sealant begins to char, blocking heat and smoke convection.
- The char layer enhances the system's structural stability.



C-AJ-1291: During a fire

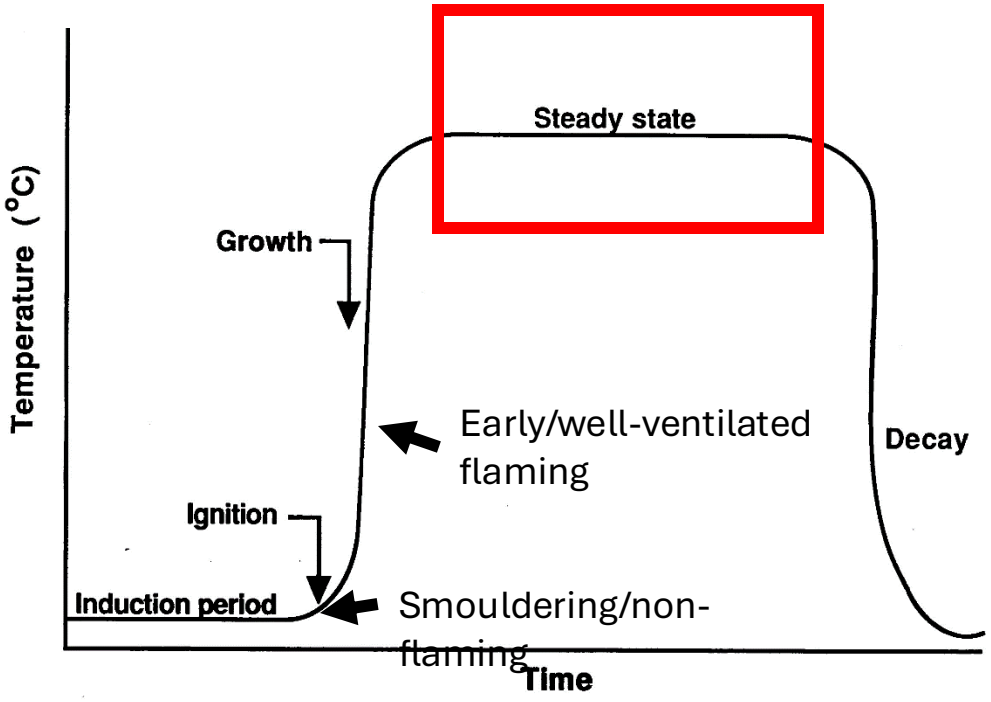
- **Stage 3: Flashover (15-20 min)**
- As temperatures rise, the mineral wool forms an insulating crust (alumina-silica sinters, thermal conductivity <0.08 W/m·K).
- The T-rating holds, with the unexposed side below 181°C (358°F).
- System integrity is maintained: no cracks, minimal smoke leakage (L-rating compliant).





C-AJ-1291: During a fire

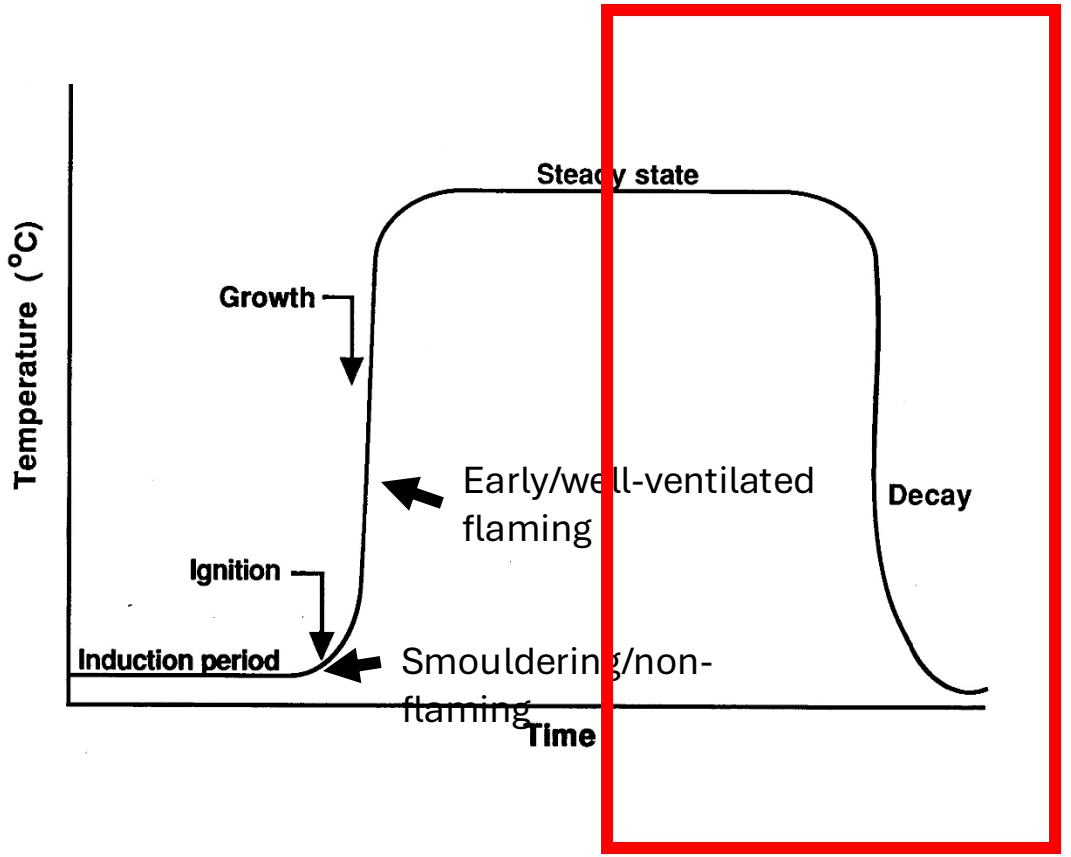
- **Stage 4: Full Development (20-120 min)**
- Under sustained exposure, the char layer from the intumescent sealant and sintered mineral wool prevents autoignition.
- Smoke leakage remains minimal, ensuring safe egress and maintaining the 2-hour F/T ratings.



C-AJ-1291: During a fire

During active firefighting, egress and decay

- ✓ The system does not erode
- ✓ 2-hr containment achieved
- ✓ Safe means of egress maintained



C-AJ-1291

The system will perform as tested……

IF it is **designed** correctly…

AND installed correctly….

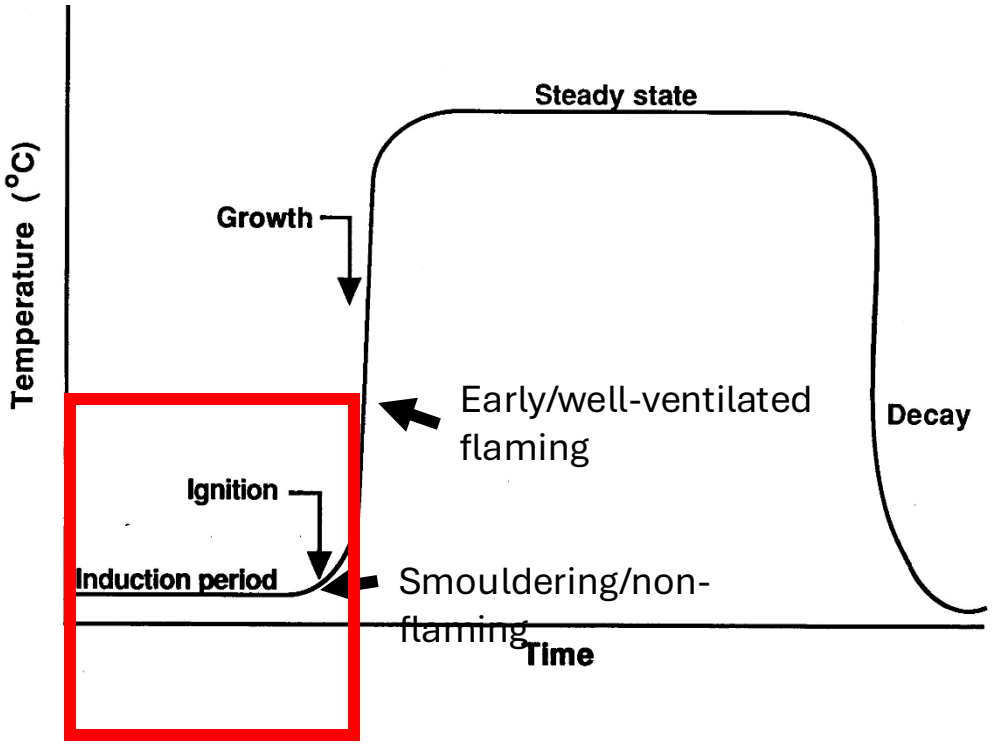
So what if it wasn’t?

C-AJ-1291: During a fire, with fibreglass

- **Substitute Fiberglass for Mineral Wool**
- Replace mineral wool with E-glass fiberglass insulation (**melting** ~800°C or 1472°F).
- It softens at approximately 600°C (1112°F) and melts into a viscous flow at ~800°C (1472°F).
- **fiberglass does not char**; it undergoes melting and viscous deformation under fire exposure.

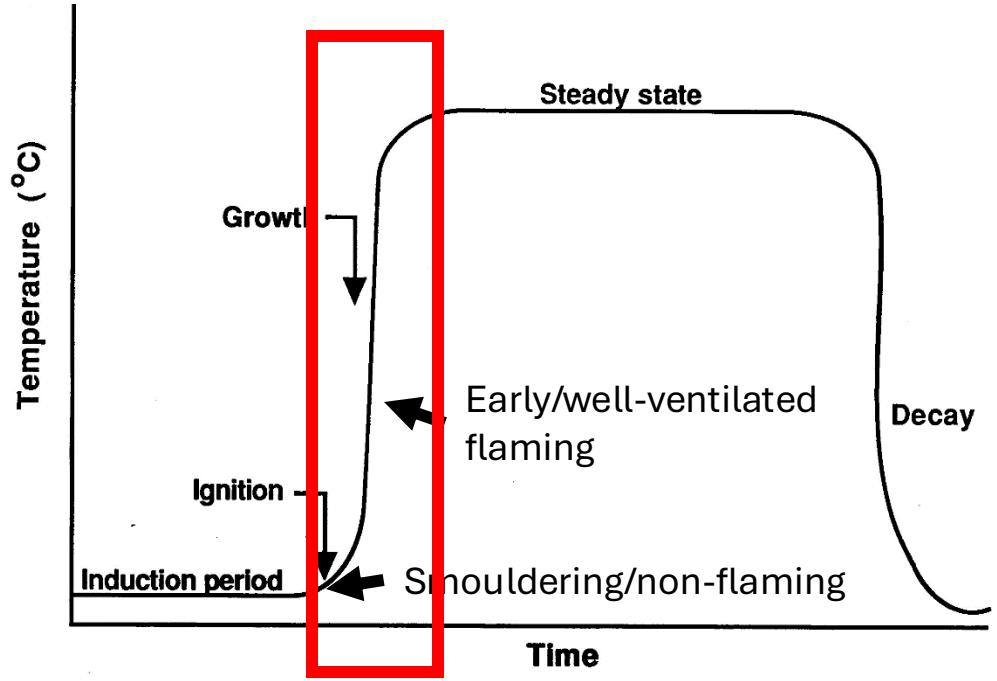
C-AJ-1291: Substitute rockwool with fibreglass

- Initial insulation holds as temperatures are low, but as heat rises, fiberglass fibres begin to soften (softening point ~600°C).
- Minor smoke leakage begins as any organic binders decompose (if present) and fibres start to sink slightly, but the intumescent sealant holds initially (T-rise <140°C on unexposed side).



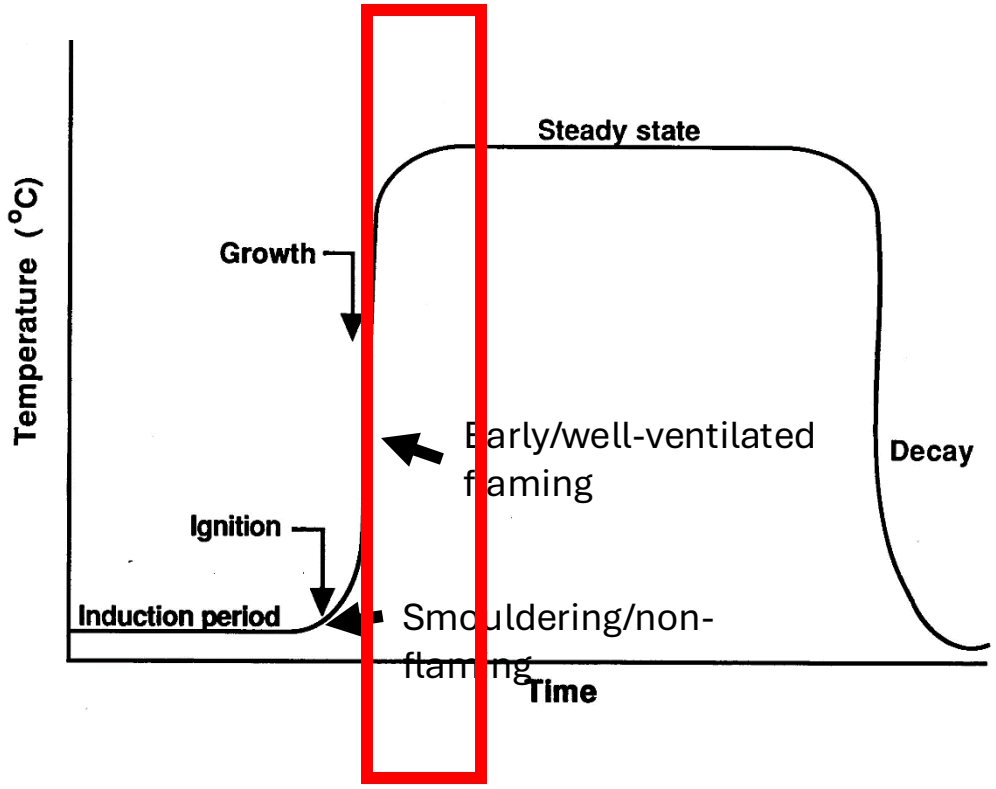
C-AJ-1291: Substitute rockwool with fibreglass

- **Stage 2: Growth (5-15 min)**
- Heat intensifies (~700-780°C), causing the fiberglass to soften further and begin melting into glassy droplets.
- Voids form as the material slumps and collapses, allowing convective heat flow.
- Flame starts to penetrate the annular space, compromising the barrier.
- The metal pipe temperature rises rapidly to over 550°C (1022°F).
- The intumescent sealant begins to expand and char, but gaps from melted fiberglass reduce effectiveness.



C-AJ-1291: Substitute rockwool with fibreglass

- **Stage 3: Flashover (15-20 min)**
- Temperature rise on unexposed side exceeds 180°C (325°F) in under 10 min, failing T-rating.
- F-rating fails due to through-flame passage as melted fiberglass creates openings.
- Smoke leakage surges with potential irritant gases from binder decomposition.



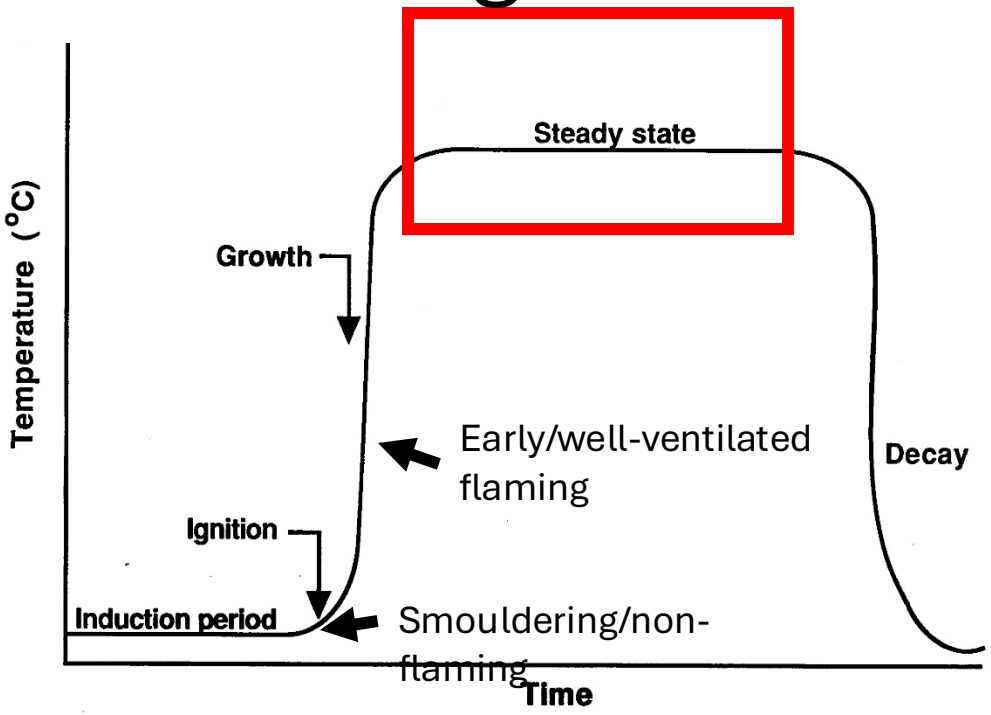
C-AJ-1291: Substitute rockwool with fibreglass

Stage 4: Full Development (20-120 min)

•Cascade failure ensues as molten fiberglass flows, exposing more areas.

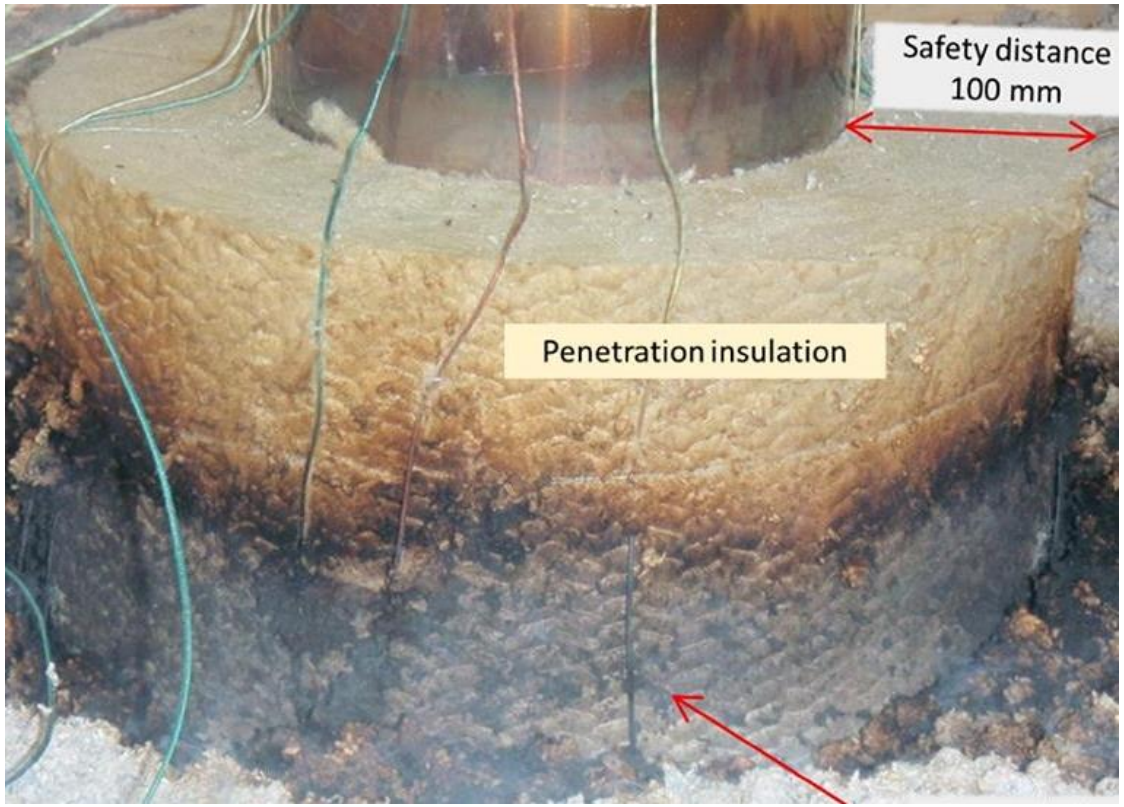
•Molten glass drips may not ignite adjacent combustibles directly (as glass is non-combustible), but heat transfer accelerates fire spread.

•The unexposed side experiences excessive heat, compromising compartmentation (sealant char may hold partially, but overall failure).



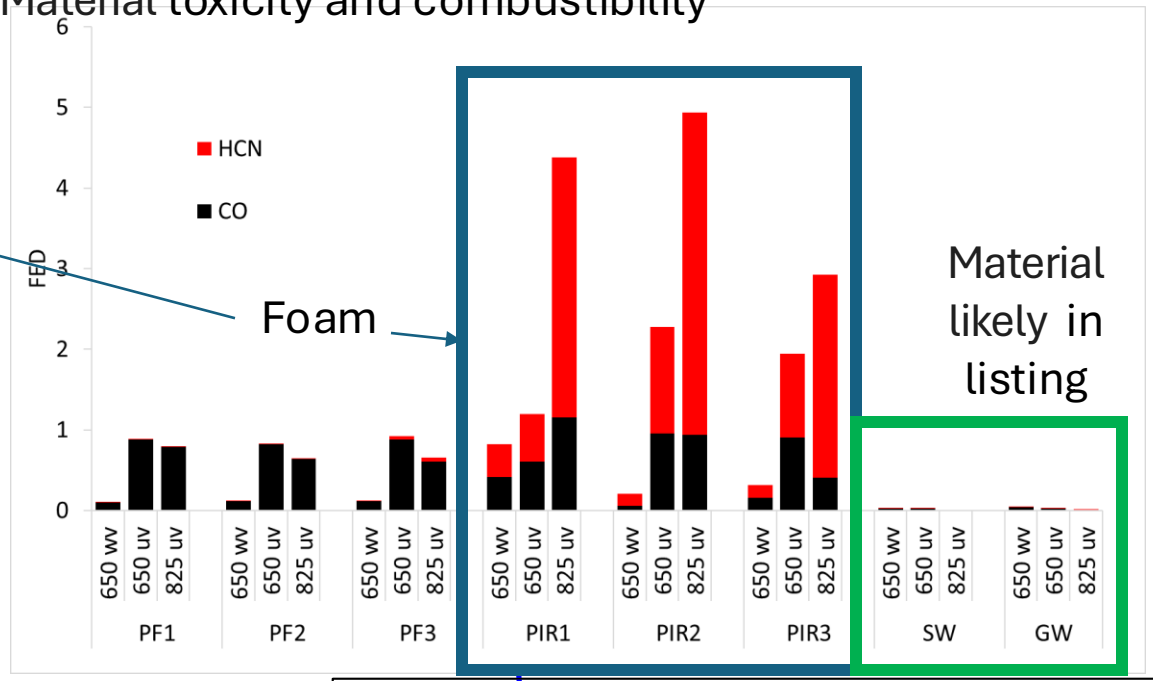
C-AJ-1291: Substitute rockwool with fibreglass

- Material selection must match what has been tested.
- Thermal/chemical profiles for penetrant-substrate vary;
- fiberglass is unsuitable for this firestop application.

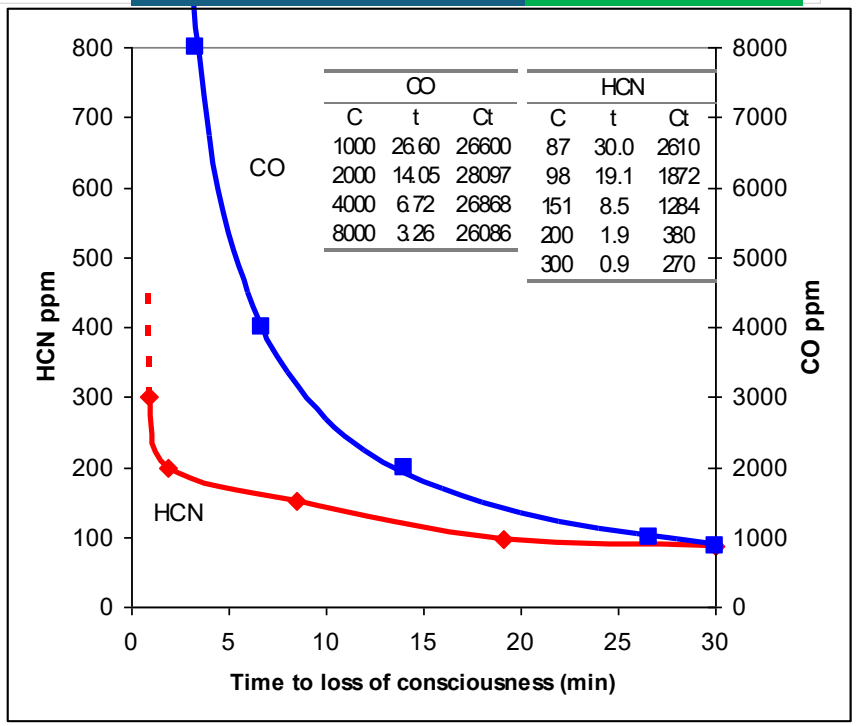

Safety distance
100 mm
Penetration insulation

Incorrect installations, and material substitutions will result in your “protection” becoming part of the problem.

Material toxicity and combustibility



Combustible foam- this will not protect the penetration. This will generate Hydrogen Cyanide on burning. This will make the problem WORSE.



HCN causes rapid incapacitation & death on inhalation

Joints and Voids: Head-of-Wall – Mineral Wool and Spray

System No. HW-D-0300

October 16, 2015

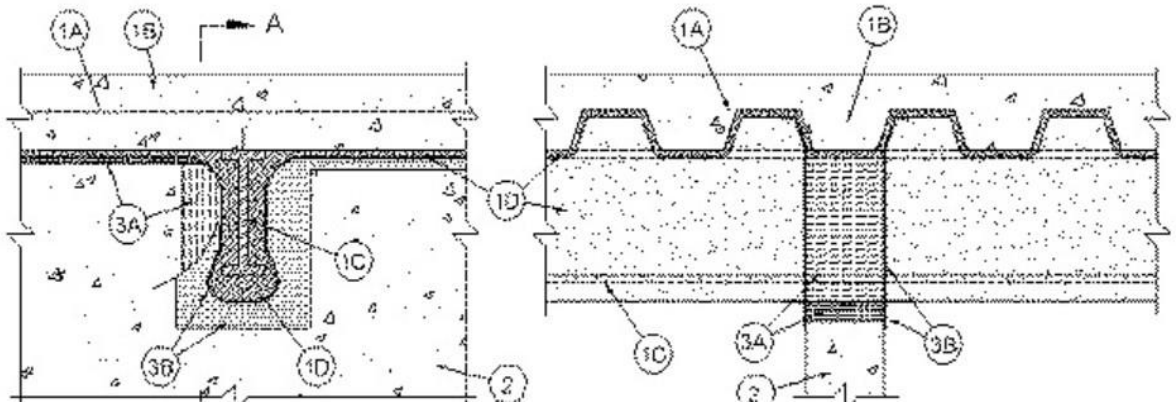
Assembly Ratings — 2 and 3 Hr (See Item 3A)

Nominal Joint Width — 1 and 2 In. (See Item 3)

Class II Movement Capabilities — 25% Compression or Extension

L Rating At Ambient - Less Than 1 CFM/Lin Ft

L Rating At 400 F - Less Than 1 CFM/Lin Ft

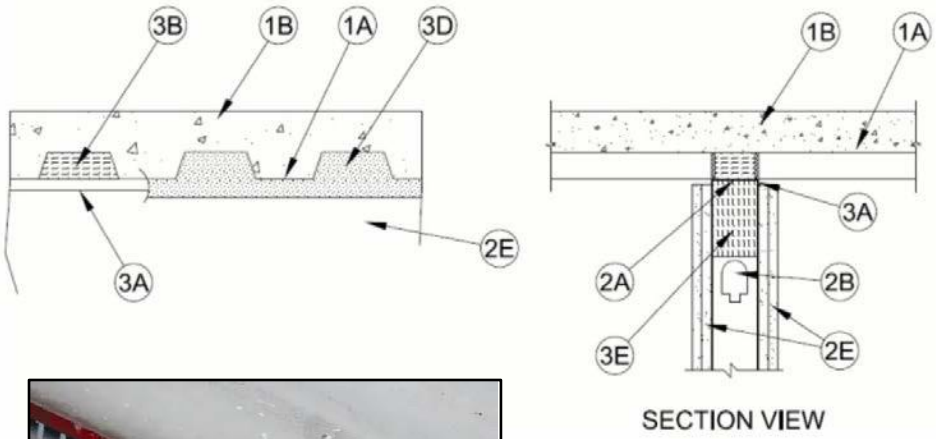


UL Solutions Image / Text HW-D0300 - Rectorseal

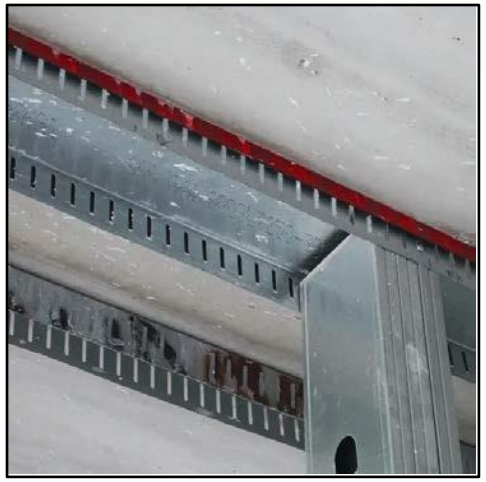
Joints and Voids
Head-of-Wall – Intumescent Strips

UL Solutions Image

Joints and Voids
Head-of-Wall – Intumescent Strips



SECTION VIEW



3. **Joint System —** Max separation between bottom plane of the floor or roof and top of gypsum board is 1 in. (25 mm). The joint system is designed to accommodate a max 100 percent compression or extension from its installed width. The joint system consists of the following:

A. Fill, Void or Cavity Material* — Factory-supplied intumescent gasket installed and nominally centered over the ceiling runner (Item 2A, 2A1, 2A2, 2A3) prior to attachment to underside of floor or roof assembly. Gypsum wallboard layers to be installed on both sides of the wall maintaining a minimum 1/8 in. (3 mm) overlap over the intumescent gasket at time of installation.

SPECIFIED TECHNOLOGIES INC — Speed Flex Track Top Gasket

C. Forming Material* — As an option to Item 3B, preformed mineral wool plugs, formed to the shape of the fluted floor units, friction fit to completely fill the flutes above ceiling runner. The forming material shall be recessed from each surface of wall ceiling runner to accommodate the required thickness of fill material (Item 3D).

THERMAFIBER INC — TopStop mineral wool deck plugs Type SAF batts

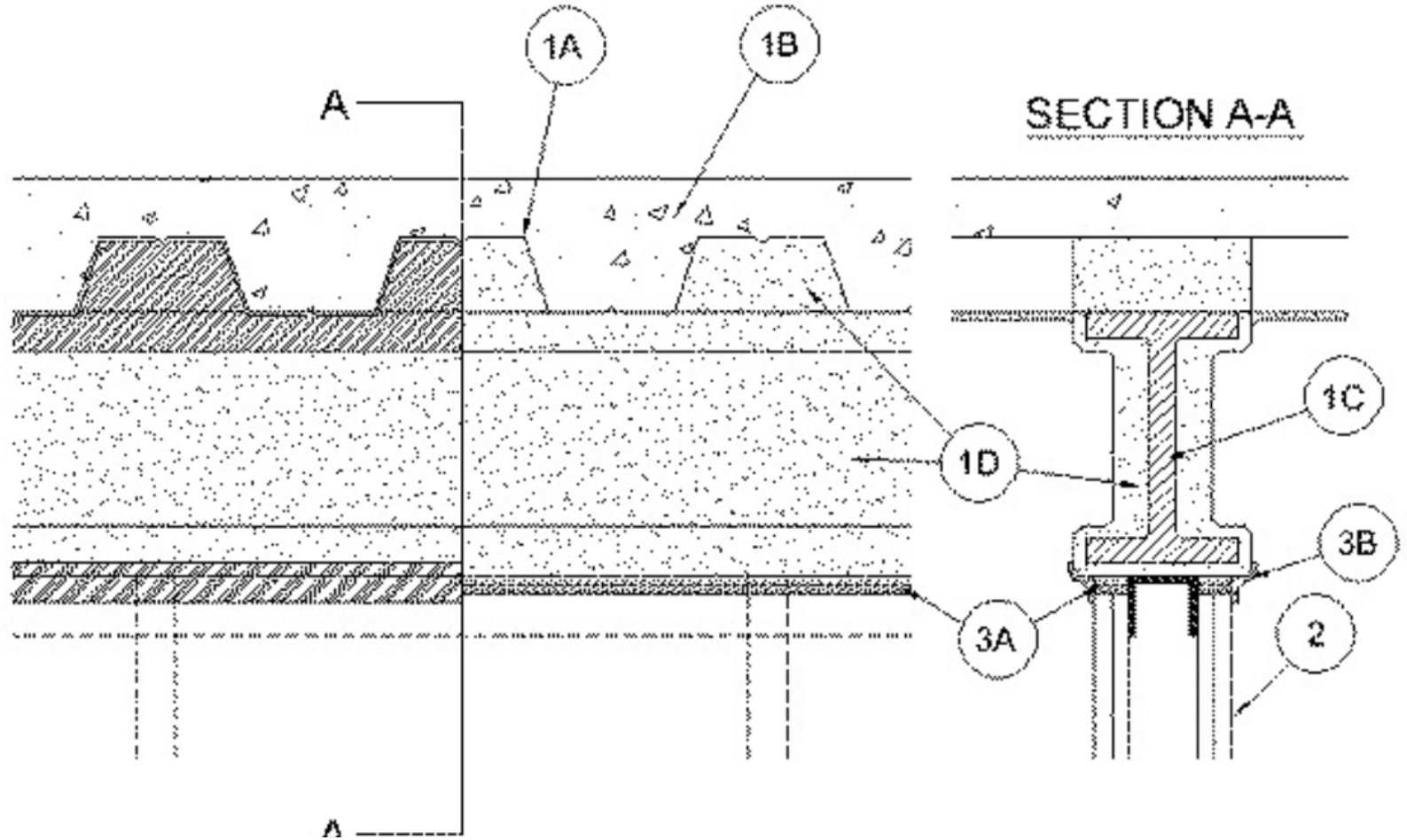
D. Fill, Void or Cavity Material* — Sealant — Min 1/4 in. (6 mm) thickness of fill material installed on each side of the wall in the flutes of the steel floor or roof deck and between the top of the fill, void or cavity material (Item 3A) and the bottom of the steel floor or roof deck, flush with each surface of wall framing.

SPECIFIED TECHNOLOGIES INC — SpecSeal ES Sealant

STI Firestop Photo – UL Solutions Image/Text HW-D0748

HW-D-0259

I-Beam to Fluted Deck OVER WALL HW-D-0259



UL Solutions Image

Substitutions

Substitutions like fiberglass batt are common because it is a cheaper alternative.

cheaper ≠ safer

This substitution WILL FAIL IN A REAL FIRE.

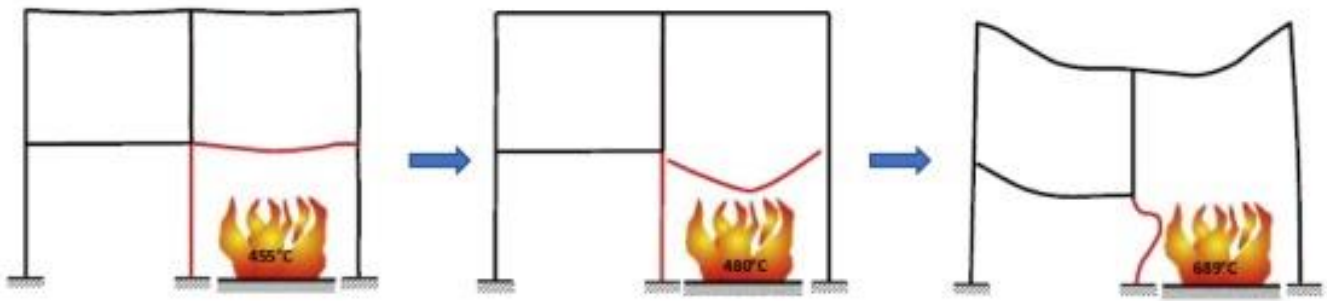
Only use what is specified in the listed system or EJ.

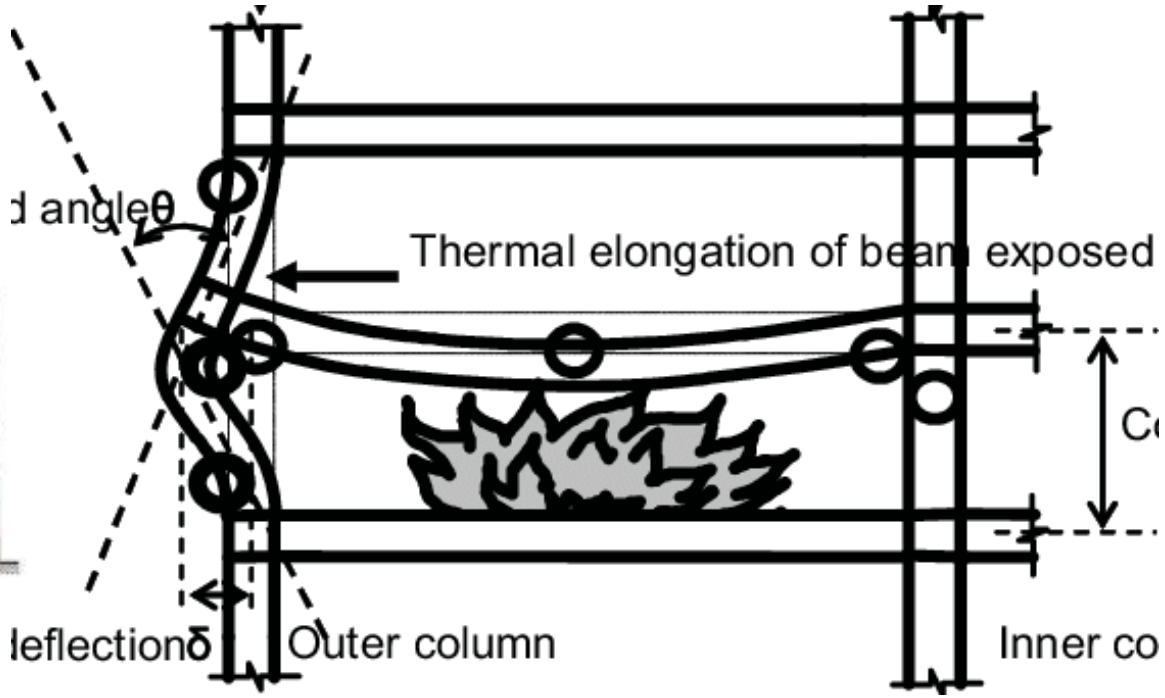
No protection causes 3 key problems:

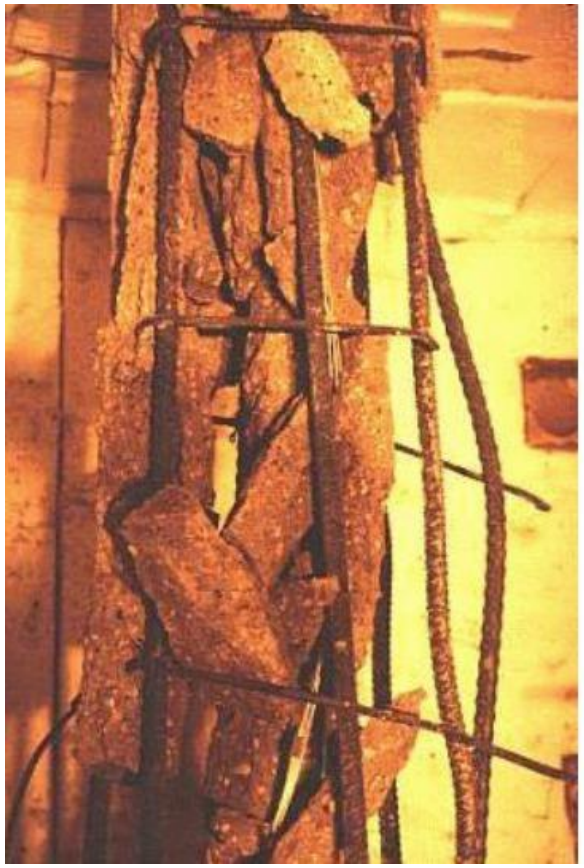
- **Smoke spread**
- **Flame spread**
- **Risk of structural collapse**

Structural instability & protection

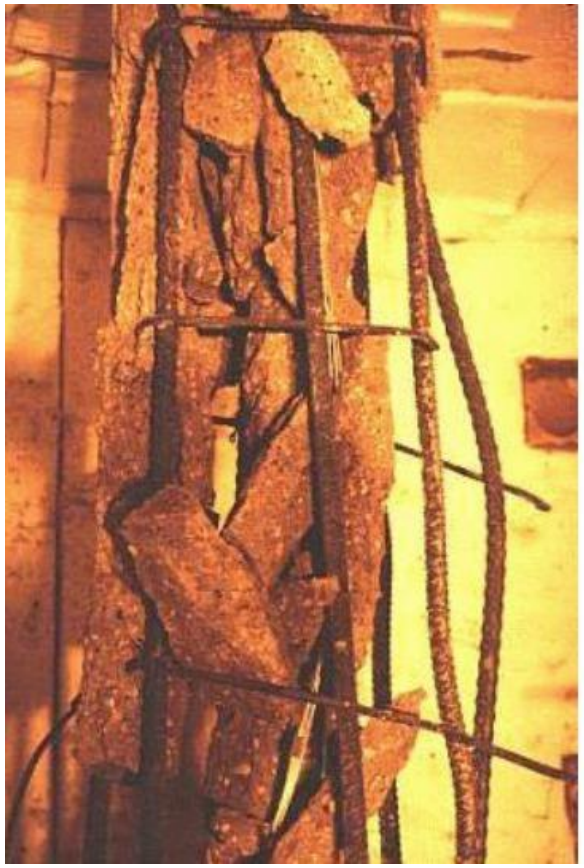
Risk of structural colapse







Gypsum: $CaSO_4.2H_20$



When exposed to high temperatures, the concretes temperature will rise.
As it rises, the **water within the concrete structure will start to evaporate** and leave the structure.
This causes the concrete to begin losing its structural integrity. On extreme heating- concrete spauls.

Gypsum: $CaSO_4.\ 2H_20$

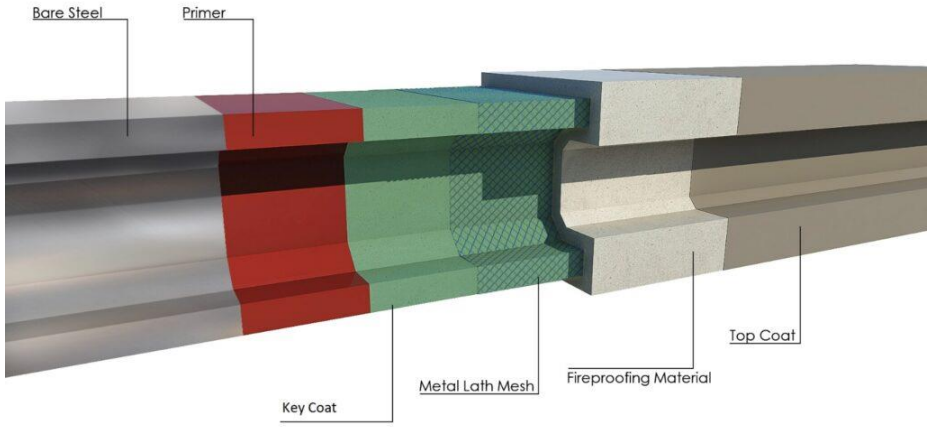
Structural protection

It is essential for:

insulating bare steel in load-bearing walls

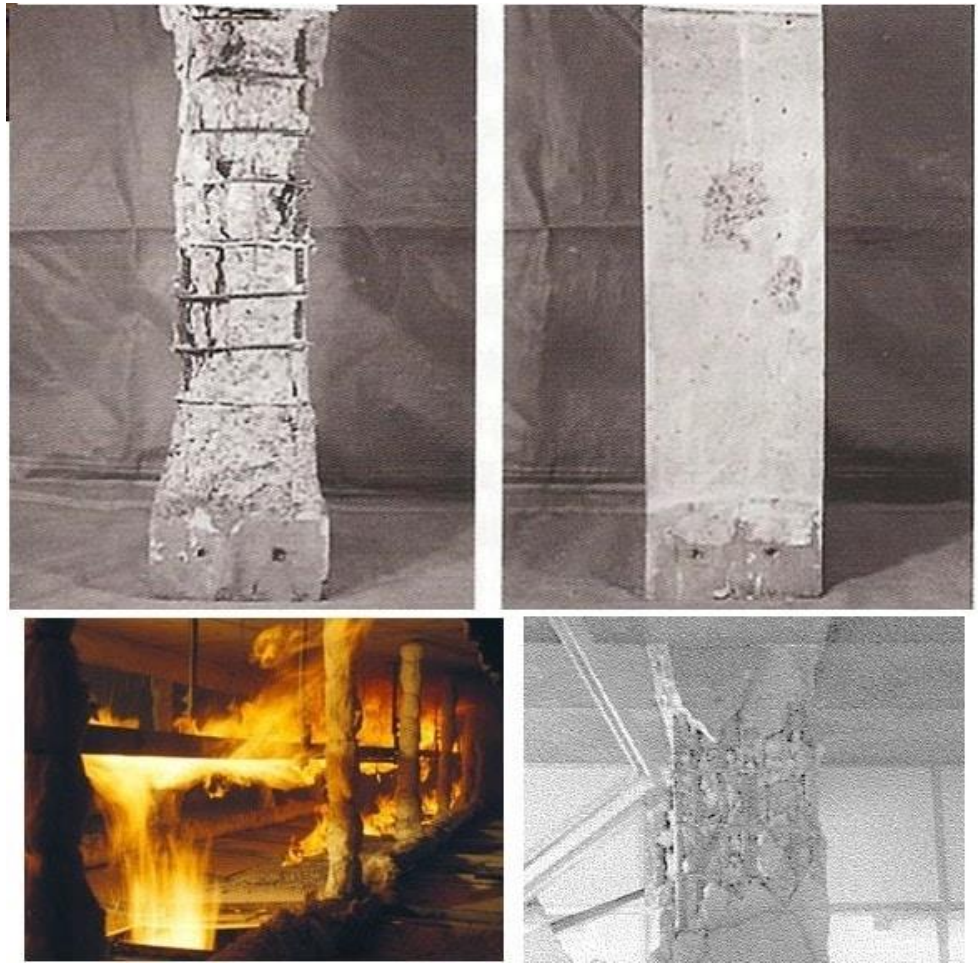
maintaining structural integrity (no buckling) (e.g. for 2 hr in high-rises per NFPA 5000).

ASFRMs adheres to irregular steel profiles, providing uniform coverage without impeding construction, and is mandated by IBC Chapter 7 for Type I/II buildings to delay critical temperature.



Inherent fire resistance & limitations

- Concrete’s low thermal conductivity and high heat capacity naturally resist fire spread, maintaining structural integrity (compressive strength retained up to ~600°C per ASTM E119 testing).



Types of protection

- **Spray-Applied Fire-Resistive Materials (SFRM)**
- **Intumescent Coatings**
- **Board Systems**
- **Outcome**: Ensures structural stability, limits temperature rise.

Everything has limitations.
Protection delays the point of failure.

Windsor tower, Madrid, Spain
12th Feb 2005

Windsor tower, Spain
12th Feb 2005

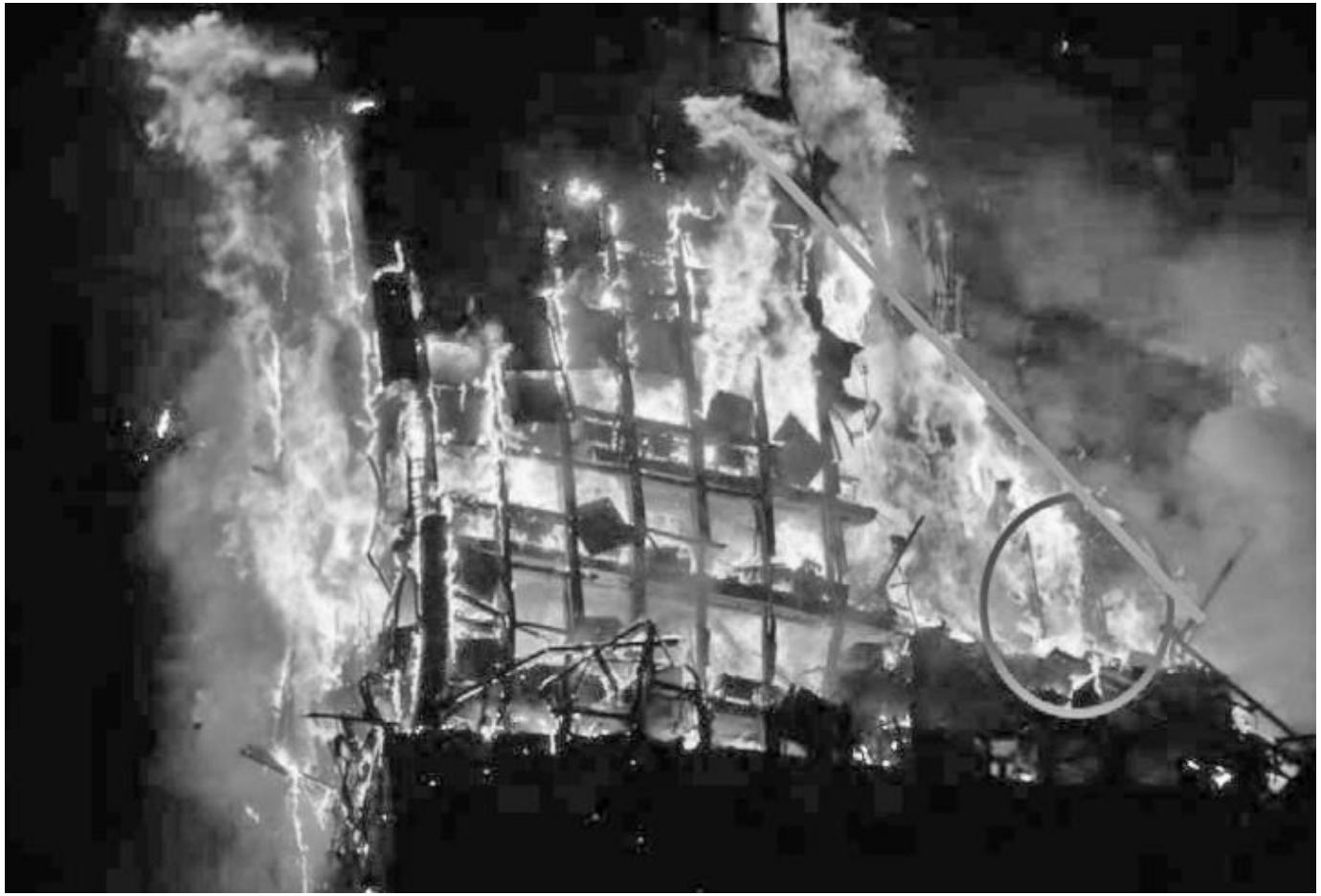
- Fire started on the 21st floor (electrical fault)
- Fire grew rapidly in the open-plan office space filled.
- Within an hour, flames engulfed floors above
- Fire **spreading upward at 6-15 minutes per floor** via broken windows and external spill plumes (hot gases rising and igniting above).

Windsor tower, Spain
12th Feb 2005

- Downward spread was slower (20-30 minutes per floor)
- fueled by falling debris
- Fueled by radiant heat through the façade
- Spread via internal paths like service voids and unsealed slab-cladding gaps

Windsor tower, Spain
12th Feb 2005

- Lacked operational sprinklers (retrofit)
- Had incomplete fire stopping → poor compartmentation.
- Blaze involved multiple floors simultaneously
- a "chimney effect" combined with very high fuel loading led to temperatures exceeding 1,000°C in spots.
- the **unprotected perimeter steel columns above the 17th floor heated exponentially buckling outward**



Windsor tower, Spain
12th Feb 2005

The building was under renovation relating to fire protection:

- New exterior emergency stairwells
- Updating existing utilities (compartmentation improvements to utilities, stairwells, floors and basement)
- Sprinkler retrofitting
- Full curtain wall replacement, including fireproofing of the perimeter steel columns.

This was only partially complete at the time of the fire.

Windsor tower, Spain
12th Feb 2005

- This triggered progressive collapses.
- 1st east face of the 21st floor at 3hrs into the fire
- 2nd upper sections around floors 20-25 shortly after
- 3rd south mid-sections of 17-20 appx 1 hour after that
- Debris from these falls thought to have cracked the 17th-floor transfer slab, aiding downward fire spread.
- Aluminum used in the curtain wall melted, “fire drops” propelled downward spread

Windsor tower, Spain
12th Feb 2005

- Below the 17th floor, **protected steel held**, but unprotected spots (e.g., 9th floor south/west sides) buckled
- The concrete core and internal columns redistributed loads, preventing further failure.

Windsor tower, Spain
12th Feb 2005

Upper floors

Lower floor damage

Windsor tower, Spain
12th Feb 2005

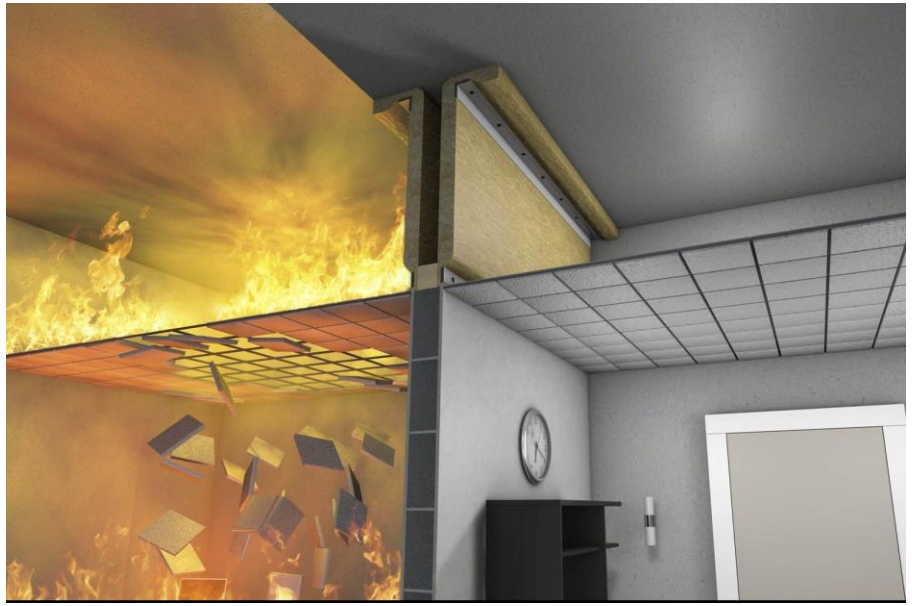
Fire protection system	At time of construction (1970s Spanish code)	At time of fire (under refurbishment)
Compartmentation	**X**	Under construction, **but not fully compartmentalised**
Fire stopping between cladding & Structure	**X**	Under construction
Protection of steel	**X**	**17th floor + above: NO** 18th floor, part complete 4-15th floor: Complete (except 9 and 15)
Sprinkler system	**X**	Being retrofitted
Fire alarm system	YES	YES

Buckling at floor 9

- Smoke spread
- Flame spread
- Risk of structural collapse

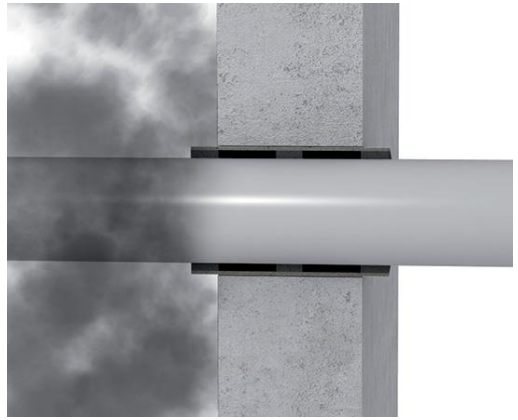
Problems mitigated:

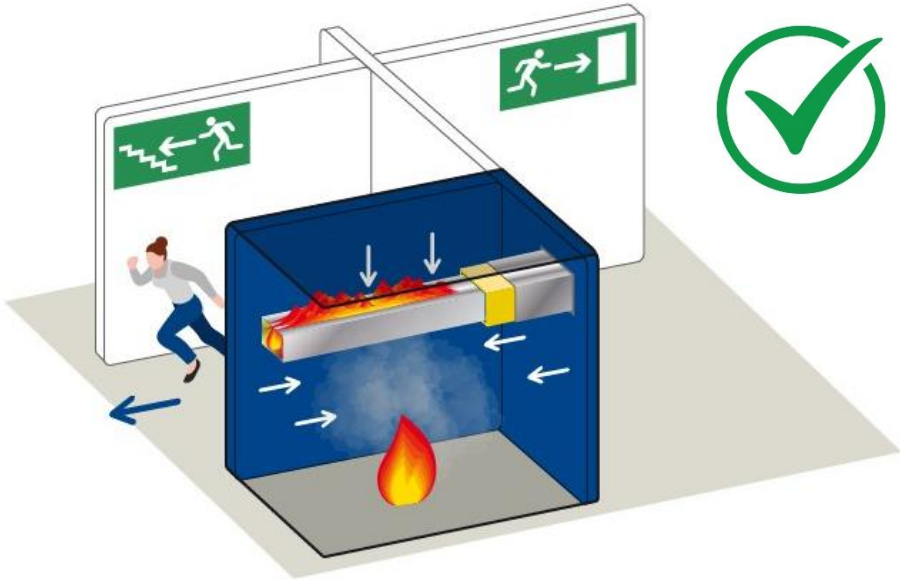
- **Smoke spread**
- **Flame spread**
- **Structural collapse**



What this means IRL:

- **Safe egress for occupants**
- **Safer entry for fire fighters**
- **Low risk of structural collapse**
- **Building performs as it is expected to during a**

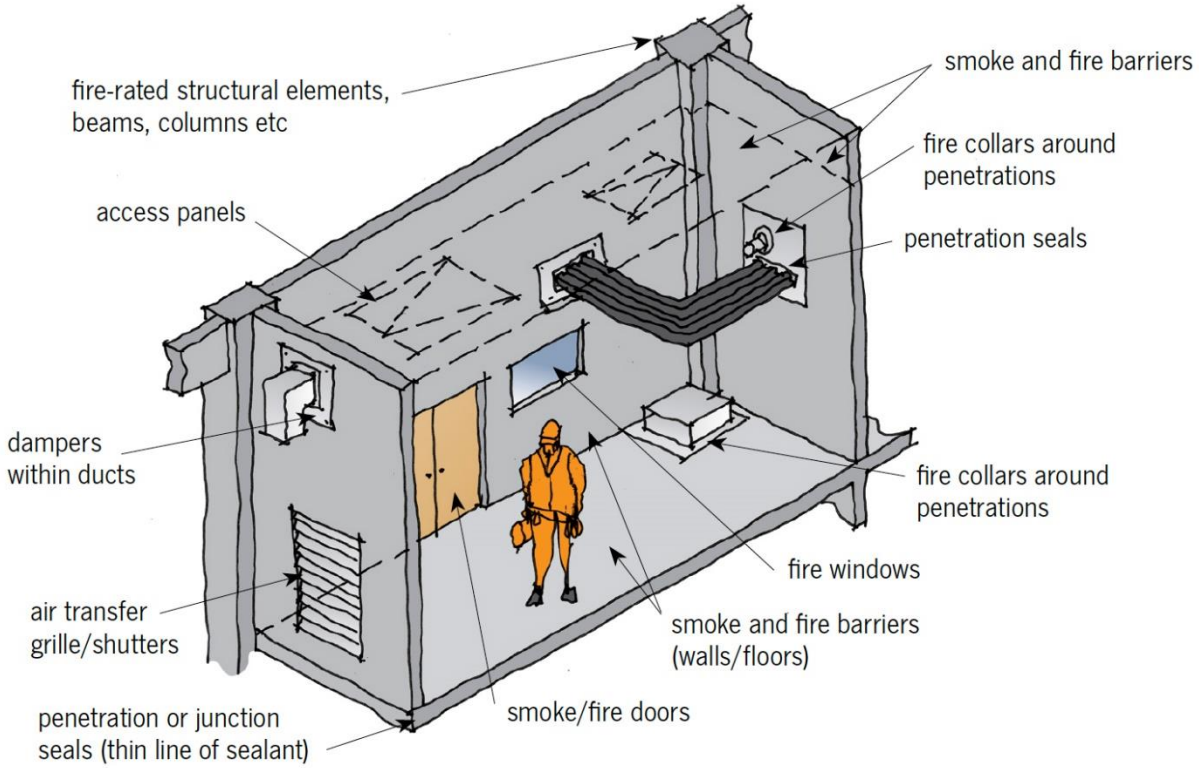




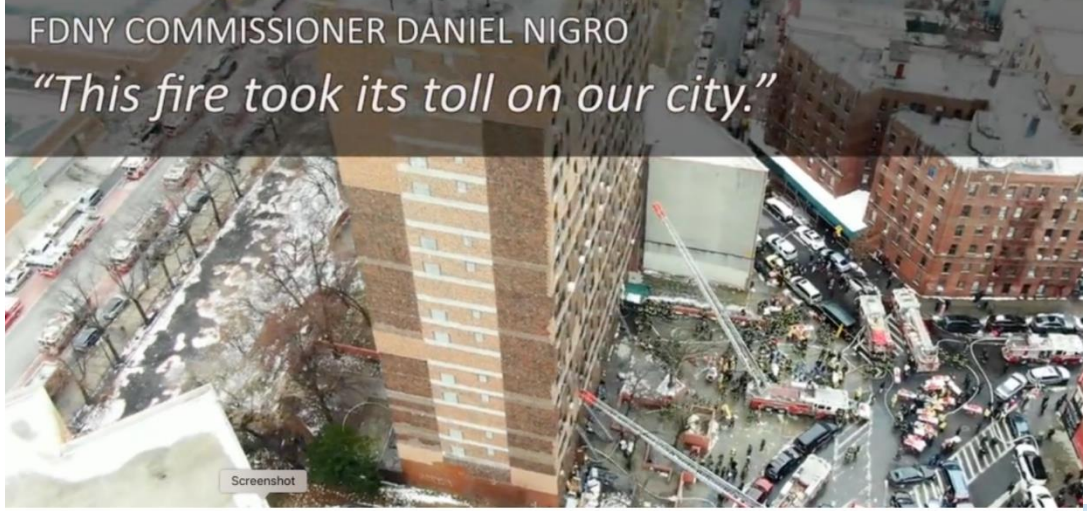
Passive fire is needed all throughout the building.

Active fire protection IS NOT a SUBSTITUTE for passive fire

Passive AND active fire protection WORK TOGETHER to create a safe building.



You can design the best system in the world, but if it's not installed correctly.... what you get won't match what you planned.



12 Jan 2022

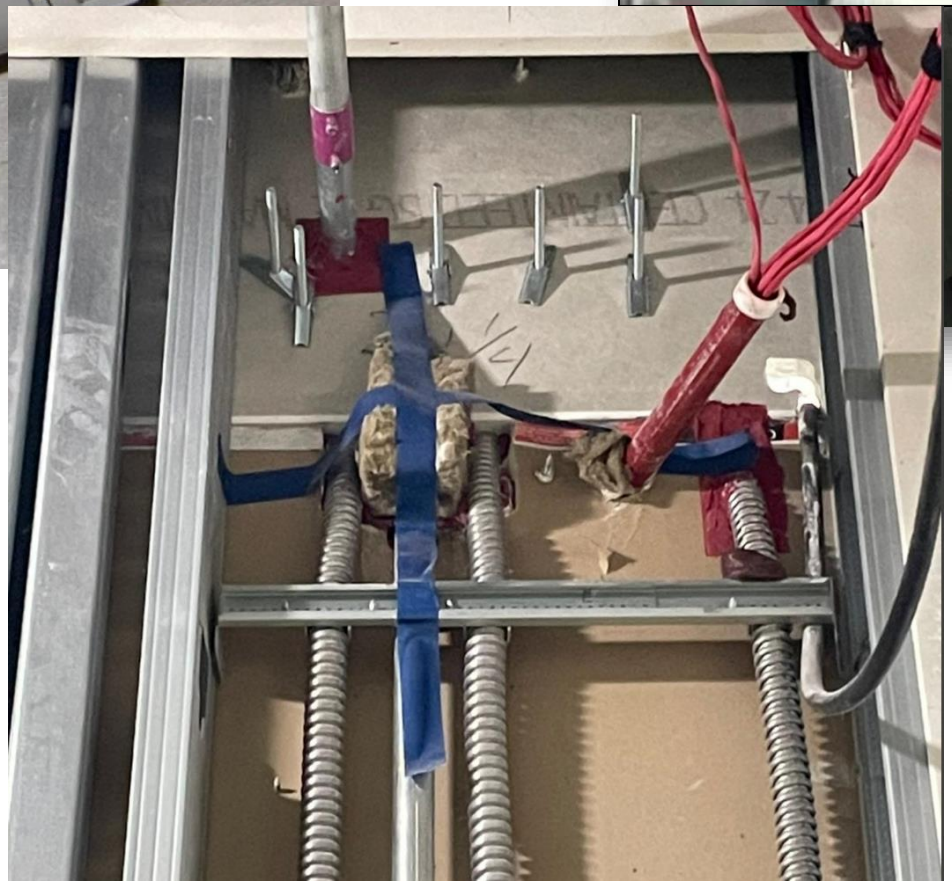
Smoke inhalation killed 19 people when door was left open in Bronx high rise fire

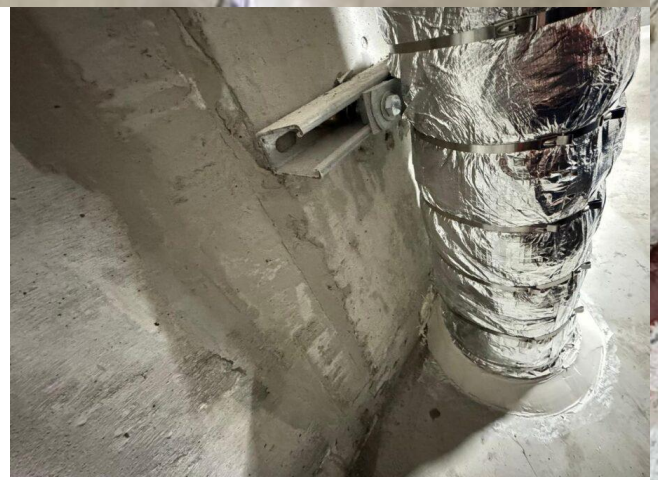
At least 10 dead in Lagos high-rise office building fire

18 September 2025

Share Save

A Brazilian court has sentenced four people to lengthy prison terms over the deaths of 242 club-goers in a fire during a party in 2013.



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DIIM Model

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Contractors Association

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Passive fire Saves Lives ———.

Contact .

Dr Gabrielle Peck Ph.D., MRSC

Technical Director

Email: gabby@FCIA.org

Phone: +44 7362299609

Web: www.FCIA.orgwww www.NFCA-online.org