

# Fire Containment in Multi-Story Buildings

Presented by ROXUL, INC. and  
Thermafiber, Inc. (An Owens Corning  
Company)

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# Contact Information

**Angela M. Ogino, LEED AP**

Technical Services Leader

**Thermafiber, Inc. Insolutions®**

(260) 569-8229

Email: [angela.ogino@owenscorning.com](mailto:angela.ogino@owenscorning.com)

[www.thermafiber.com](http://www.thermafiber.com)



**Melanie Bisson, CSI, CDT**

Southeast Territory Sales Manager

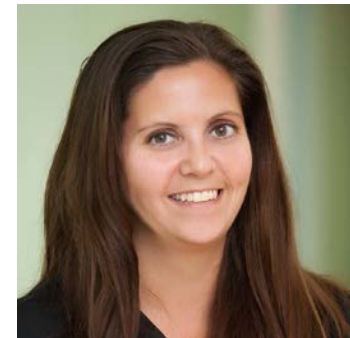
Commercial & Residential Solutions

**Roxul USA INC.**

(413) 265-8915

Email: [melanie.bisson@roxul.com](mailto:melanie.bisson@roxul.com)

[www.roxul.com](http://www.roxul.com)



# Agenda

- Importance of Fire Containment
- Building Code Requirement and ASTM E 2307
- Fire Performance of Building Materials
- What is Mineral Wool?
- Perimeter Fire Containment / Curtain Wall Ratings
- Basic Design Principles
- Installation
- Leap Frog Effect
- Engineering Judgments
- Q&A



# Why is fire containment important?



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# Why is fire containment important?



# Unsealed or Improperly sealed perimeter joints cost lives and huge liability losses...

- **Summerland**, Isle of Man, British Isles. Fire spread through safing slot. **50 people killed.**
- **Hilton Hotel**, Las Vegas, NV. Fire spread from 8<sup>th</sup> to 13<sup>th</sup> floor in 25 minutes. **8 fatalities.**
- **First Interstate Bank**, Los Angeles, CA. Flames spread from 13<sup>th</sup> to 16<sup>th</sup> floor via perimeter joint. **One death.**
- **One Meridian Plaza**, Philadelphia, PA. Fire spread from 22<sup>nd</sup> to 30<sup>th</sup> floor through unprotected openings including slab edge.





# Fire Containment

## 12/6/04 High-Rise fire at 135 S. LaSalle Building- Chicago

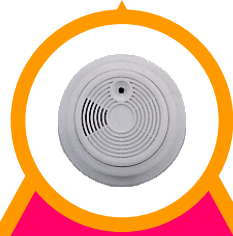


The fire burned for 6 hours. Fire was contained to the 29th and 30th floors.



# The Balanced Approach

**DETECTION**



**Passive Systems**  
**COMPARTMENTATION**

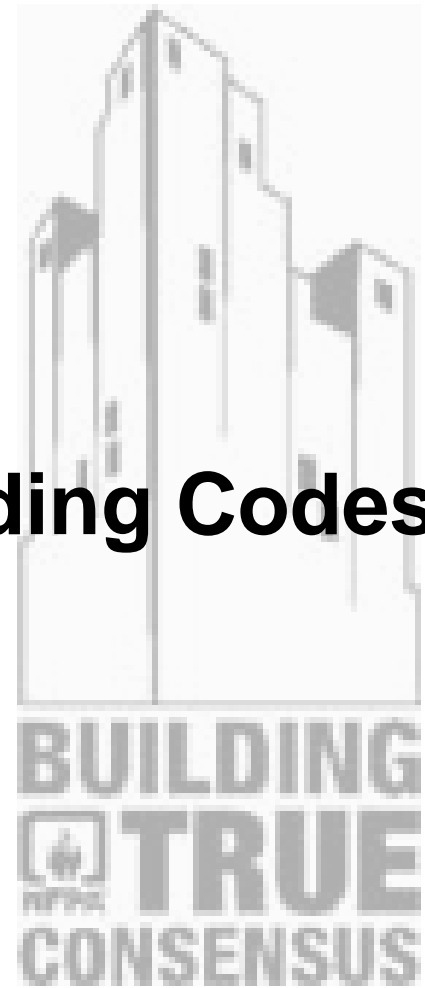


**Active Systems**  
**SUPPRESSION**





# What do the codes say?



## What do the Building Codes say?



# Building Codes – IBC (2015)

## Section 705.8.5 **Vertical Separation of openings.**

**Openings in exterior walls** in adjacent stories **shall be separated vertically** to protect against fire spread on the exterior of the buildings where the openings are within 5 feet (1524mm) of each other horizontally and the opening in the lower story is not a protected opening with a fire protection rating of not less than  $\frac{3}{4}$  hour. Such openings shall be separated vertically **at least 3 feet** (914mm) by spandrel girders, exterior walls or other similar assemblies that have a fire-resistance rating of at least 1 hour or by flame barriers that extend horizontally at least 30 inches (762mm) beyond the exterior wall...

### Exceptions:

- 1) This section shall not apply to buildings that are three stories or less above grade plane.
- 2) This section shall not apply to buildings equipped throughout with an automatic sprinkler system in accordance with section 903.3.1.1 or 903.3.1.2.
- 3) This section shall not apply to open parking garages.



# Building Codes – IBC (2015)

**Section 715.4 Exterior curtain wall/floor intersection.** Where fire resistance-rated floor or floor/ceiling assemblies are required, **voids created at the intersection of the exterior curtain wall assemblies and such floor assemblies shall be sealed with an approved system** to prevent the **interior spread** of fire. **Such systems shall be securely installed and tested in accordance with ASTM E2307 to provide an F rating for a time period not less than the fire-resistance rating of the floor assembly.** Height and fire-resistance requirements for curtain wall spandrels shall comply with Section 705.8.5.

**Exception:** Voids created at the intersection of the exterior curtain wall assemblies and such floor assemblies **where the vision glass extends to the finished floor level shall be permitted to be sealed with an approved material to prevent the interior spread of fire.** Such material shall be securely installed and capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste where **subjected to ASTM E 119 time-temperature fire conditions** under a minimum positive pressure differential of 0.01 inch (0.254 mm) of water column (2.5 Pa) for the time period equal to the fire-resistance rating of the floor assembly.



# Building Codes – IBC (2015)

## Section 715.5 **Spandrel wall:**

Height and fire-resistance requirements for curtain wall spandrels shall comply with Section 705.8.5. **Where Section 705.8.5 does not require a fire-resistance-rated spandrel wall, the requirements of Section 715.4 shall still apply to the intersection between the spandrel wall and the floor.**

**Section 715.4 ...Such systems shall be...installed and tested in accordance with ASTM E 2307 to provide and F rating...**



# Building Codes – IBC (2012)

**Section 715.4 Exterior curtain wall/floor intersection.** Where fire resistance-rated floor or floor/ceiling assemblies are required, **voids created at the intersection of the exterior curtain wall assemblies and such floor assemblies shall be sealed with an approved system** to prevent the **interior spread** of fire. **Such systems shall be securely installed and tested in accordance with ASTM E2307 to provide an F rating for a time period at least equal to the fire-resistance rating of the floor assembly.** Height and fire-resistance requirements for curtain wall spandrels shall comply with Section 705.8.5.

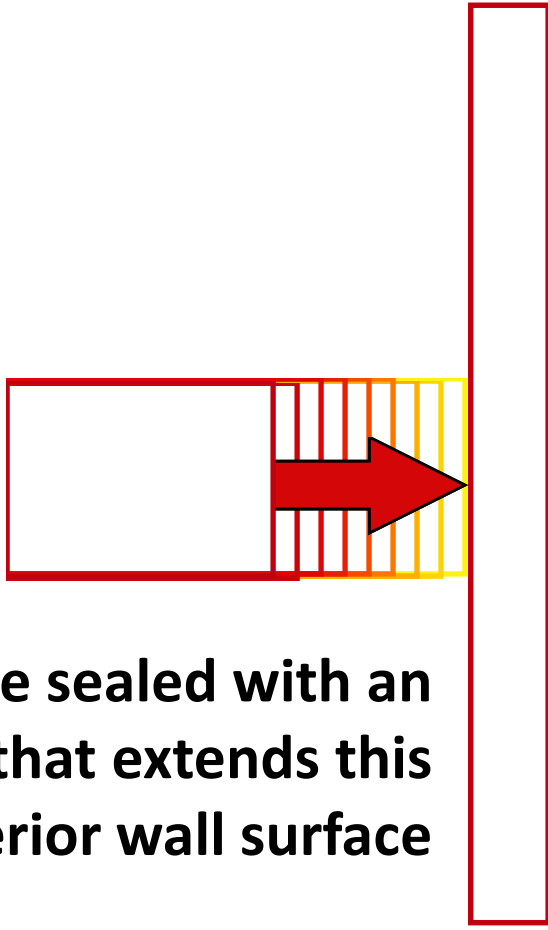
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# Extending the Rated Floor to the Wall...

**MANDATORY!**

In rated construction, all floors are rated

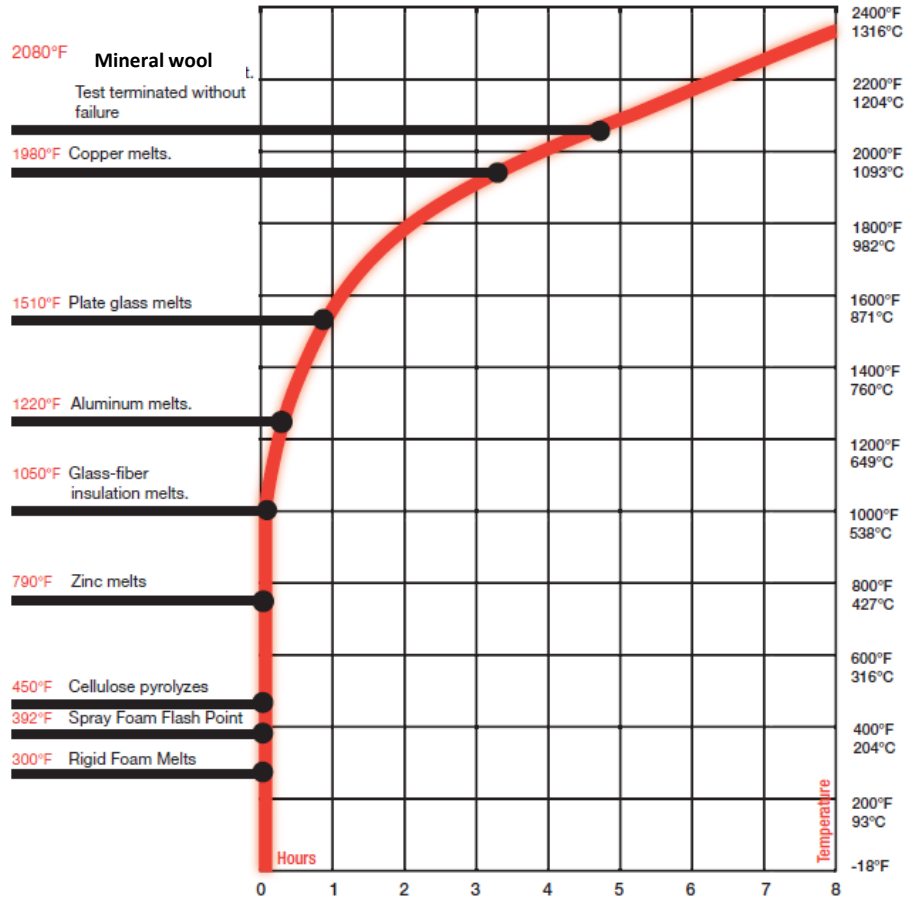


The perimeter joint must be sealed with an approved material or system that extends this rating to the exterior wall surface



# Fire Performance of Mineral Wool

## ASTM E 119 Time Temperature Curve

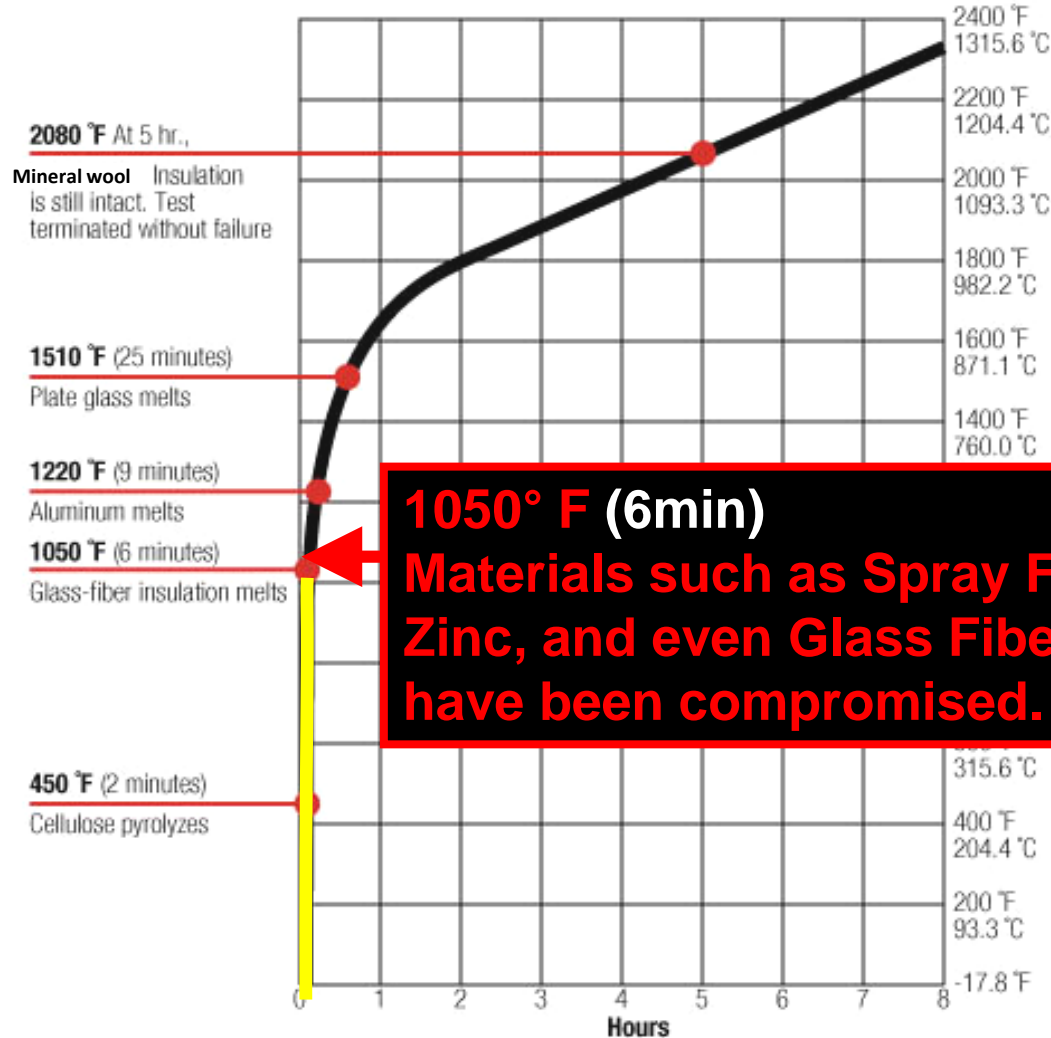


(1) Not for service operation at this temperature. Refer to the appropriate Thermafiber insulation literature which states recommended maximum service temperature limits of individual products.  
Time-temperature curve from "Standard of Methods of Fire Tests of Building Constructions and Materials," (ASTM E119-81)





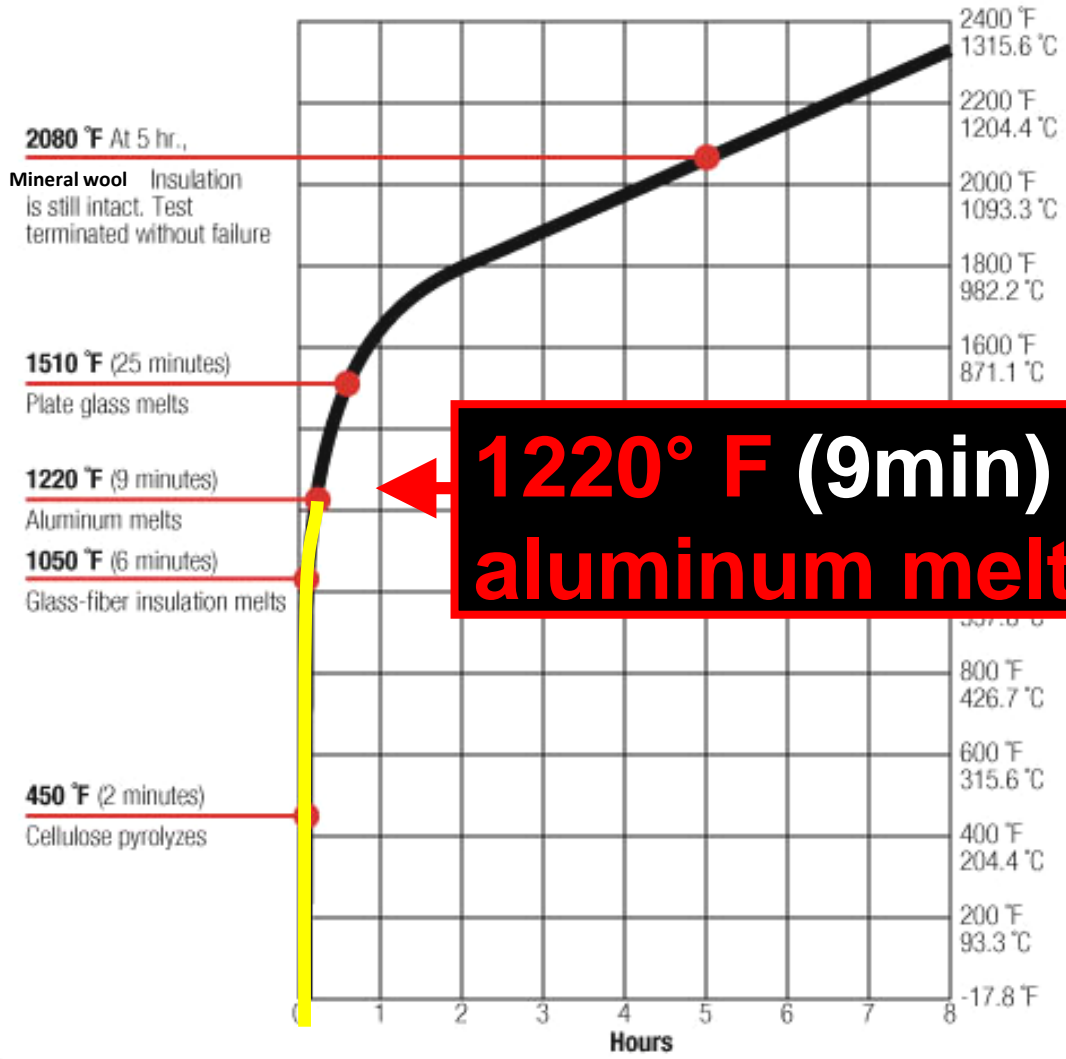
# Fire Performance of Mineral Wool



**1050° F (6min)**  
**Materials such as Spray Foam, Zinc, and even Glass Fiber have been compromised.**



# Fire Performance of Mineral Wool



# Curtain Wall Test Assembly

## Pre-Burn



- Transom above floor
- Mineral wool insulation at spandrel area
- Mechanical attachments supporting insulation
- Transom below floor
- Mullions



# Assembly Interior View

## Pre-Burn

Thermocouples measuring  
temperature rise



# Interior Burner Lit - Time: 0:00





# Exterior Burner Lit - Time: 0:05



# Flames Climbing Exterior

Time: 0:15



©2004 International Firestop Council



# Melting of Mullions & Transoms

Time: 0:45



# Transom exposure to fire test



Transom bending  
down 11 min. into test.



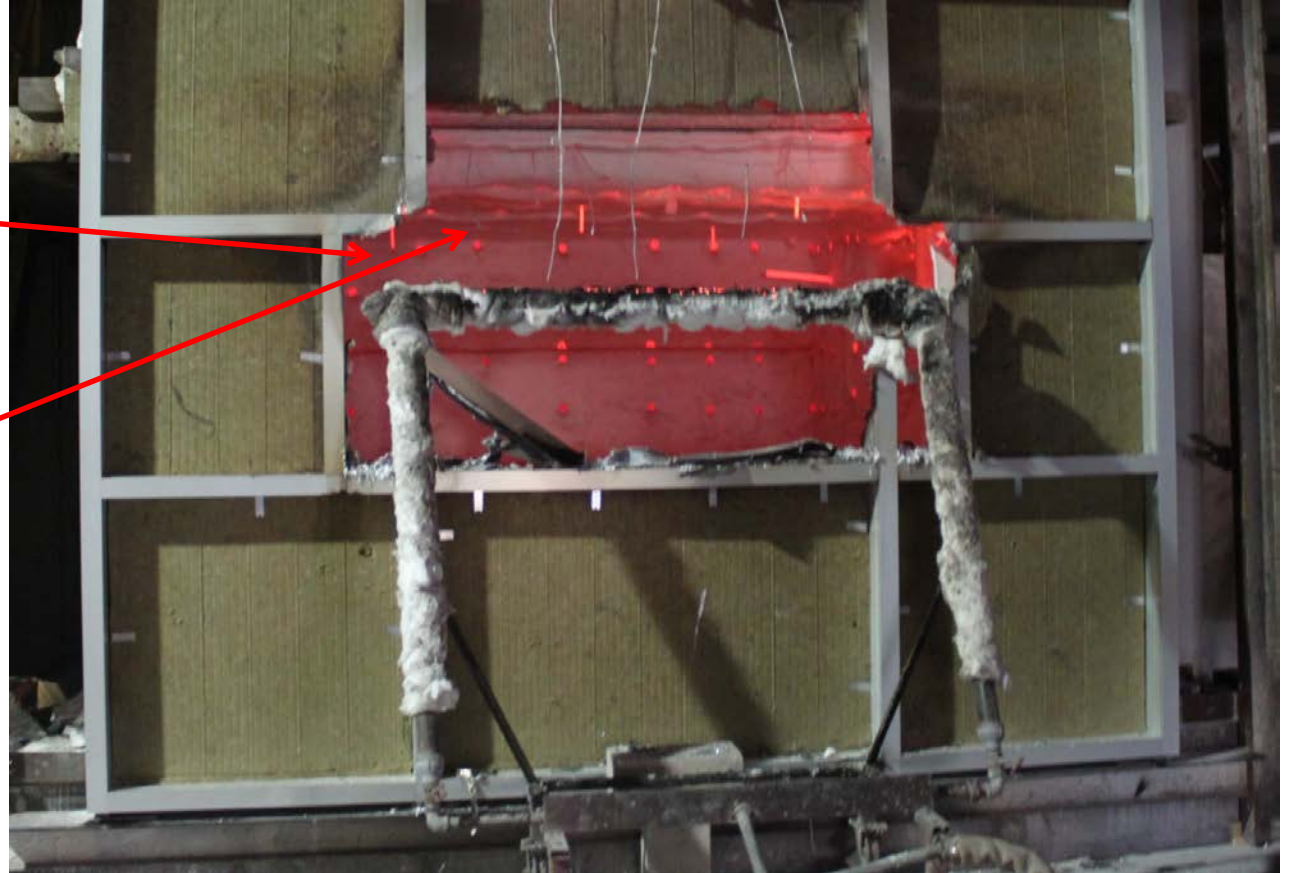
# Post Test:

Close up Detail of  
Mullion and Transom  
Damage

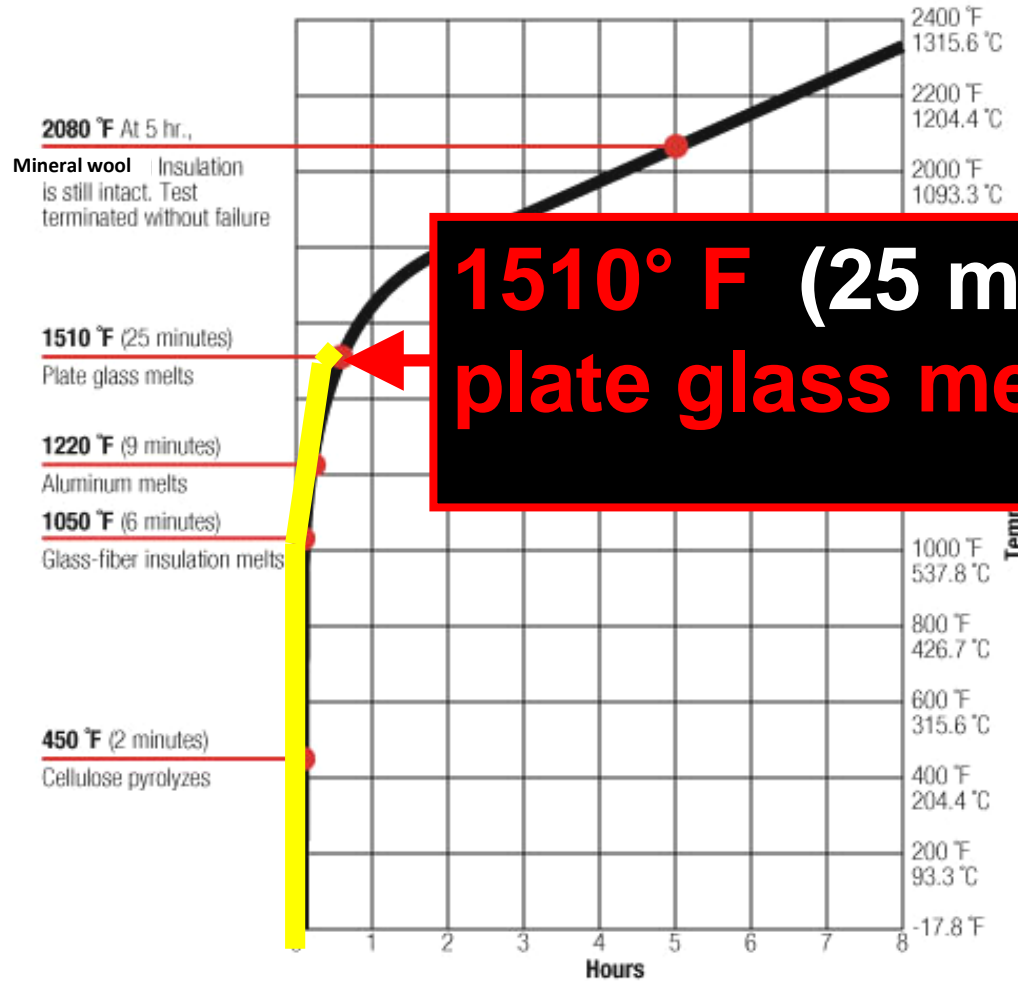


# Mullions and Transoms after exposure to fire test

Complete loss of horizontal transom and vertical mullions.



# Fire Performance of Mineral Wool





# Fire Performance of Mineral Wool

Glass breakage  
approximately  
11 minutes into  
a fire test.



# Vision Glass Breaks

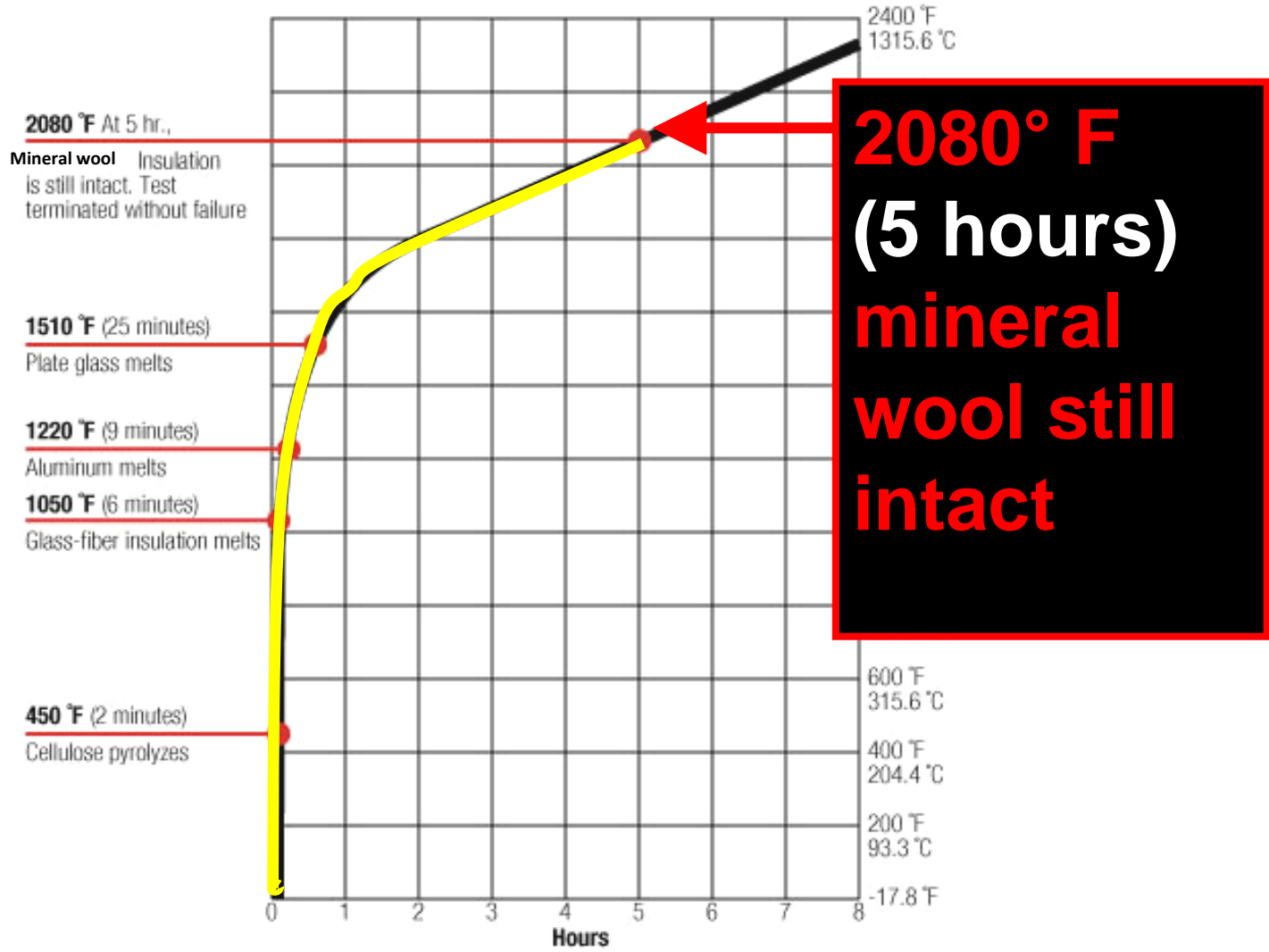
Time:  
2:00



©2004 International Firestop Council



# Fire Performance of Mineral Wool



# Burner Off at 2 hours



# What is Mineral Wool?



- Stone wool or “mineral wool” products are made from a combination of natural basalt rock and recycled slag.
- Raw Materials are melted into a molten state and then spun into stone fibers.
- Minor amounts of binder & oil are added.
- Various manufacturers feature up to 40%+ recycled content.

# Industry Definition: Mineral Wool



*Mineral Fiber raw materials & Finished Goods*

Technical Codes & Standards/Industry Associations define Mineral Wool and Mineral Fiber to include the following:

- Mineral Fiber
  - Glass Fiber
  - Rock & Slag Fiber
- Mineral Wool (Stone Wool)
  - Rock & Slag Fiber (does not include glass fiber by definition).

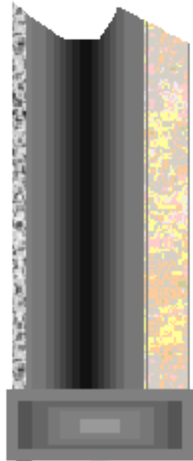
# Why Specify Mineral Wool?

## The Top 6 Reasons

- ✓ Fire Resistance
- ✓ Sound Absorbency
- ✓ Long-term Thermal Resistance
- ✓ Dimensional Stability
- ✓ Water Repellency
- ✓ Vapor Permeability

*What are the  
dynamics of  
vertical spread in a  
high-rise building?*





*Fire begins on a lower floor,  
products of combustion  
accumulate at ceiling level, and  
positive pressure builds*

*Rated Floor Assembly and non-  
rated Curtain Wall System*

*Vision Glass*

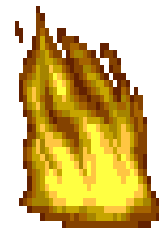




*The fire follows the flow of air currents...*



*If the void between the floor and curtain wall is not properly sealed, flames will spread vertically...*



*and compartmentation is breached!*

*Vision Glass* →

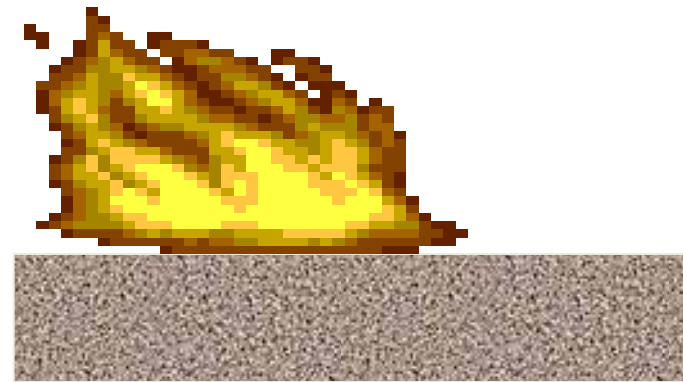
*Rated Floor Assembly and non-rated Curtain Wall System*





*Fire attacks the curtain wall structure from both sides causing a premature failure of the wall structure and potentially the vision glass above!*

*Flames may erupt through the windows. Oxygen fuels the fire.*

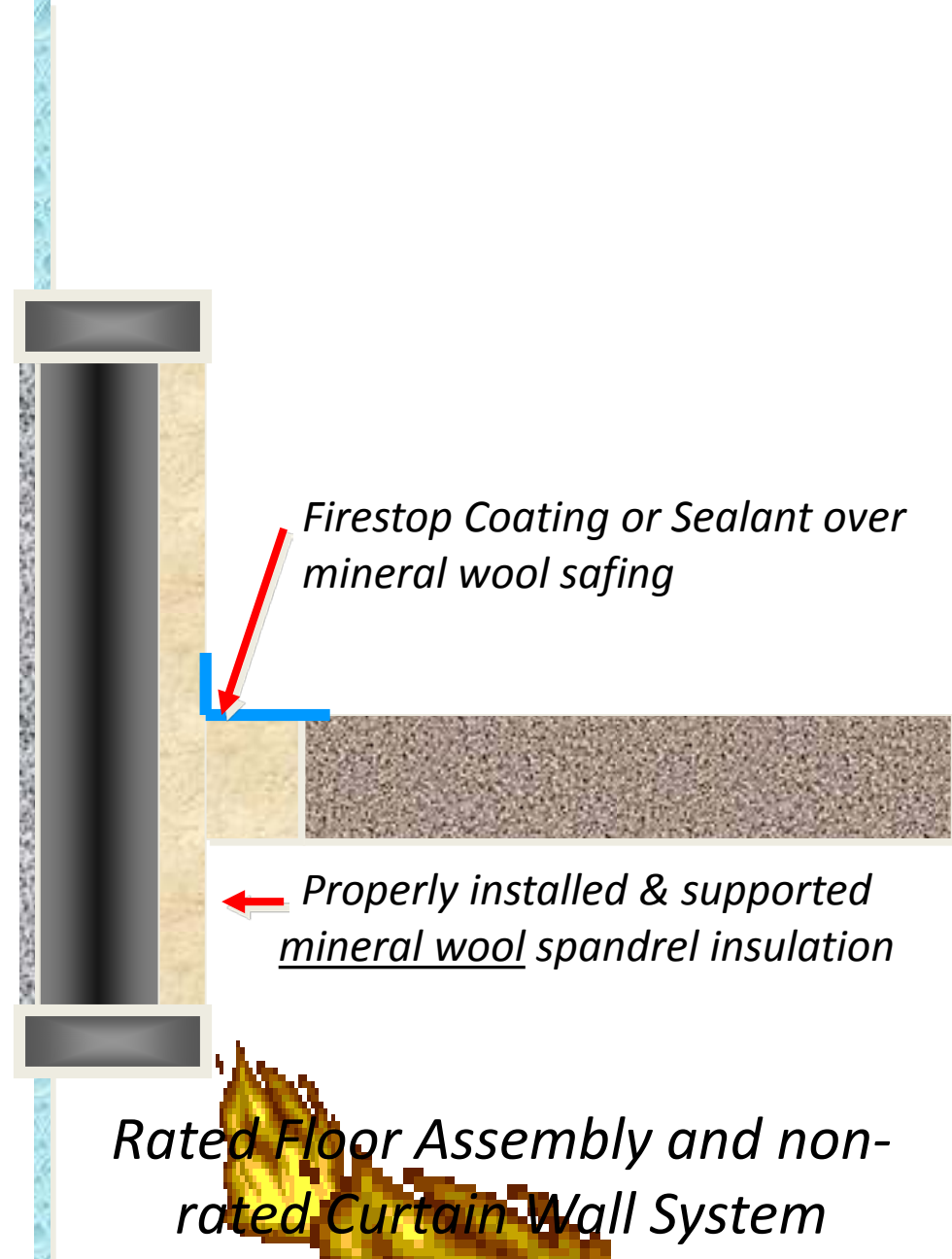


*Elevated temp. and pressure breaks lower vision glass*

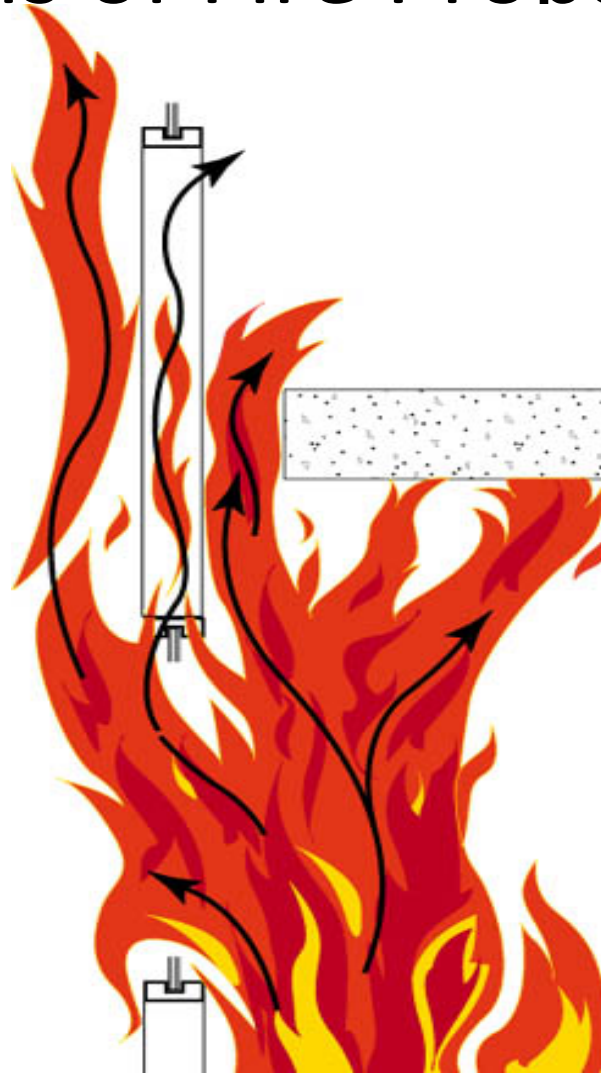
*Rated Floor Assembly and non-rated Curtain Wall System*



*A properly designed & tested Perimeter  
Fire Barrier System  
not only protects the perimeter joint but  
critical wall framing and support elements  
as well!*



# Paths of Fire Propagation



# *How Are Perimeter Fire Barrier Systems Tested?*



## ASTM E2307

Standard Test Method for  
Determining Fire  
Resistance of Perimeter  
Fire Barriers Using  
Intermediate-Scale,  
Multi-Story Test  
Apparatus



# How Are Perimeter Fire Barrier Systems Tested?

Only two labs presently perform testing in accordance with newly developed test methods:

- Underwriters Laboratories Inc. – Northbrook, IL
- Intertek/Omega Point Laboratories – Elmendorf, Texas





# UL & OPL Testing

- Perimeter joint curtain wall test is performed in accordance with ASTM E2307
- Other labs, testing per UL 2079 alone, do not adequately capture the dynamics between a rated floor and a non-rated curtain wall assembly, the structural nature of curtain walls, and fire attacking at two planes
- Intermediate-Scale, Multi-Story Test Apparatus (ISMA) was developed for this application



# Post Test – Interior View



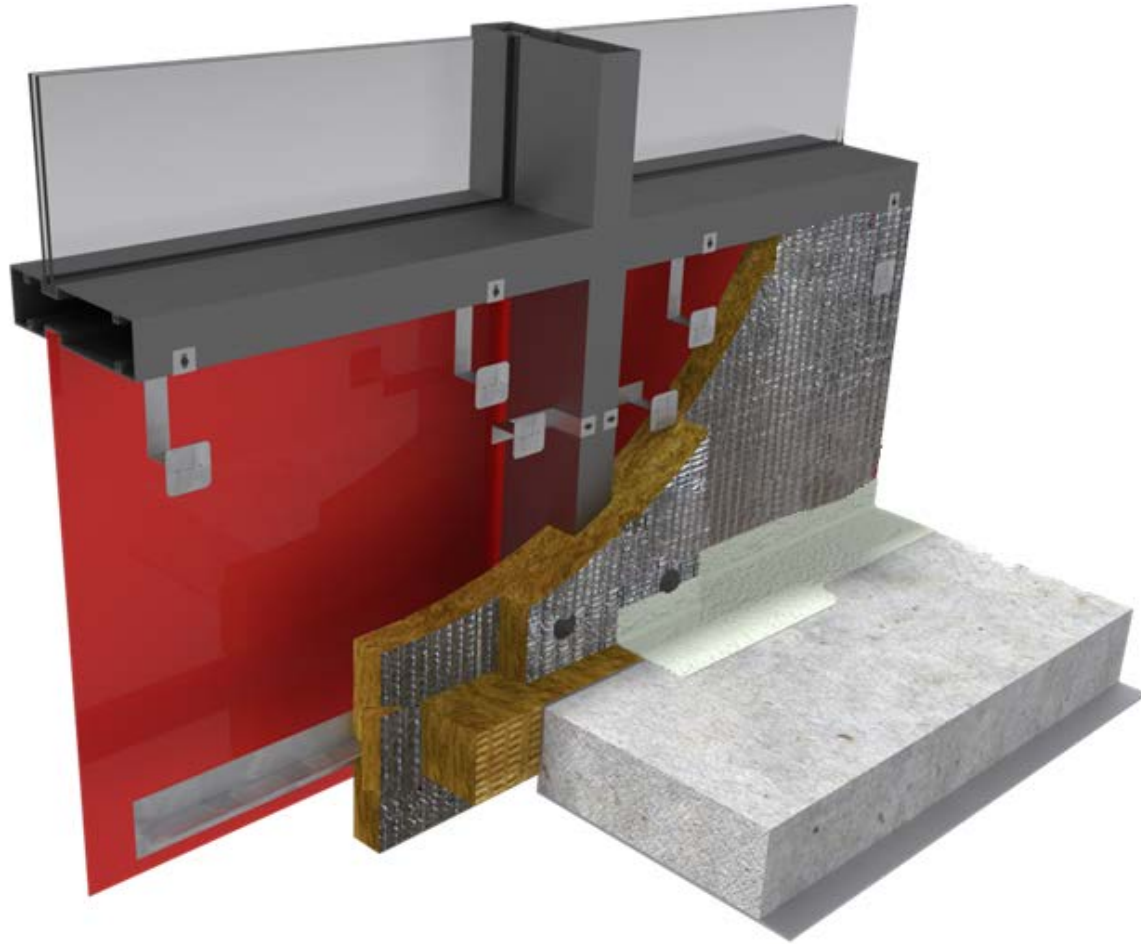
# Perimeter Fire Containment



**How Is a Fire  
Like This Contained?**



# Perimeter Fire Containment

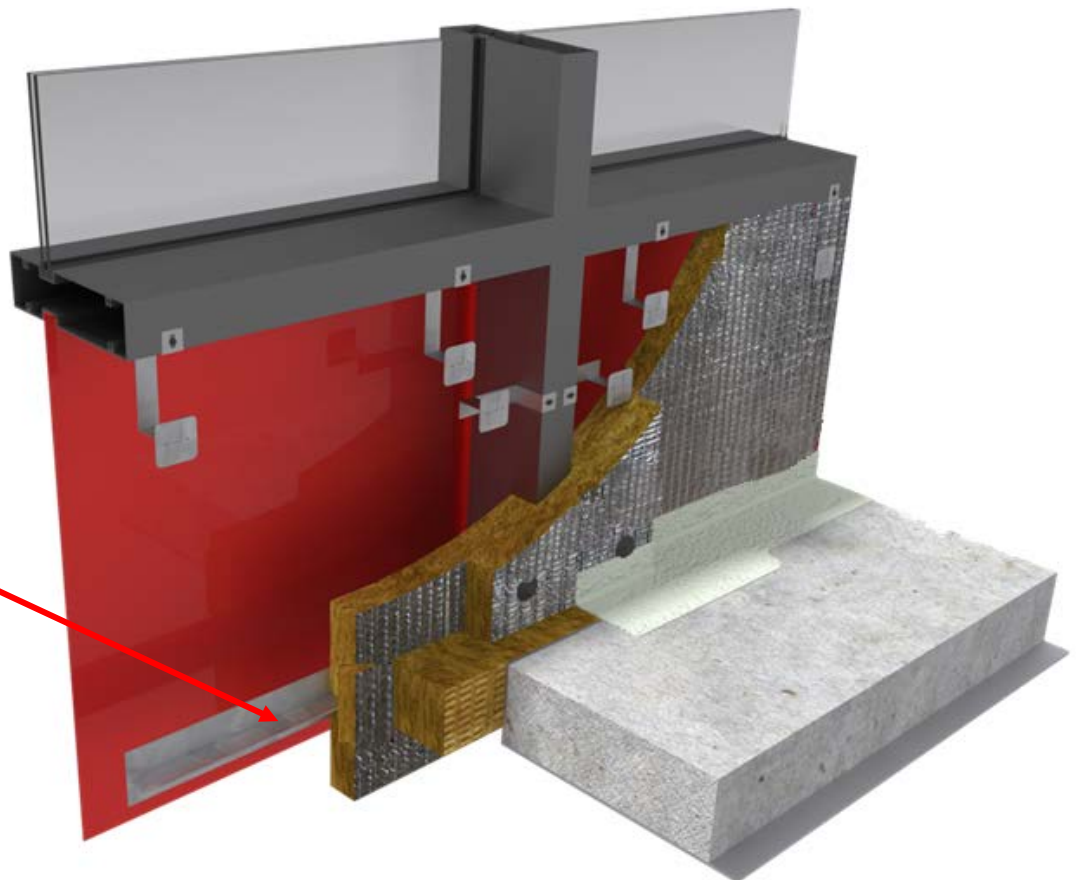


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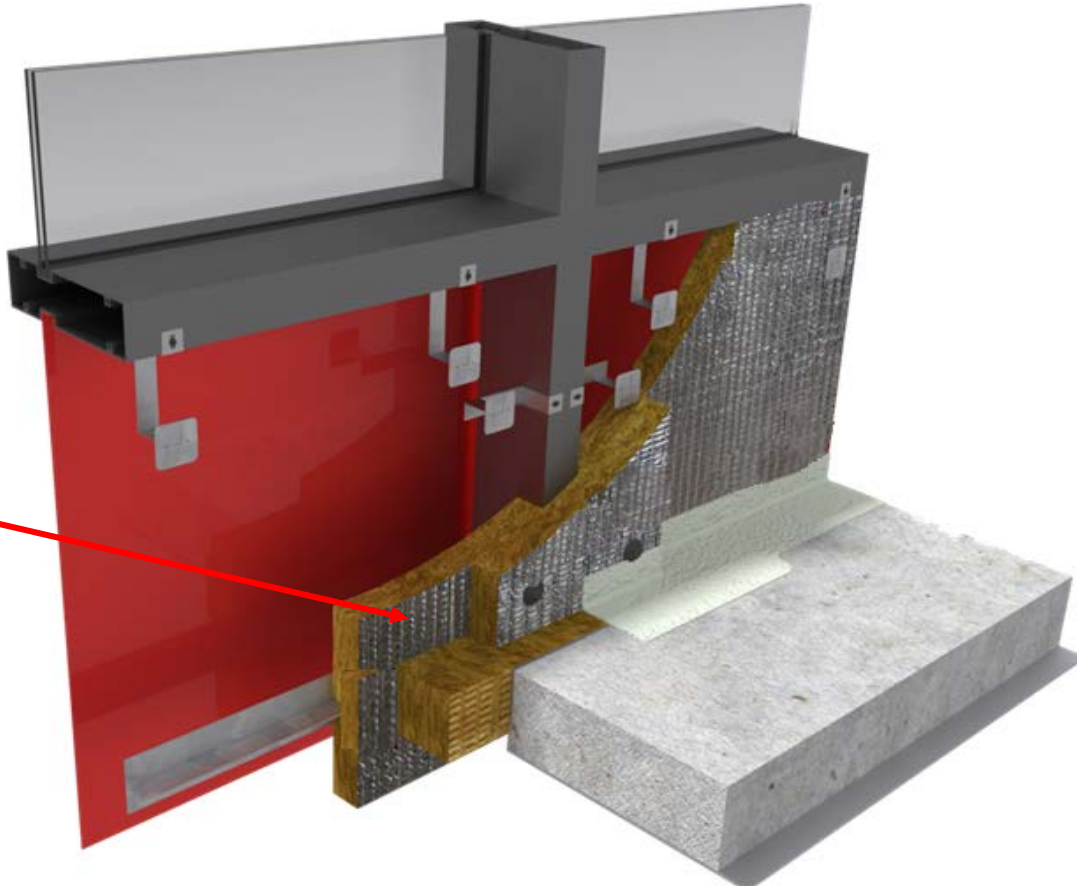


# Basic Design Principles

Reinforcement Member  
Mechanically Attached



# Basic Design Principles

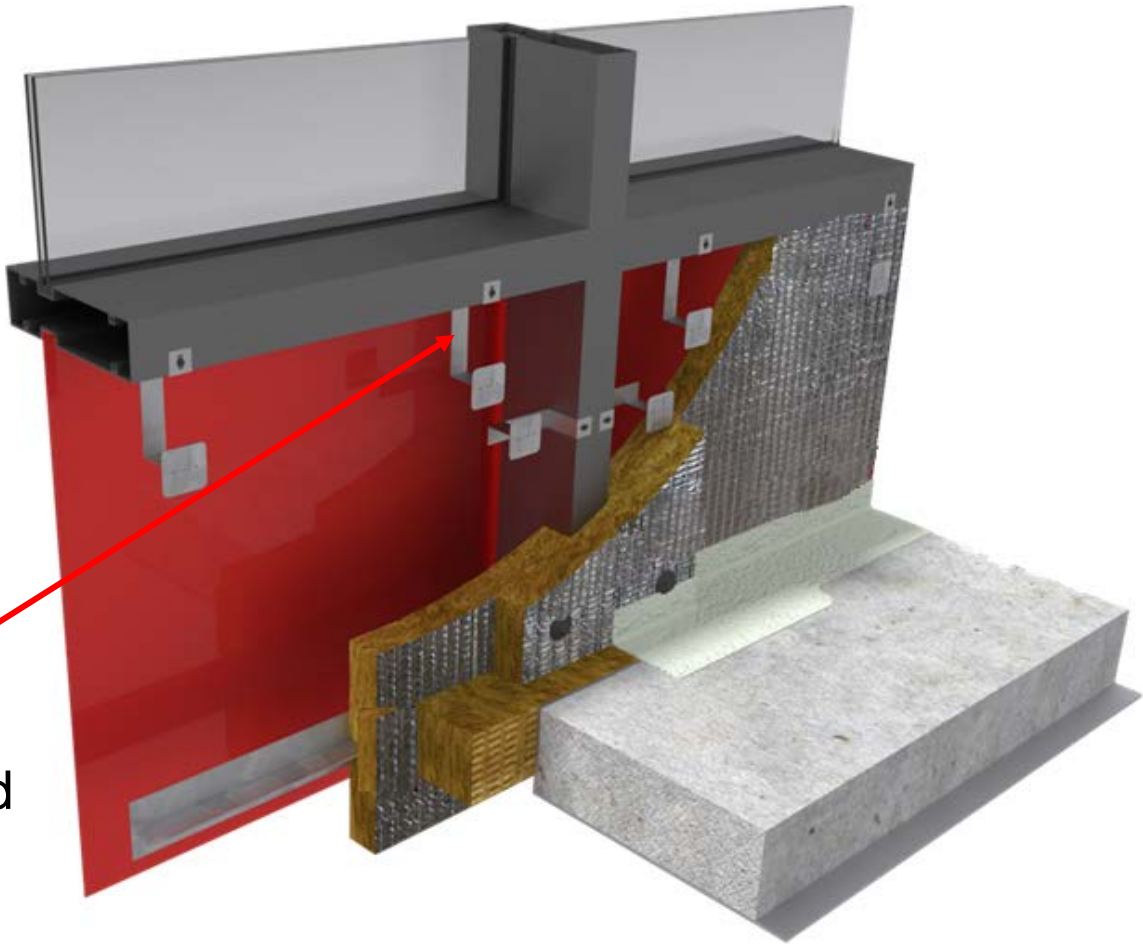


Mineral Wool  
Insulation





# Basic Design Principles

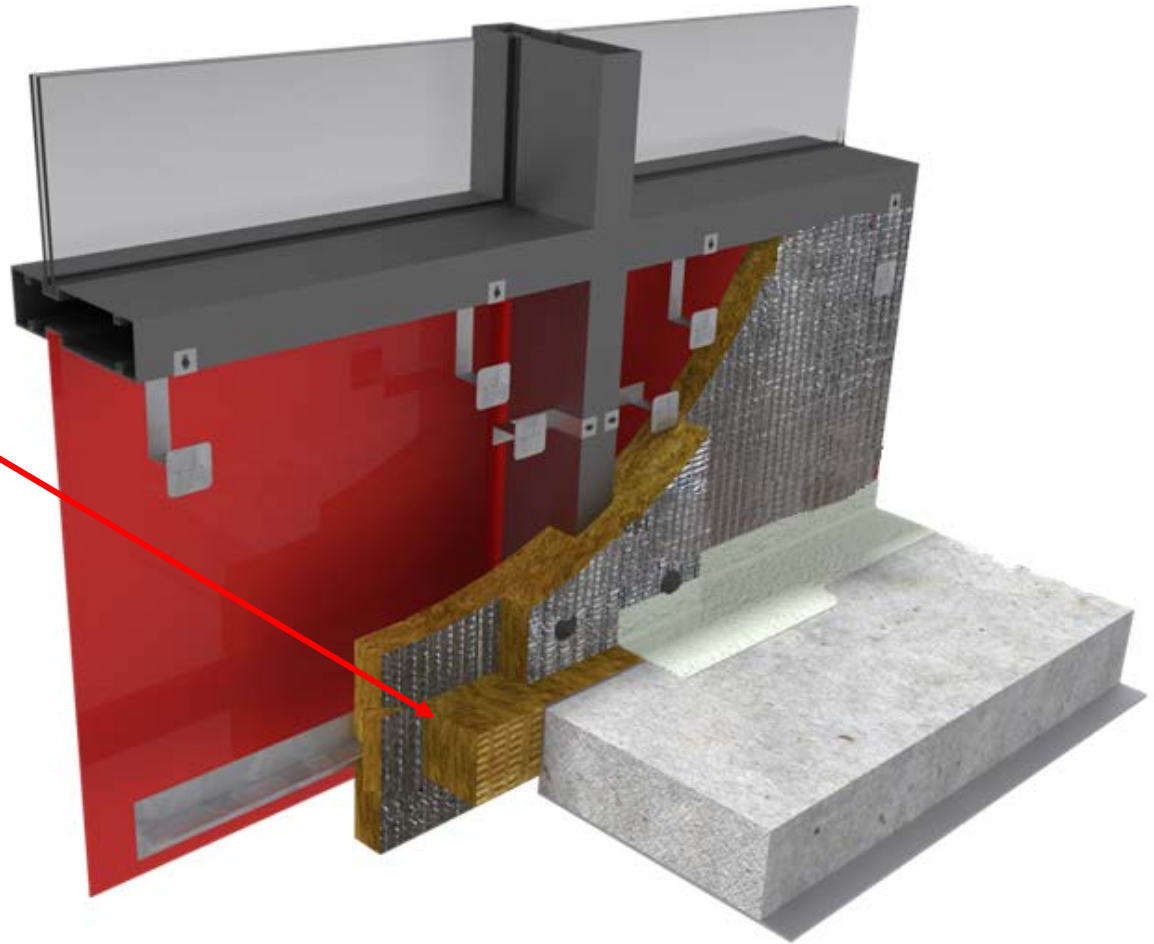


Mineral Wool  
Insulation -  
Mechanically Attached



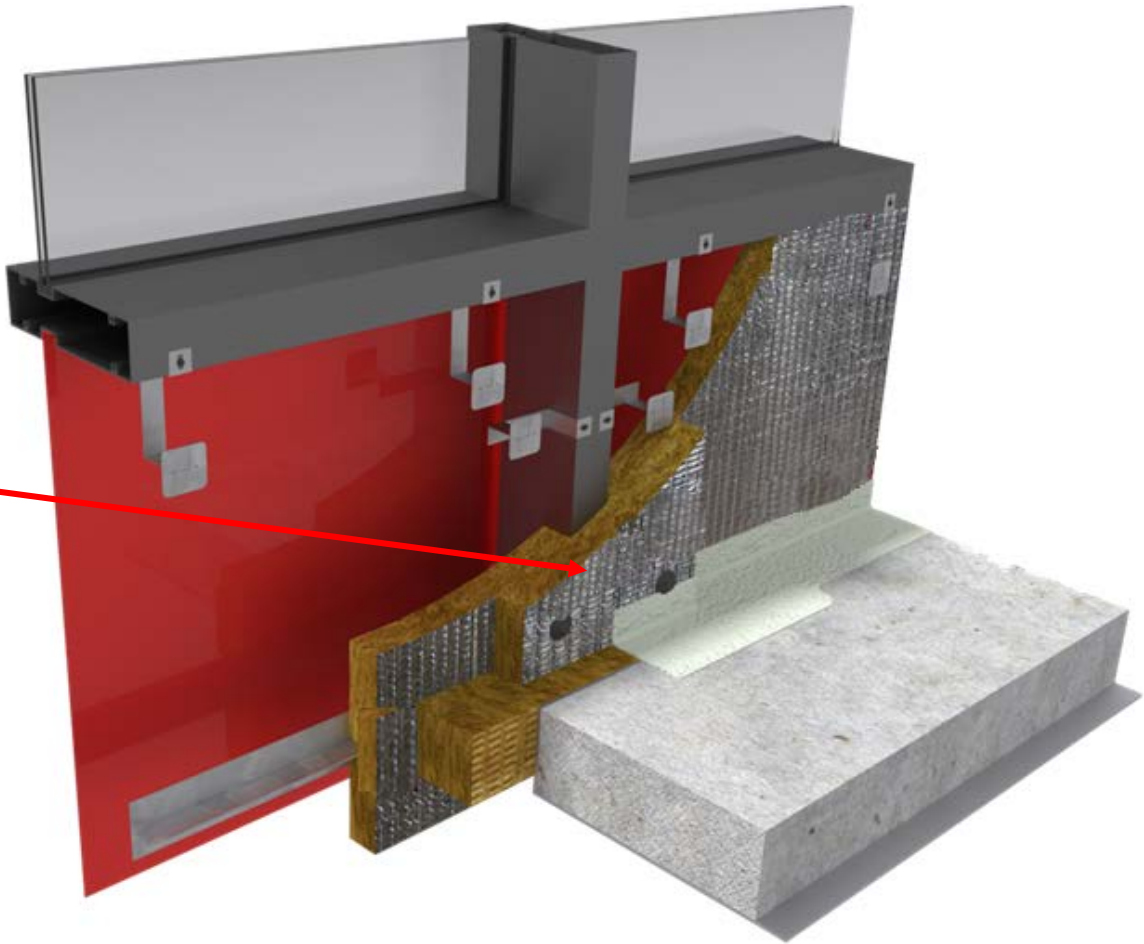
# Basic Design Principles

Compression Fit Safing  
(Direction of Safing as required  
per tested assembly)



# Basic Design Principles

Protect Mullions with Mineral Wool Insulation



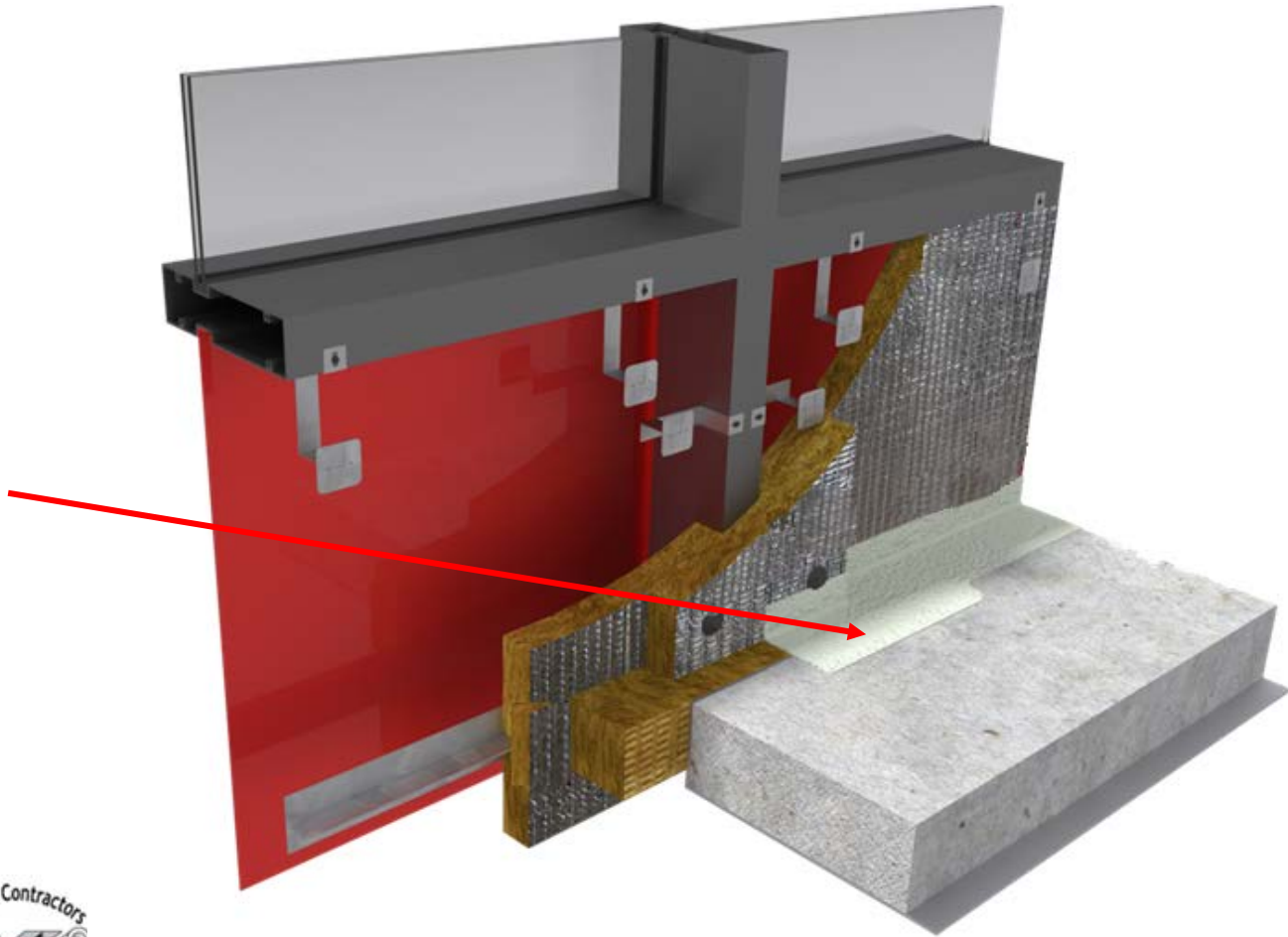
# Smoke- The known killer

**The major contributor of fire related deaths  
is smoke inhalation**

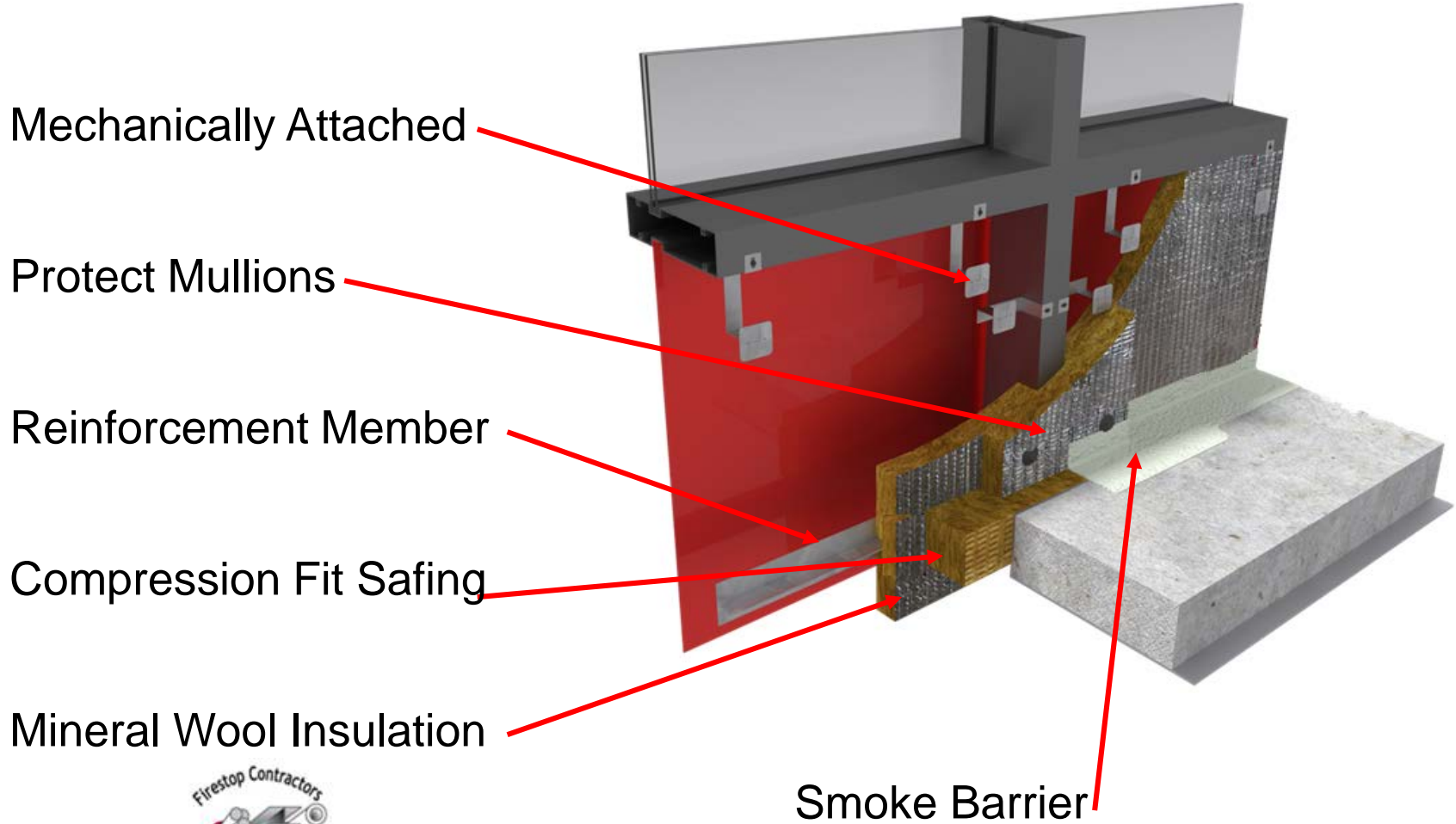


# Basic Design Principles

Smoke Barrier



# Basic Design Principles





# Basic Design Principles

## The Six Basic Components of Any Listed Perimeter Fire Containment Assembly

1. Mineral wool insulation
2. Provide Backing/Reinforcement at the Safing Line
3. Mechanically Attached Curtain Wall Insulation
4. Compression-fit Safing Insulation
5. Protect Aluminum Mullions
6. For “Smoke Containment,” Apply a Smoke Barrier System



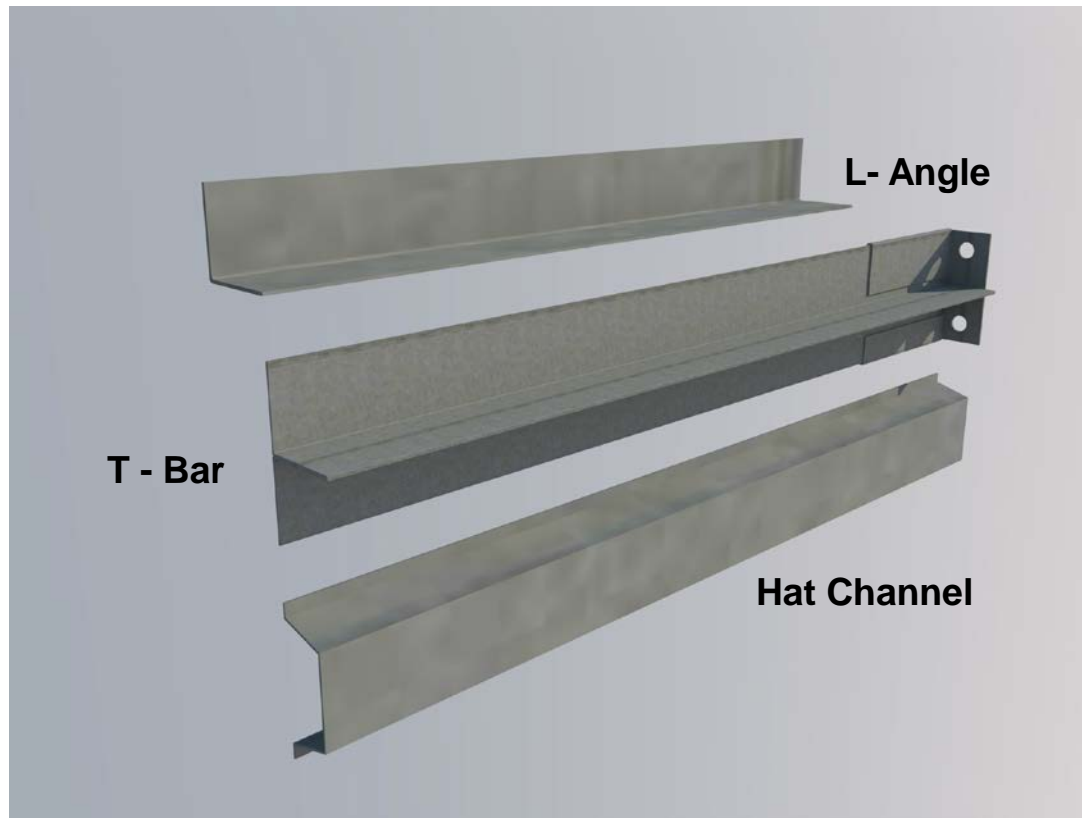
# Installation



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# Installation

## Backer/Reinforcement Bars



# Installation



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# Installation

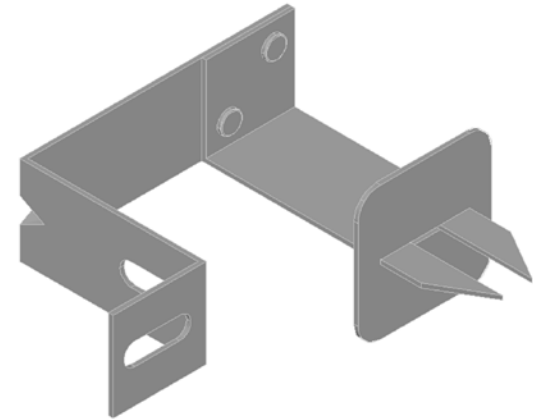
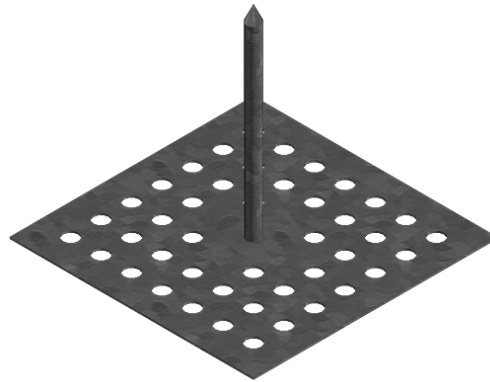
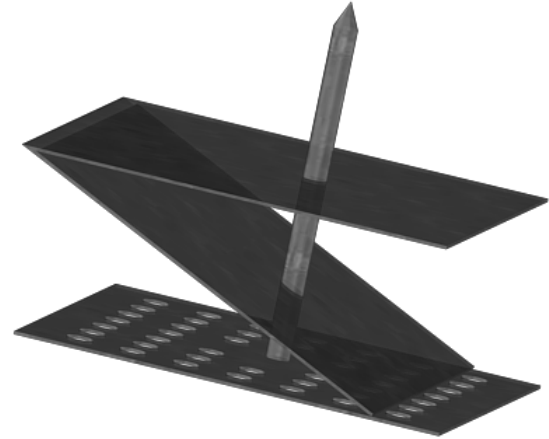
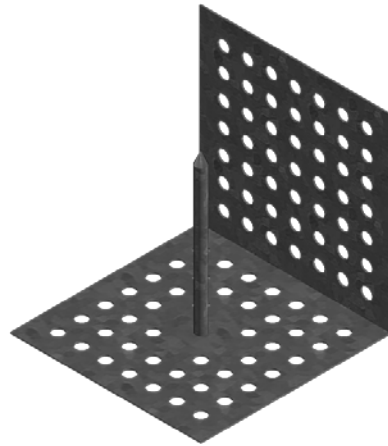
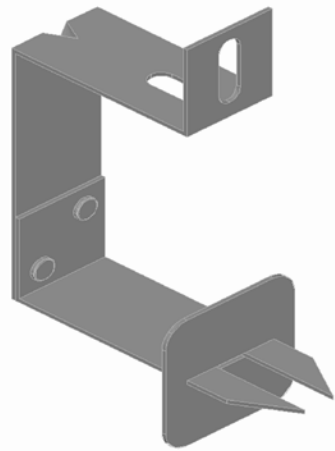


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# Installation

## Mechanically Attached Hangers



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# Installation





# Installation



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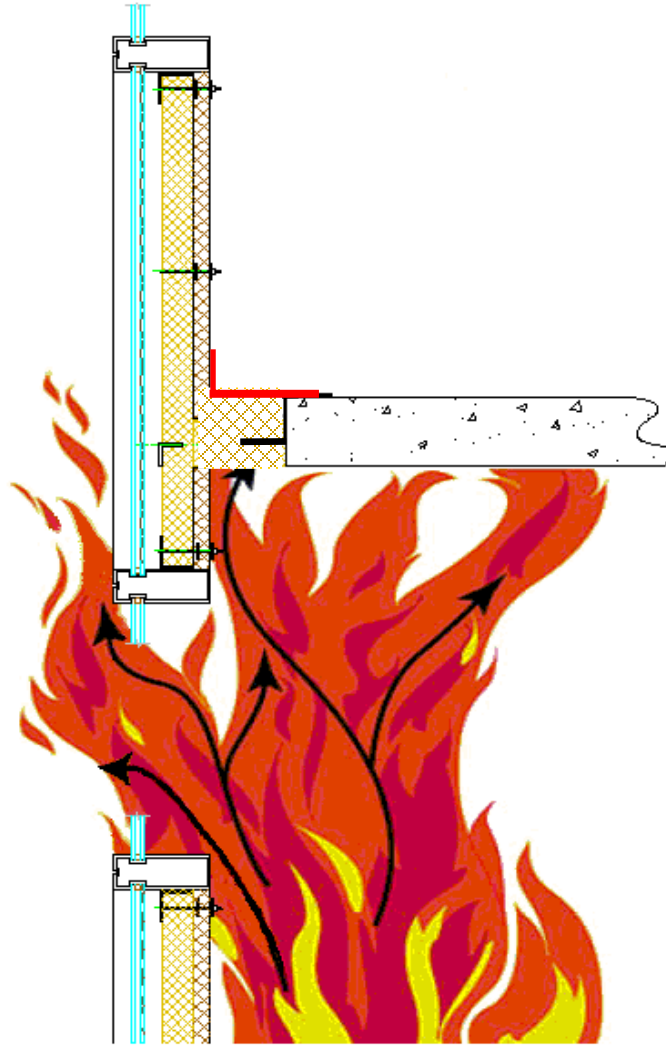
# Installation



# Installation



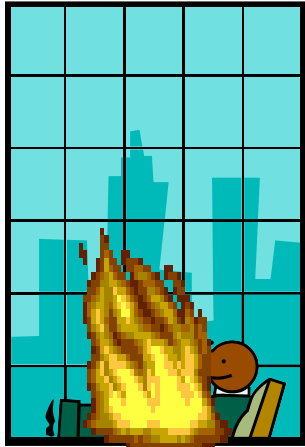
# Perimeter Fire Containment



# The Leap Frog Effect...

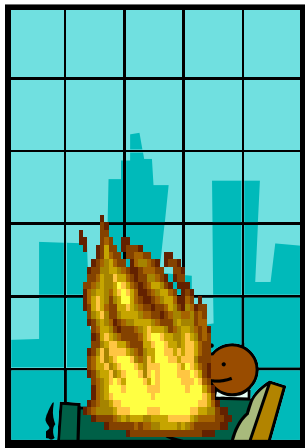






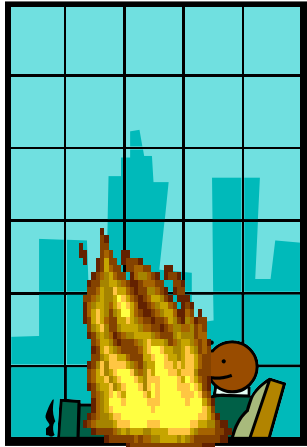
The Leap Frog effect...

**Fire may break out of a window  
and leap back to the floor  
above!**



**That being the case... *Why  
bother to protect the  
perimeter???***

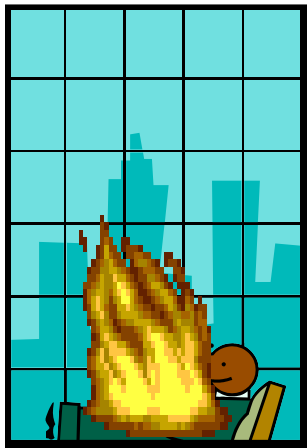


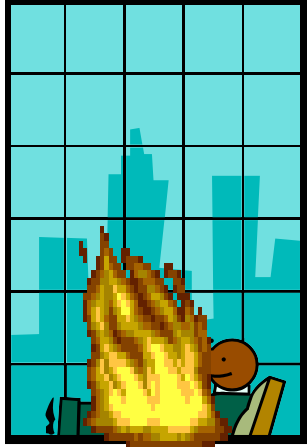


# The Leap Frog effect...

**Sprinklers are an exception to window separation requirements...**

***But not to requirements for protection of safing slot!***

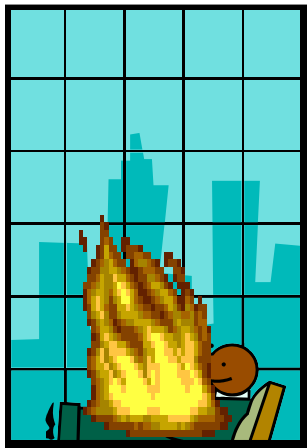


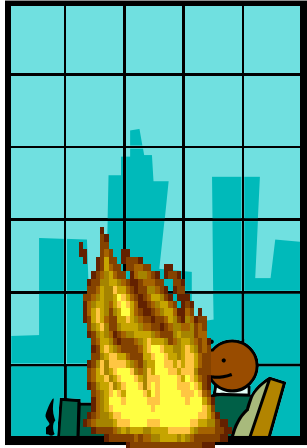


The Leap Frog effect...

**Sprinkler advocates are lobbying to reduce these requirements...**

***After all... The fire may jump around the protection!***

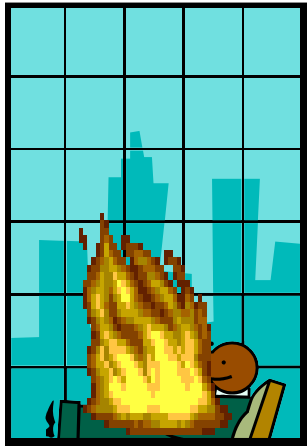




The Leap Frog affect...

The fact is, depending on window spacing and other factors, the fire *may* jump!

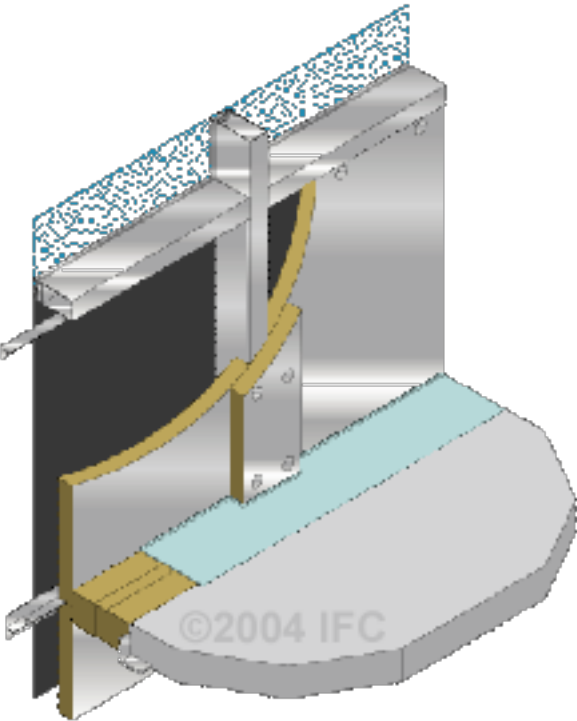
*So what exactly does a Perimeter Fire Barrier System do?*



# The Perimeter Fire Barrier System...

**Slows the process down. Of course it depends on window spacing and other construction factors...**

***As well as the nature and severity of the fire...***



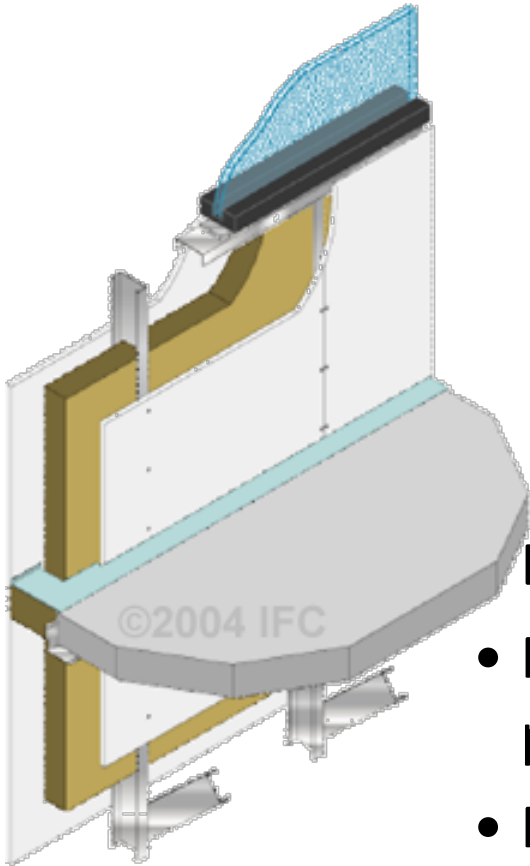
# The Perimeter Fire Barrier System...

Along with sealing the slot area, a well engineered system provides structural protection and maximizes the integrity of the wall system...

*Keeping the wall and window system above intact longer!*



# The Perimeter Fire Barrier System...



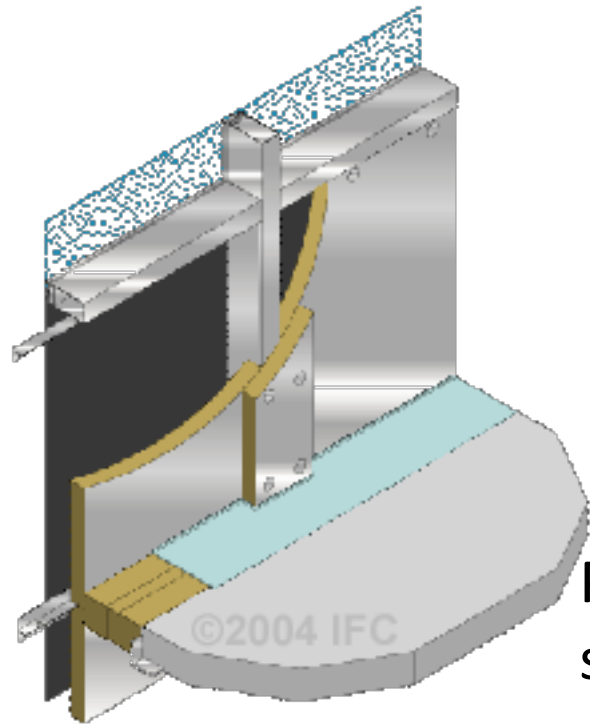
Extends the rating of the floor to the wall.

- Forces the fire to exit the building in order to propagate to upper floors.
- Protects structural elements and helps prevent catastrophic failure of the spandrel system.
- Maximizes fire protection afforded by the non-rated wall.





# The Perimeter Fire Barrier System...



Prevents the migration of flame, hot gases and smoke through to floors above.

- Buys time for occupants to escape.
- Buys time for first responders to secure the building
- Provides additional protection in the event of a sprinkler or detection failure.



# The Perimeter Fire Barrier System...

**Provides energy savings through increased thermal efficiencies throughout the life of the building...**

***When considered this way, the life safety benefits are free!***



# Understanding Designs

## Reading and Understanding Perimeter Fire Containment Systems

Static or Dynamic

CW-D-/ CW-S-/ TFL/BPF-120-08

Insulation Rating- Hour

(Max temp rise not to exceed 325° F max individual or 250° F average above the starting temp on unexposed surface or 1" above)

L Rating- Hour

Measure of air leakage in CFM/Linear Ft. @ ambient & 400° F

Movement Capabilities

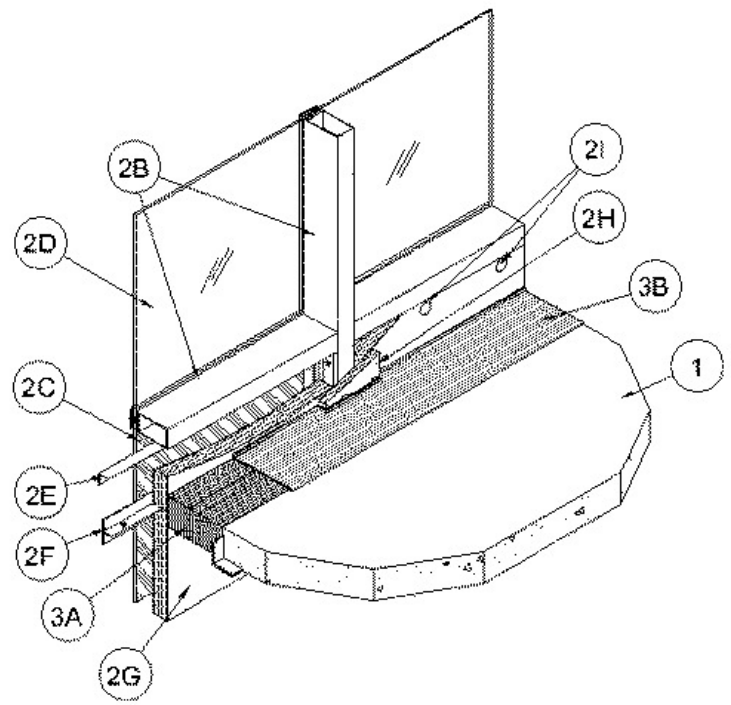
Vertical Shear & Horizontal Movement



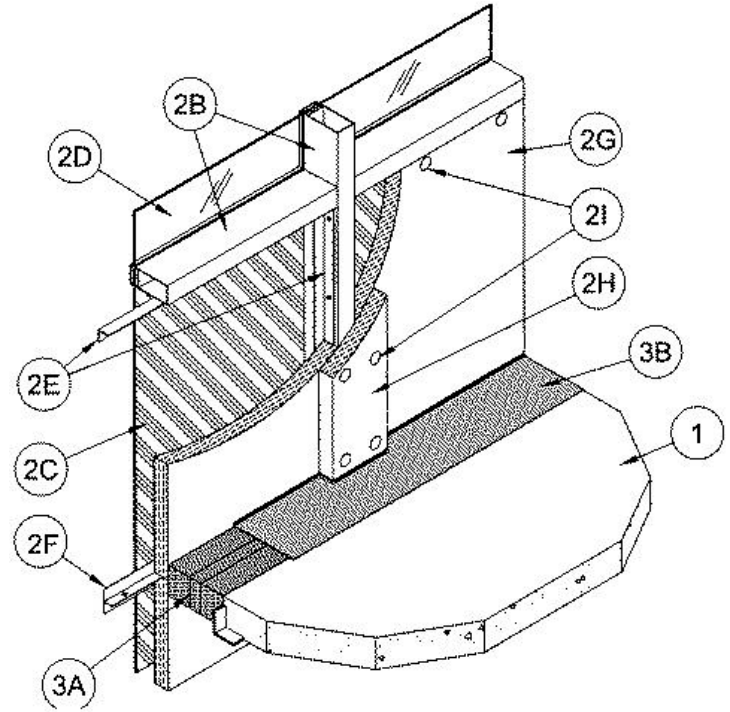
# Understanding Designs

**F- Rating- Hour**  
**Integrity Rating- Hour**

**(Interior Spread per ASTM E 2307)**  
**(Interior Spread & Leap Frog)**



F Rating — 2 Hr



Integrity Ratings — 1-1/2 and 2 Hr



# Where are listed systems?



Within these two directories there are over 275 tested and listed perimeter fire containment systems.



# Engineering Judgments



## RECOMMENDED IFC GUIDELINES FOR EVALUATING FIRESTOP SYSTEMS IN ENGINEERING JUDGEMENTS (EJ's)

### PERIMETER FIRE BARRIER SYSTEMS

The International Firestop Council, IFC, is a not-for-profit association of manufacturers and users of fire protective materials and systems. IFC's mission is to promote the technology of fire containment in modern building construction through research, education programs, and the development of safety standards and code provisions. These recommended guidelines are presented as part of the IFC's educational information program. They are for informational and educational purposes.

#### THE PREMISE OF FIRESTOP SYSTEMS

Perimeter Fire Barrier systems protect against the passage of fire, hot gasses and toxic smoke through the void between the floor slab edge and the curtain wall.

These systems are required by building codes to be tested and rated as part of an assembly in accordance with ASTM E 2307, Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-Story Test Apparatus, or with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subject to ASTM E119 time-temperature conditions under a positive pressure differential of 0.01 inch water column.

All elements of a tested and rated perimeter fire barrier system, including the assembly into which the system is installed, constitute a specific and inseparable engineered unit that must be utilized as such. These systems (designs) are tested and listed by





# Questions?



# Contact Information

**Angela M. Ogino, LEED AP**

Technical Services Leader

**Thermafiber, Inc. Insolutions®**

(260) 569-8229

Email: [angela.ogino@owenscorning.com](mailto:angela.ogino@owenscorning.com)

[www.thermafiber.com](http://www.thermafiber.com)



**Melanie Bisson, CSI, CDT**

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Commercial & Residential Solutions

**Roxul USA INC.**

(413) 265-8915

Email: [melanie.bisson@roxul.com](mailto:melanie.bisson@roxul.com)

[www.roxul.com](http://www.roxul.com)

