FCIA Webinar Series

The Interrelationship Between NFPA 285, ASTM E2307 and ASTM E2874

Bill McHugh, Technical Director of FCIA
Tony Crimi, A.C. Consulting, Consultant to the IFC
Rich Walke, CTI, Consultant to FCIA

FCIA
Firestop Contractors International Association

February 26, 2025

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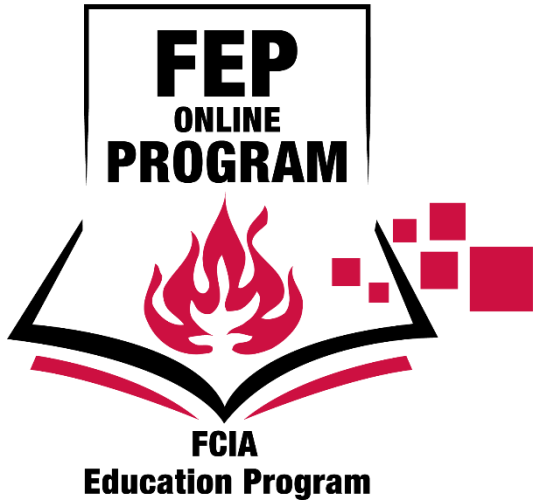

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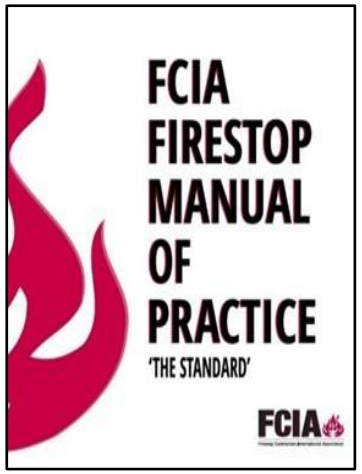

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DESIGN
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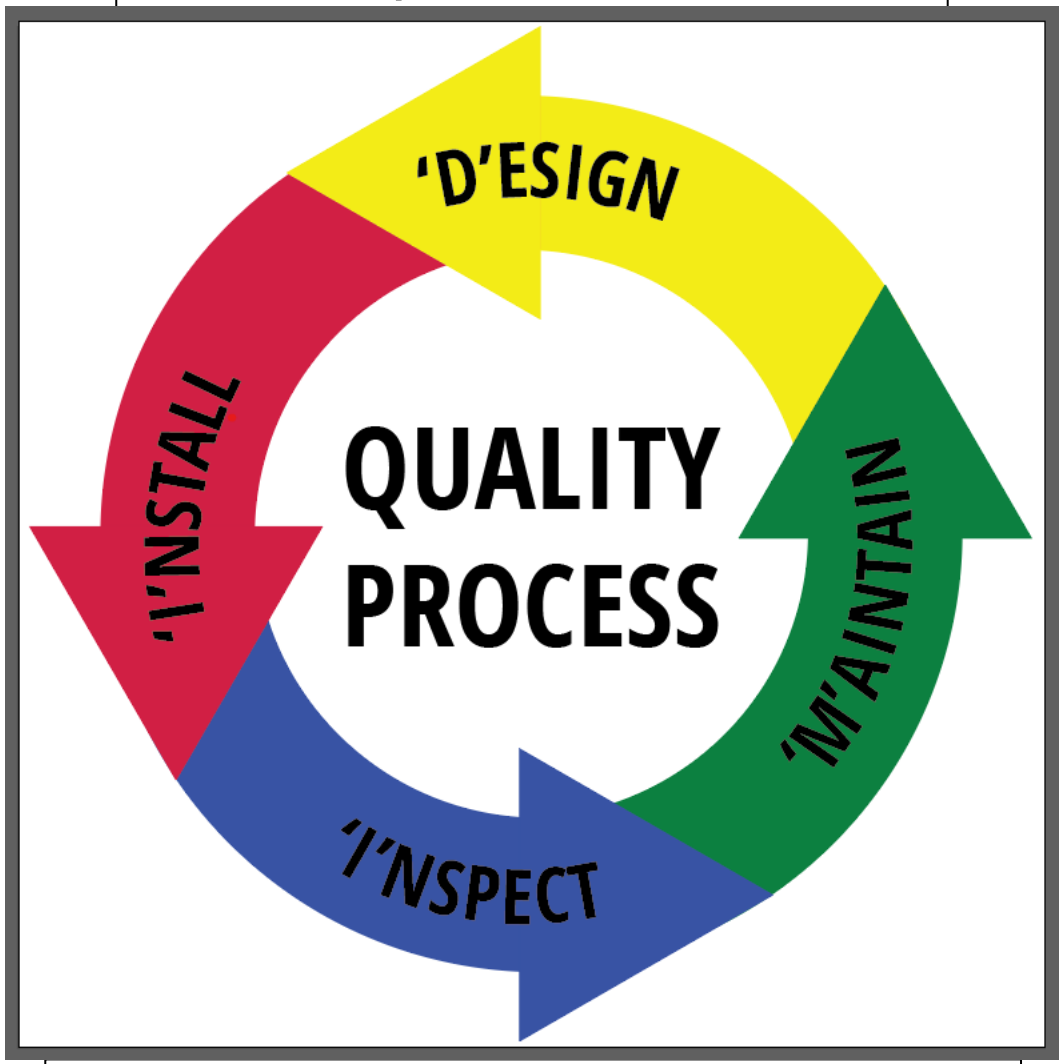

INSTALLATION
FM 4991/UL QFCP
Programs AND
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PFP/BARRIERS
MAINTAIN
PROTECTION
Fire Codes

INSPECTION
IBC Ch. 17 -NFPA 80 - NFPA 1

FCIA

“TOTAL FIRE PROTECTION”

- Effective Compartmentation
  - Fire Barriers, Fire Walls, Floors, Smoke Barriers
  - Firestopping, Fire Dampers, Swinging and Rolling Fire Doors, Fire-Rated Glazing
  - Fire-Resistive Protection for Ductwork
- Detection & Alarm Systems
- Sprinkler Suppression Systems
- Education & Egress –
  - Building Owners & Managers, Building Occupants and Firefighters

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The Interrelationship Between NFPA 285, ASTM E2307 and ASTM E2874

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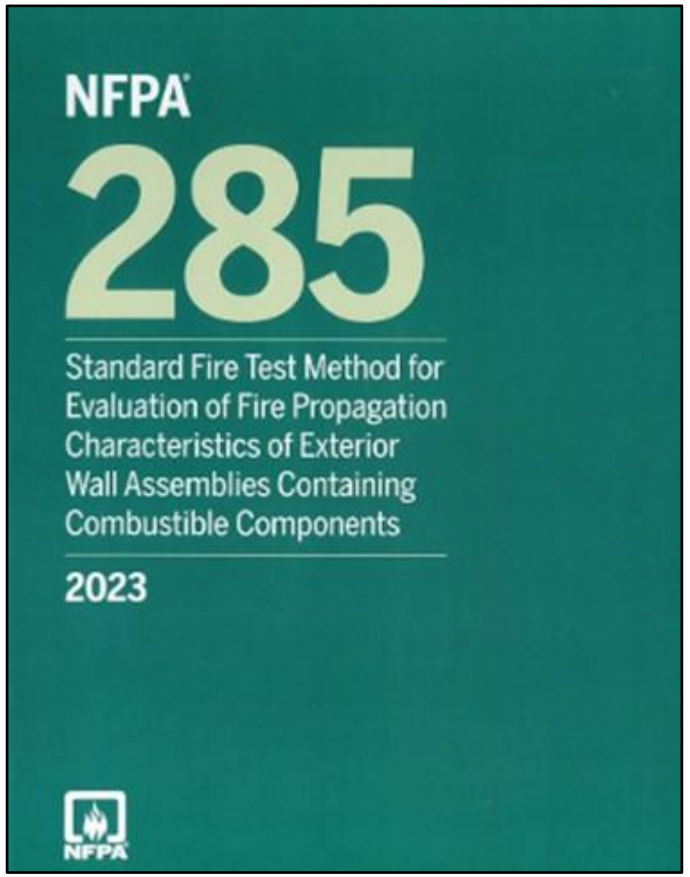
February 26, 2025

Objective

- At the end of this lesson, you will be able to:
  - ***Understand*** the differences between NFPA 285, ASTM E2307 and ASTM E2874
  - ***Differentiate*** between the applications which require NFPA 285, ASTM E2307 and ASTM E2874

NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components



Why NFPA 285?

The Torch, Dubai

Torre del Moro Tower, Milan

Neo 200 Apartments, Melbourne

Grenfell Tower, London

33-story Tower, Ulsan

NFPA 285

- Intermediate-scale test apparatus (ISMA) – Same apparatus and burner configuration as used in ASTM E2307 and ASTM E2874
- 30-minute exposure
- Evaluates the fire propagation characteristics of exterior wall assemblies that contain combustible components. Specifically evaluates the ability to resist:
  - Flame propagation over the exterior face
  - Vertical flame propagation within the combustible components from one story to the next
  - Lateral flame propagation from the compartment of fire origin to adjacent compartments or spaces

Intertek Photo

Multi-Story Testing History
Large-Scale Testing - The Early Years

- Initial test method developed as a result of concern over the use of foam plastic insulation in exterior non-load bearing walls. The concern focused on vertical and horizontal spread of fire over the combustible face or through the combustible cores of these types of walls.

- The first test standard was developed based on testing at Southwest Research Institute sponsored by the Society of Plastics Industry (SPI) in 1980. The test apparatus utilized a 26 ft tall two-story structure constructed with two perpendicular walls. The test materials were installed on the exterior side of the test apparatus walls. One wall incorporated a window opening.

Fig. 1. Face of full-scale, permanent, fire-test facility at USG Corporation Research Center is set up for curtain wall fire test. Metal frame supports thermocouples for measuring flame plume temperature. Left side is "THERMAFIBER Curtain Wall Insulation Unit"; right side is "Glass Fiber Unit."

Multi-Story Testing History
Large-Scale Testing - The Early Years Cont.

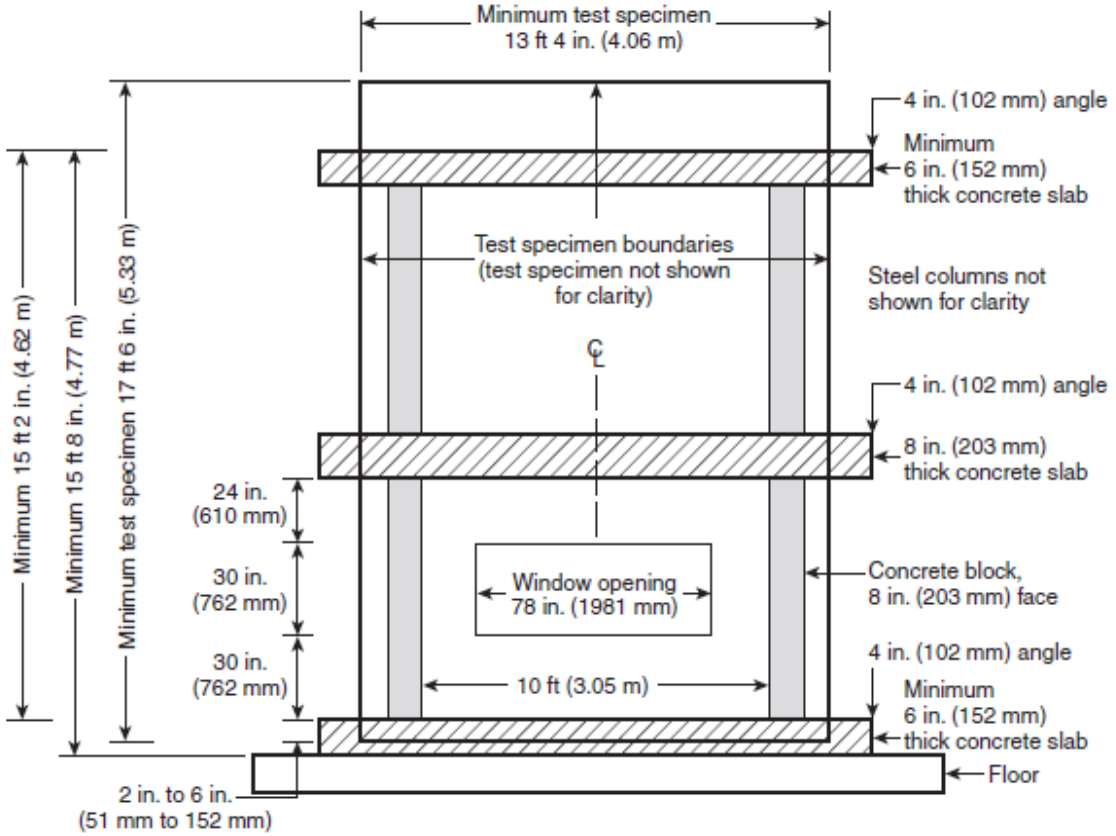
- A 1285 lb wood crib was placed in the interior of the corner, on the lower floor, and when ignited produced a fire exposure which approximated the *Standard* ASTM E119, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials* time-temperature fire exposure on the interior of the wall system
- At approximately 5 minutes into the test, flames exited the window opening and simultaneously expose the exterior face of the test specimen. Temperature measurements and visual observations were made during the 30-minute test, and visual observations were made after the test to evaluate the extent of flame propagation.
- This test method was first described in 1988 Uniform Building Code (UBC) as Standard 17-6 and later in the 1994 UBC as Standard 26-4

Multi-Story Testing History
The Next Generation – Intermediate Scale

- In the early 90s, SPI sponsored research tests to scale down the size of the test assembly. Due to the smaller size, the test could be conducted indoors under controlled conditions. The new test used roughly a 2/3 scale two-story test furnace, with the test specimen representing one wall of the furnace.
- New test method was initially identified through an ICBO-ES Acceptance Criteria AC108 which was first recognized in the 1994 UBC. The test method was later published as UBC Standard 26-9 and was recognized in the 1997 UBC. Ultimately, NFPA published this same method as NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components* in 1998.

NFPA 285
Test Apparatus

- Intermediate-Scale Multi-Story Apparatus (ISMA) is a 2/3 scale representation of a two-story building
- Dimensions of the test apparatus:
  - Height of each story is 7 ft
  - Burn Room Width and length is 10 ft
- Minimum test specimen dimensions are 13 ft, 4 in. wide by 17 ft, 6 in. high



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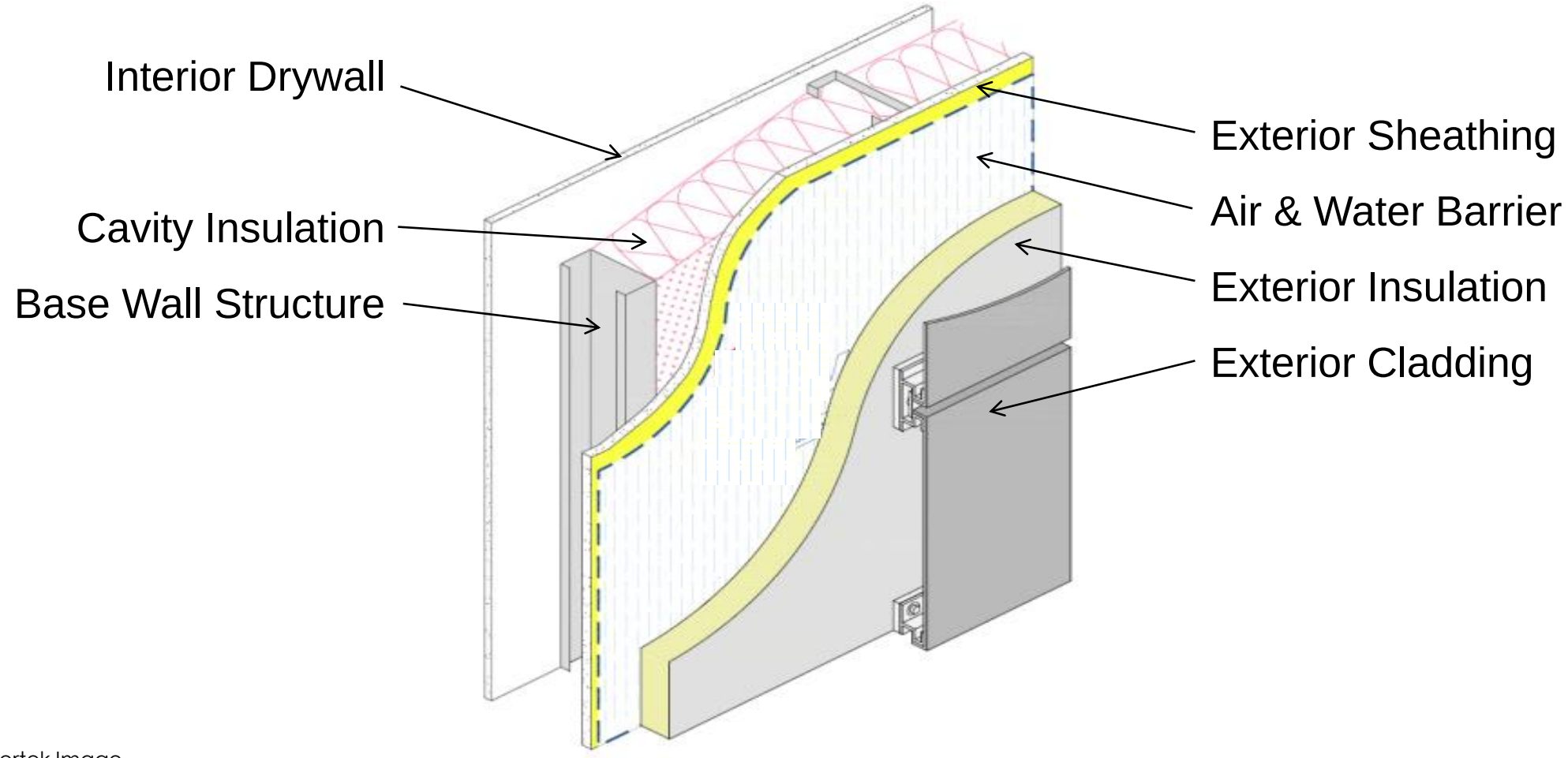
NFPA 285
One Example of Sample Construction



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NFPA 285
Test Apparatus

- A window opening 30 in. high by 78 in. wide located in test specimen adjacent to first floor. This widow opening allows a flame plume from the first-floor room exposing the exterior side of the test specimen. The window sill is 30 in. above the Burn Room floor.
- Focus of test is the flame propagation along the exterior side of the test specimen. Interface between edge of floor slabs and test specimen is evaluated based on ASTM E2307.

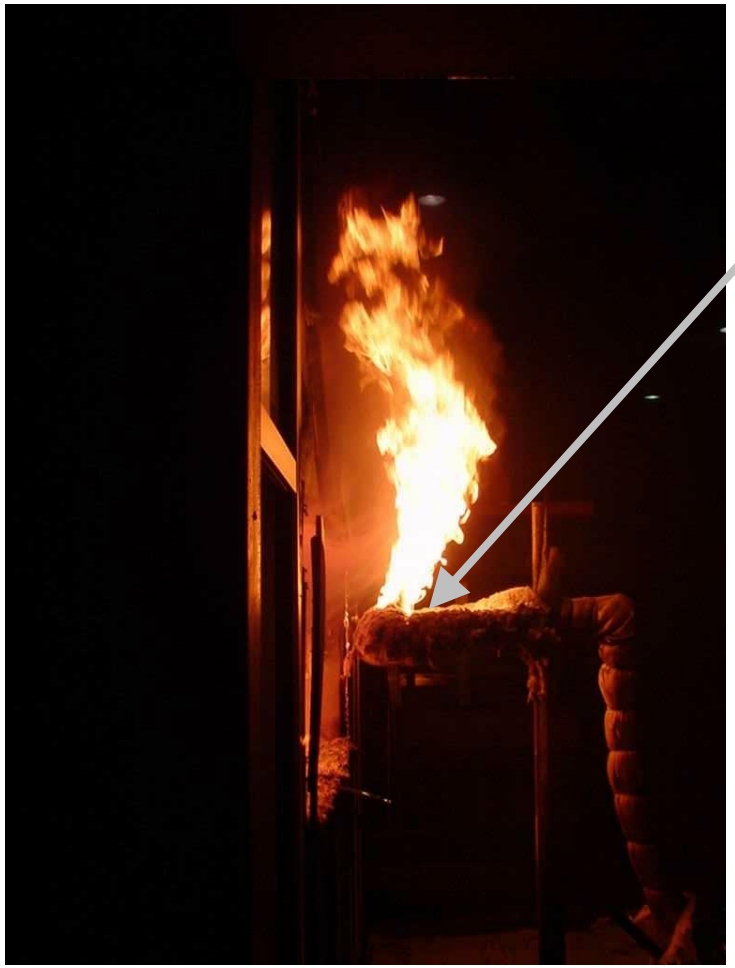
Intertek Photo

NFPA 285
Test Apparatus and Procedure

- Test apparatus uses two burners
  - Room Burner located in first floor room
  - Window Burner located outside the test apparatus, adjacent to window opening to assist is developing an initial flame plume.
- Gas flow to Room Burner and Window Burner determined based upon Calibration Test.
- Room burner ignited at start of test. Gas flow follows flow determined by calibration test for first 30 min. This temperature within the burn room approximates the ASTM E119 temperature curve.

Intertek Photo

NFPA 285
Procedure and Conditions of Acceptance



- Window burner ignited at 5 minutes. Gas flow follows flow determined by calibration test for first 30 min.
- Test terminated at 30 minutes
- Conditions of Acceptance:
  - The temperature on the exterior face of the wall shall not exceed 1000°F at a height 10 ft above the top of the window opening
  - Flaming emitting from the surface of the exterior face of the wall shall not exceed a height 10 ft above the top of the window opening
  - Flaming emitting from the surface of the exterior face of the wall shall not reach a horizontal distance of 5 ft from the vertical centerline of the window opening

NFPA 285
Conditions of Acceptance

- Conditions of Acceptance Cont:
  - Flame propagation shall not occur vertically through the combustible components or the combustible insulation installed within the test specimen, as determined by temperatures measured internally within the test specimen
  - Flame propagation shall not occur horizontally through the combustible components or the combustible insulation installed within the test specimen, as determined by temperatures measured internally within the test specimen
  - The temperature within second floor observation room 1 in. away form the interior surface of the test specimen shall not rise more than 500°F during the fire test
  - Flaming shall not occur in the second floor observation room

Intertek Photo

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Current Code References to NFPA 285

- International Building Code (IBC)
  - Section 1402.5 of the 2024 International Building Code (IBC) requires NFPA 285 compliance for exterior walls, in Type I, II, III and IV construction that contain:
    - A combustible water-resistive barrier (WRB) (1402.6),
    - Metal Composite Material (MCM) systems (1406.10.3),
    - Exterior Insulation and Finish (EIFS) systems (1407.5),
    - High-pressure decorative exterior-grade compact laminate (HPL) systems (1408.10.4),
    - Foam plastic insulation (2603.5.5)
- National Building Code of Canada (NBC) does not refer to NFPA 285 but instead uses CAN/ULC-S134

NFPA 285
What is NOT Covered in the Standard?

Anchoring/Wall Attachment:

- NFPA 285 does not address wall anchors or attachments

Measurement of Fire Resistance or the Fire-Resistance Rating:

- NFPA 285 is not a substitute or equivalency for an ASTM E119 or UL 263 tested, fire-resistance-rated assembly, where one is required

Any assessment of Perimeter Fire Containment:

- Perimeter fire containment is addressed by ASTM E2307

The effect of openings above the room of fire origin

- ASTM E2874

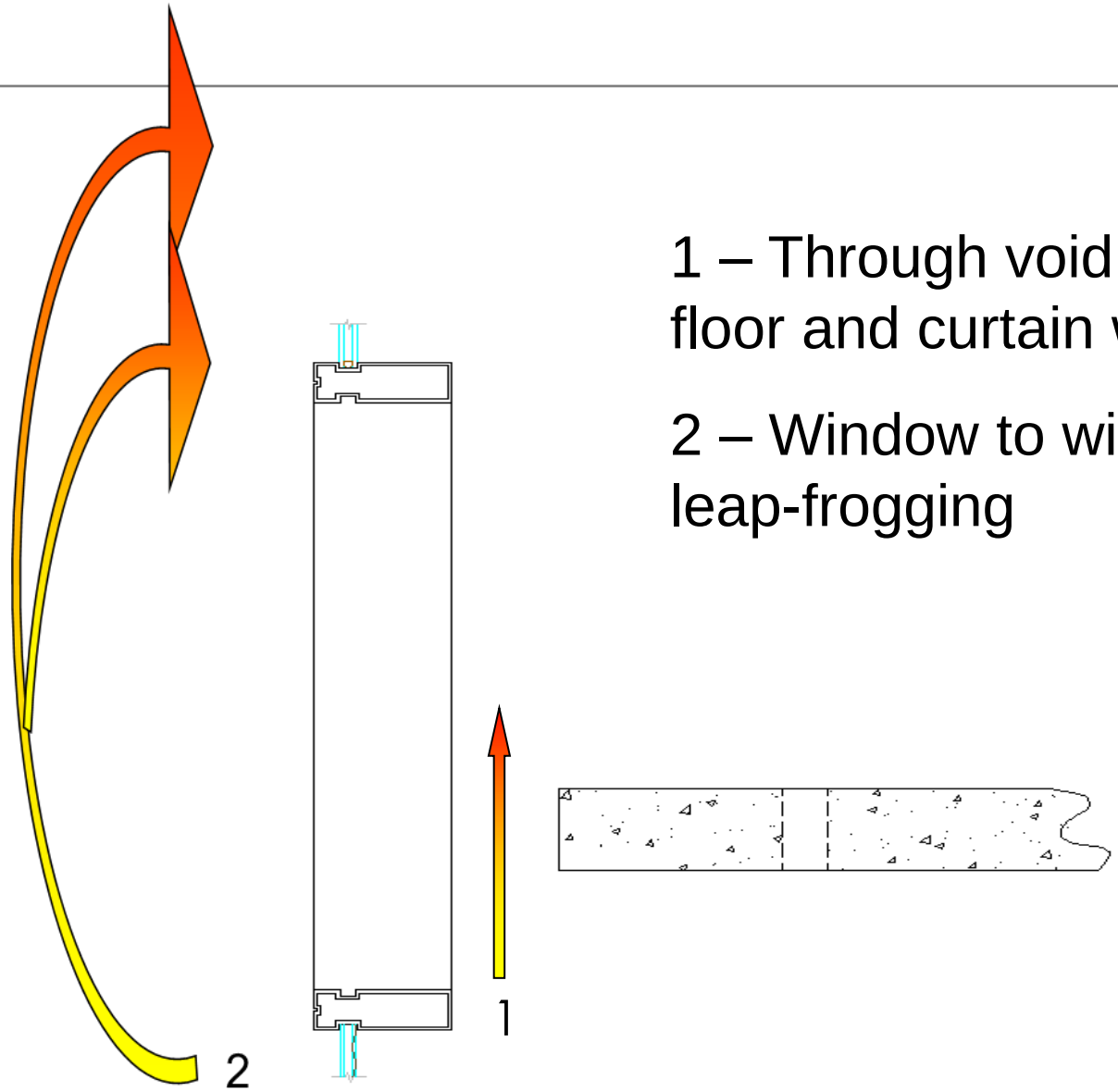
Intertek Photo

Three Methods for Evaluating Perimeter Fire Containment

- ASTM E2307 – As required by the IBC. Protects against passage of flames through void at edge of floor
- UL's "Enhanced" Perimeter Fire Containment – Protects against passage of flames through void at edge of floor and via leap-frogging
- ASTM E2307 in conjunction with ASTM E2834 – Protects against passage of flames through void at edge of floor and via leap-frogging

Perimeter Fire Containment

Two Paths of Fire Propagation at Perimeter of Building

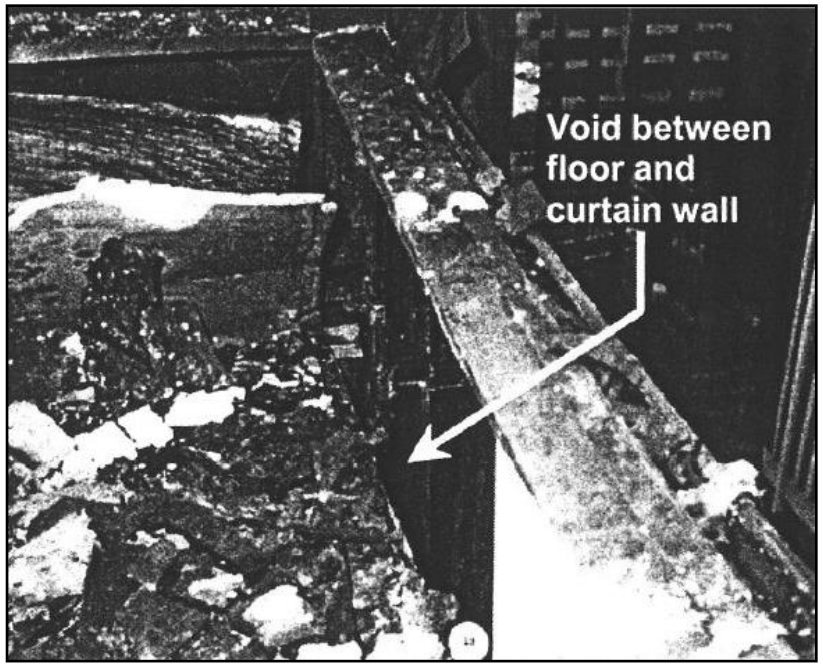


1 – Through void between floor and curtain wall

2 – Window to window leap-frogging

Why Perimeter Fire Containment?

First Interstate Bank, Los Angeles

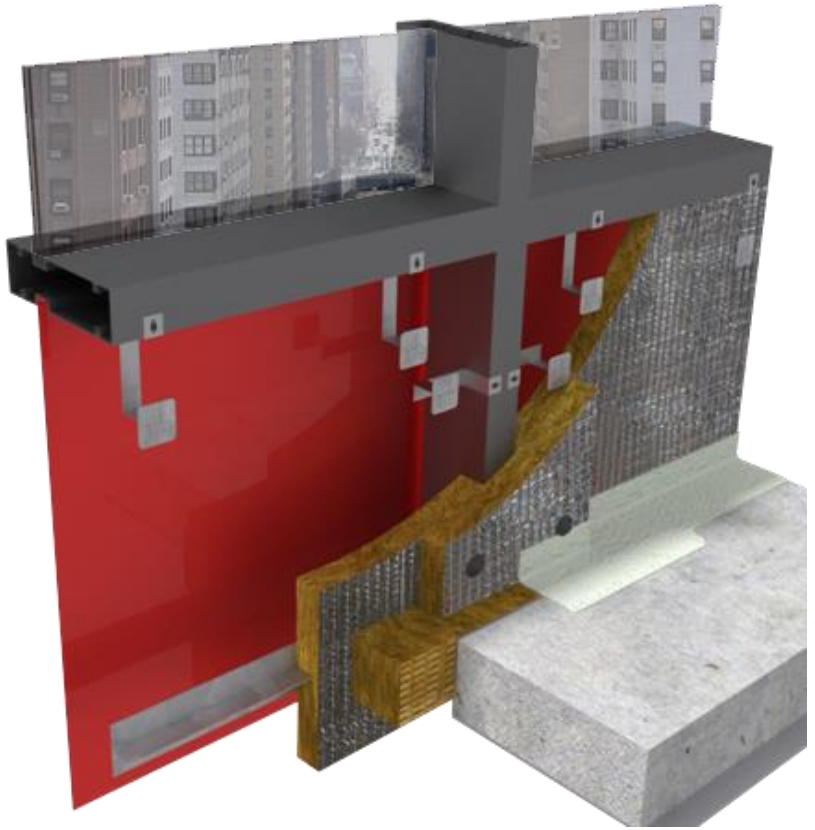


First Interstate Bank, Los Angeles

One Meridian Plaza, Philadelphia

ASTM E2307

ASTM E2307: Standard Fire Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-Story Test Apparatus

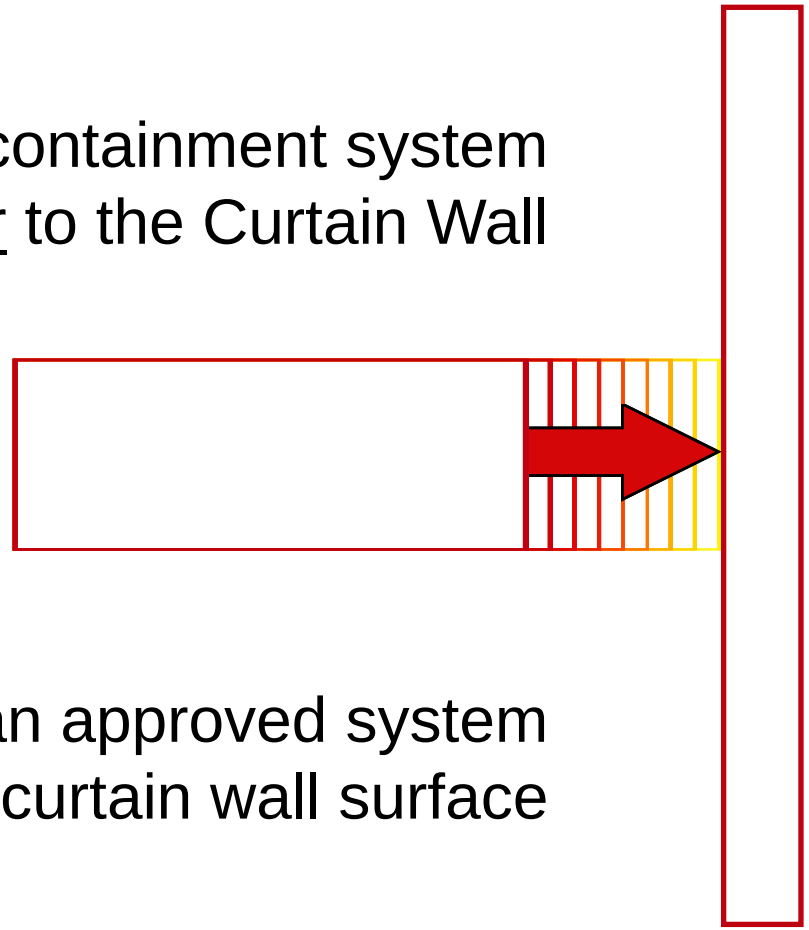


Thermafiber Image

ASTM E2307

A perimeter fire containment system
extends the Floor to the Curtain Wall

Required by the IBC & NBC!



The void must be sealed with an approved system
that extends to the exterior curtain wall surface

Does not address “leap frogging” or internal flame propagation within the curtain wall

ASTM E2307

- Intermediate-scale test apparatus (ISMA) – Same apparatus and burner configuration as used in NFPA 285
- Test duration equal fire-resistance rating of adjacent floor assembly
- Evaluates the flame and heat passage between edge of floor stab and interior surface of exterior wall

Intertek Photo

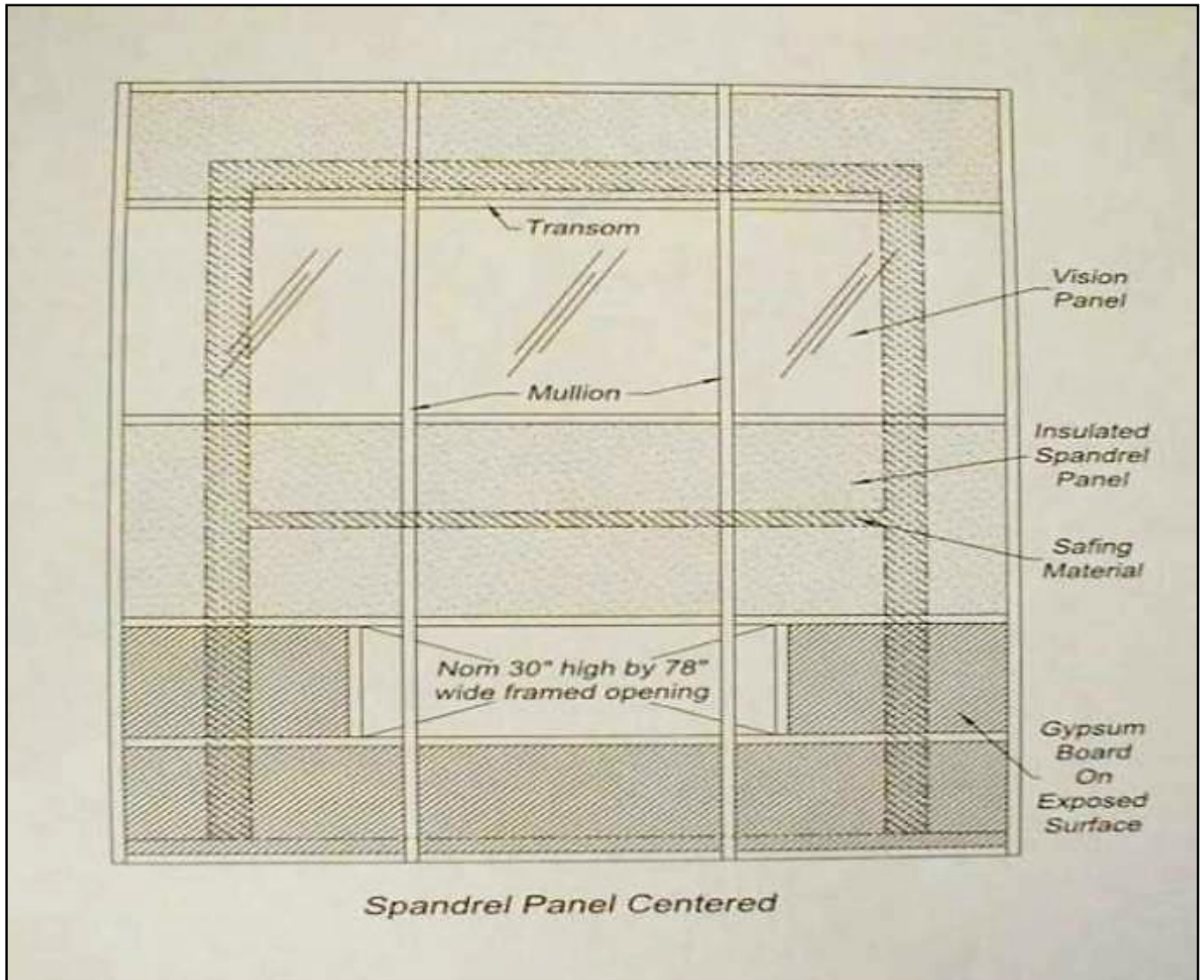
Perimeter Fire Containment History

- Standard development started in Subcommittee E05.11 in mid-1990s
- Work was occurring on what became NFPA 285 on a parallel path
- Work was occurring at UL on the development an “Enhanced” Perimeter Fire Containment Method on a parallel path
- ASTM E2307 and UL’s method were based on the apparatus first described in ICBO-ES AC108 and later in UBC Standard 26-9 and NFPA 285.
- UL and Omega Point Laboratories both first published systems for perimeter fire containment in 1997.

Perimeter Fire Containment History

- Meanwhile ICBO-ES AC108 was first referenced in the 1994 edition of the UBC for exterior wall flammability and UBC Standard 26-9 was first referenced in the 1997 edition of the UBC again for exterior wall flammability
- First edition of ASTM E2307 published in April 2004
- ASTM E2307 revised eight times since publication – 2020 is the current edition
- Standard largely unchanged throughout the revisions
  - Many systems successfully tested and listed to the original draft still meet the current standard edition’s requirements

Curtain Wall Orientation



Three Elements of Perimeter Fire Containment Systems

- Floor Assembly
- Curtain Wall Assembly
- “Firestopping” Materials

First Floor - Underside of Floor

First Floor - Underside of Floor

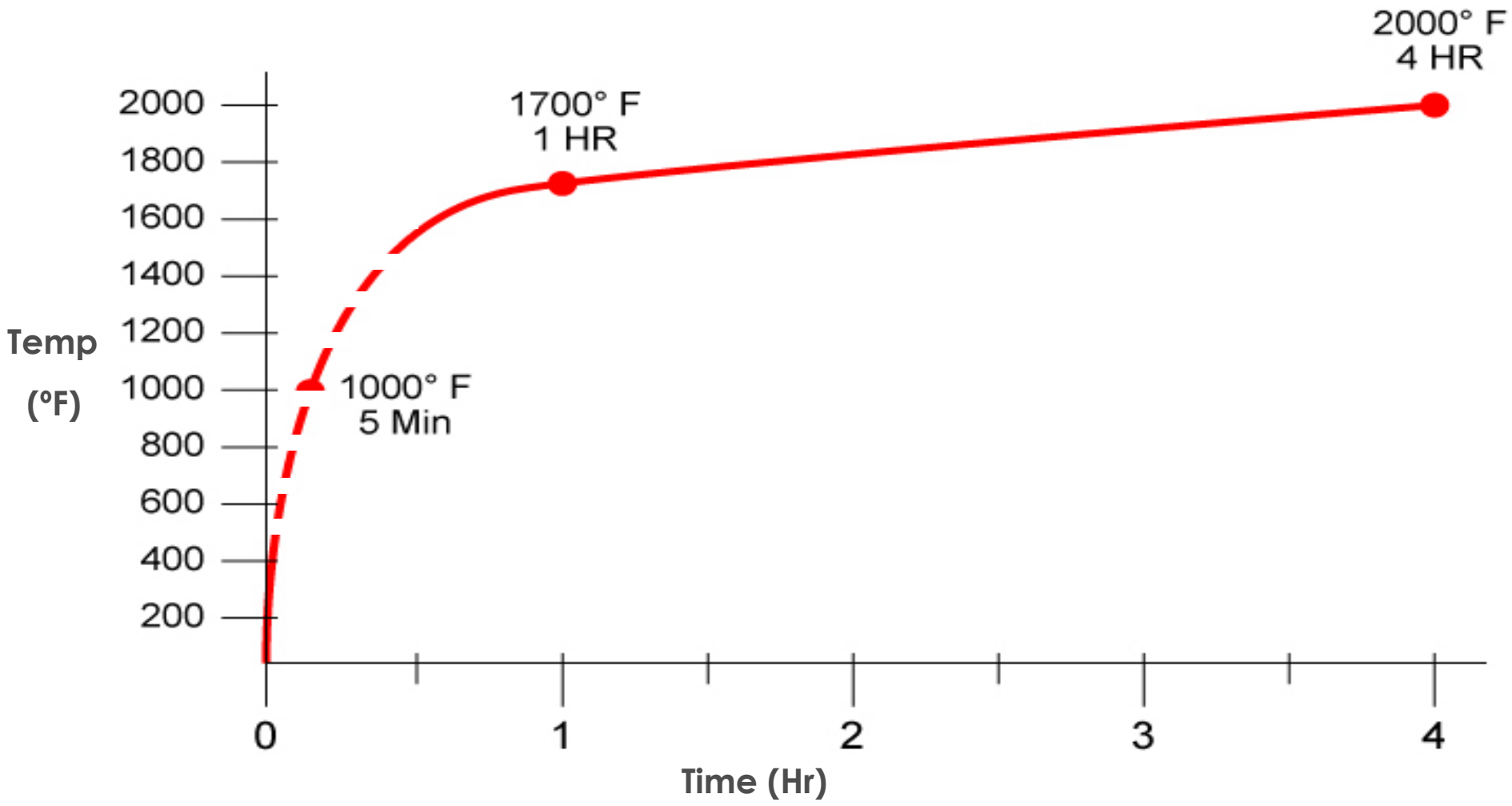
Second Floor – Top of Floor

Second Floor – Top of Floor

Conditioning Prior to Fire Test

Movement Class	Min. No. of Cycles	Min. Cycling Rate (Cycles / Minutes)
Class I (Thermal)	500	1
Class II (Wind Sway)	500	10
Class III (Seismic)	100	30

Time – Temperature Curve



Approximately 2 Minutes

Approximately 30 Minutes

Approximately 60 Minutes

Approximately 120 Minutes

Ratings – Perimeter Fire Containment System

- F Rating – Passage of Flames through Void Only
- T Rating – Heat Transmission through Void Only

Both the IBC and the NBC require only an F Rating of not less than the fire-resistance rating of the horizontal assembly

ASTM E2307 Building Code References

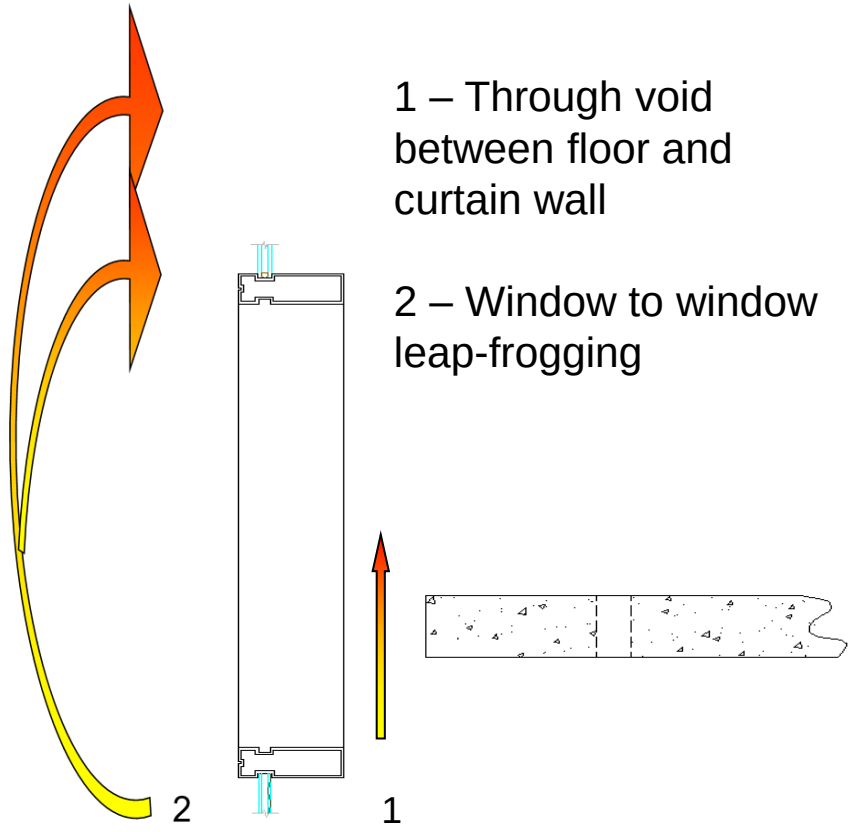
- **National Building Code of Canada (NBC) References:**
  - ASTM E2307 first referenced in 2020 NBC
    - Requires joints located in a horizontal plane between a floor and an exterior wall shall be tested to E2307 and have an F Rating not less than the rated floor
    - 3.1.8. Fire Separations and Closures - 3.1.8.3.(4)
    - 9.10.9. Fire Separations and Smoke-tight Barriers between Rooms and Spaces within Buildings - 9.10.9.2.(4)
    - A-3.1.8.3.(2) Fire Separation Continuity references ASTM E2307 being included with CAN/ULC-S115, which occurred in the 2018 revision
  - 2025 edition of NBC will reference CAN/ULC-S115 directly, <u>but no technical change</u>.

ASTM E2307
What is NOT Covered in the Standard?

- Construction Dynamics:
  - The test floor slab is between 12 and 24 in. wide and at approximately 13 ft long
    - This may result in differences in rigidity and flexibility during the fire test as compared to a larger span, continuous floor found in actual construction
- Anchoring/Wall Attachment:
  - ASTM E2307 does not currently address wall attachments or anchors
  - Testing of wall anchors is at the discretion of the testing laboratory
  - If wall anchors are testing, testing only relates to flame and heat transfer around the anchor and not the structural integrity of the anchors
  - Span between anchors in testing is limited, due to the 10 ft apparatus width, for fire exposure conditions
- Any assessment of the Flammability of the exterior wall
  - Flammability of exterior wall is addressed by NFPA 285

UL's "Enhanced" Perimeter Fire Containment

Uses ASTM E2307, Standard Fire Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-Story Test Apparatus in conjunction with additional criteria relating to leap-frogging



“Enhanced” Perimeter Fire Containment Systems

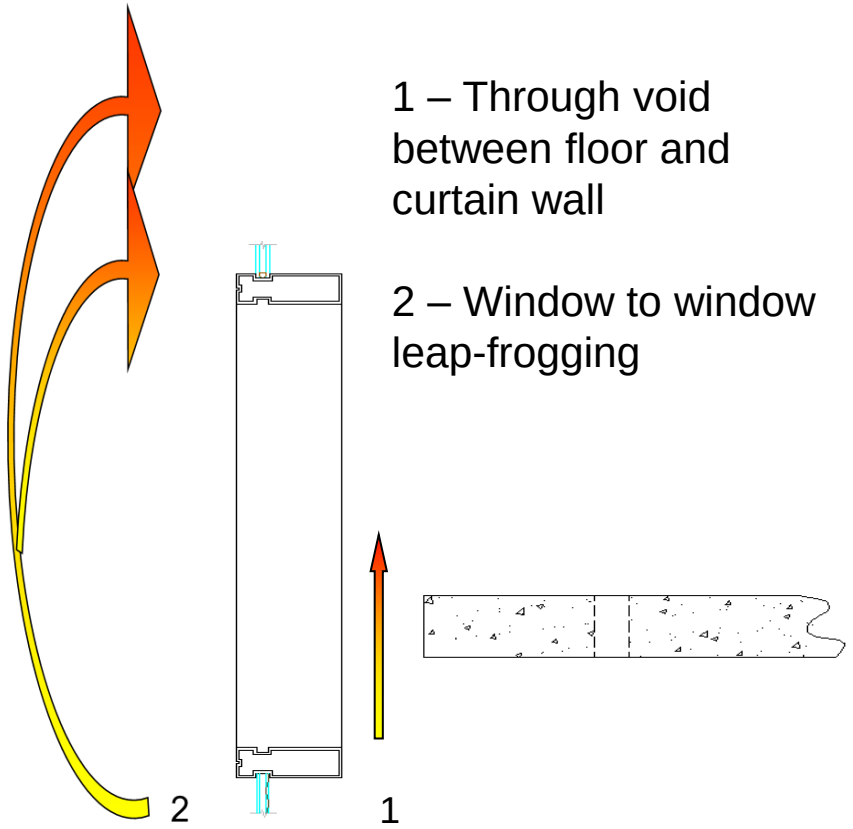
- Includes methodology for evaluating against both passage of flames through void at edge of floor and via leap-frogging
- Developed by UL during their original development of their method of listing perimeter fire containment systems
- Uses same test apparatus and same basic test procedures as described in ASTM E2307
- Adds criteria beyond ASTM E2307 relating to flame passage and heat transfer into the second floor observation room of the test apparatus

“Enhanced” Perimeter Fire Containment Systems

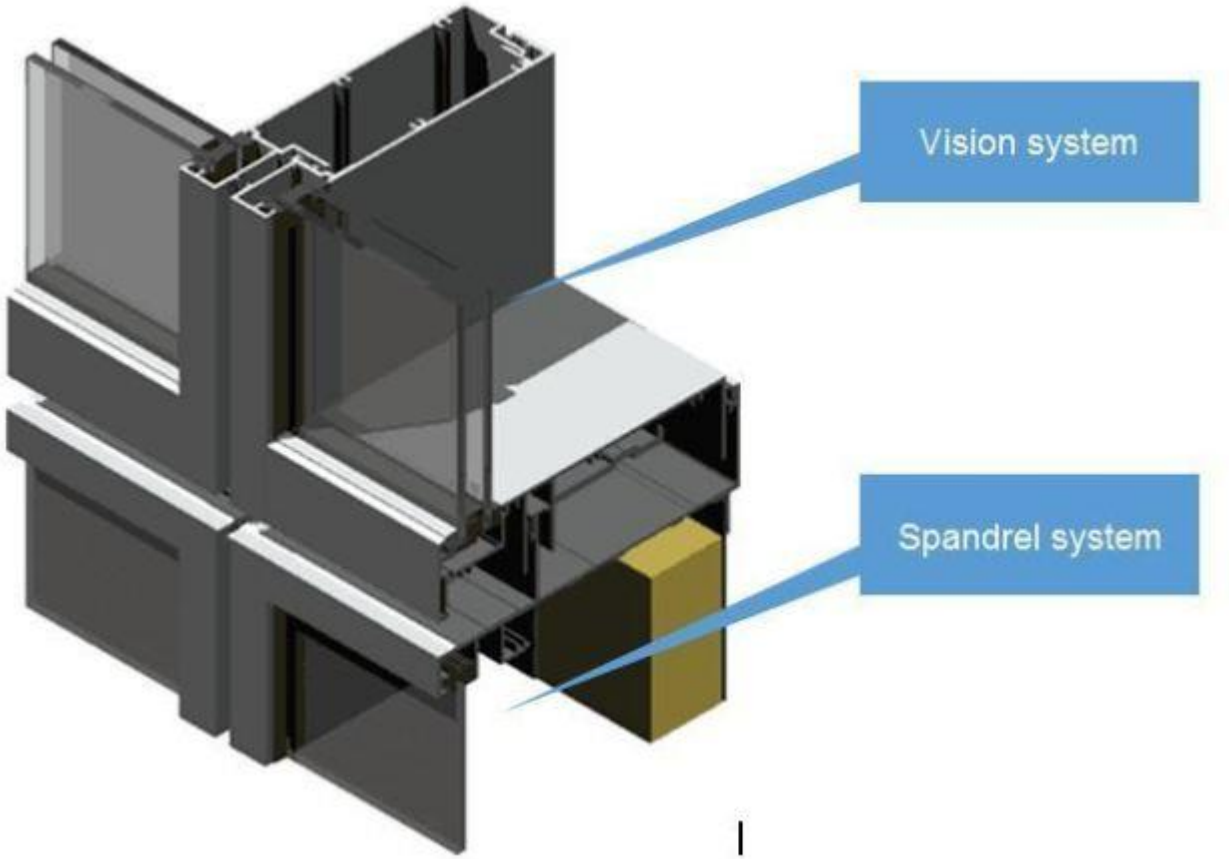
- Ratings:
  - Integrity Rating – Passage of Flames through any location into second floor Observation Room
  - Insulation Rating – Passage of Flames through any location into second floor Observation Room and heat transmission at any location to second floor Observation Room
  - L Rating – Air Leakage at ambient temperature and 400ºF (Optional)

Leap-Frog Protection

Uses ASTM E2307, Standard Fire Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-Story Test Apparatus in conjunction with ASTM E2874, *Test Method for Determining the Fire-Test Response Characteristics of Spandrel-Panel Assemblies Due to External Spread of Fire*



ASTM E2874: Standard Test Method for Determining the Fire-Test Response Characteristics of a Building Spandrel-Panel Assembly Due to External Spread of Fire

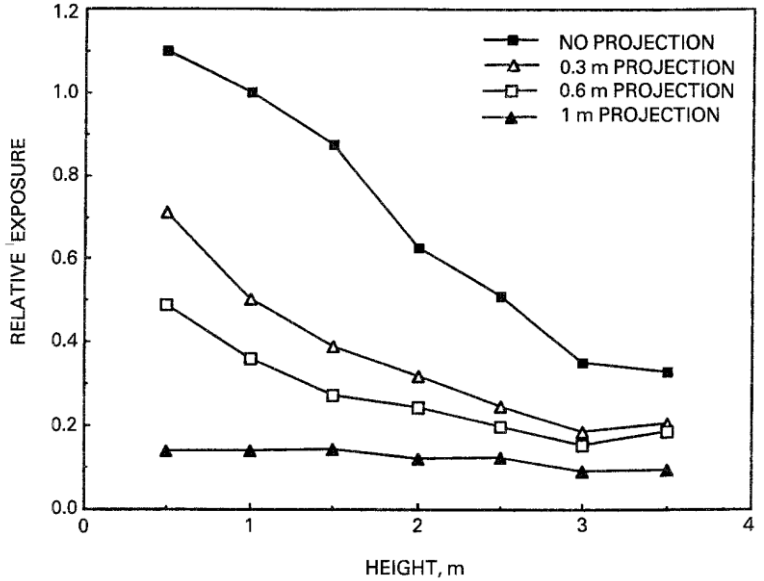


IBC Spandrel Requirements - US

IBC Requirements already exist to Protect against “leap-frog” fire spread

705.8.5 – Vertical Separation of Openings

- Requires unprotected openings in exterior walls not separated horizontally by 5 ft to be:
- Separated 3 ft minimum vertically by 1 hr wall, or
- By 1h rated spandrel girders or exterior walls, or
- Install min. 30 in. horizontally 1h flame barrier
- BUT … these requirements waived if building is sprinklered and/or three stories of less

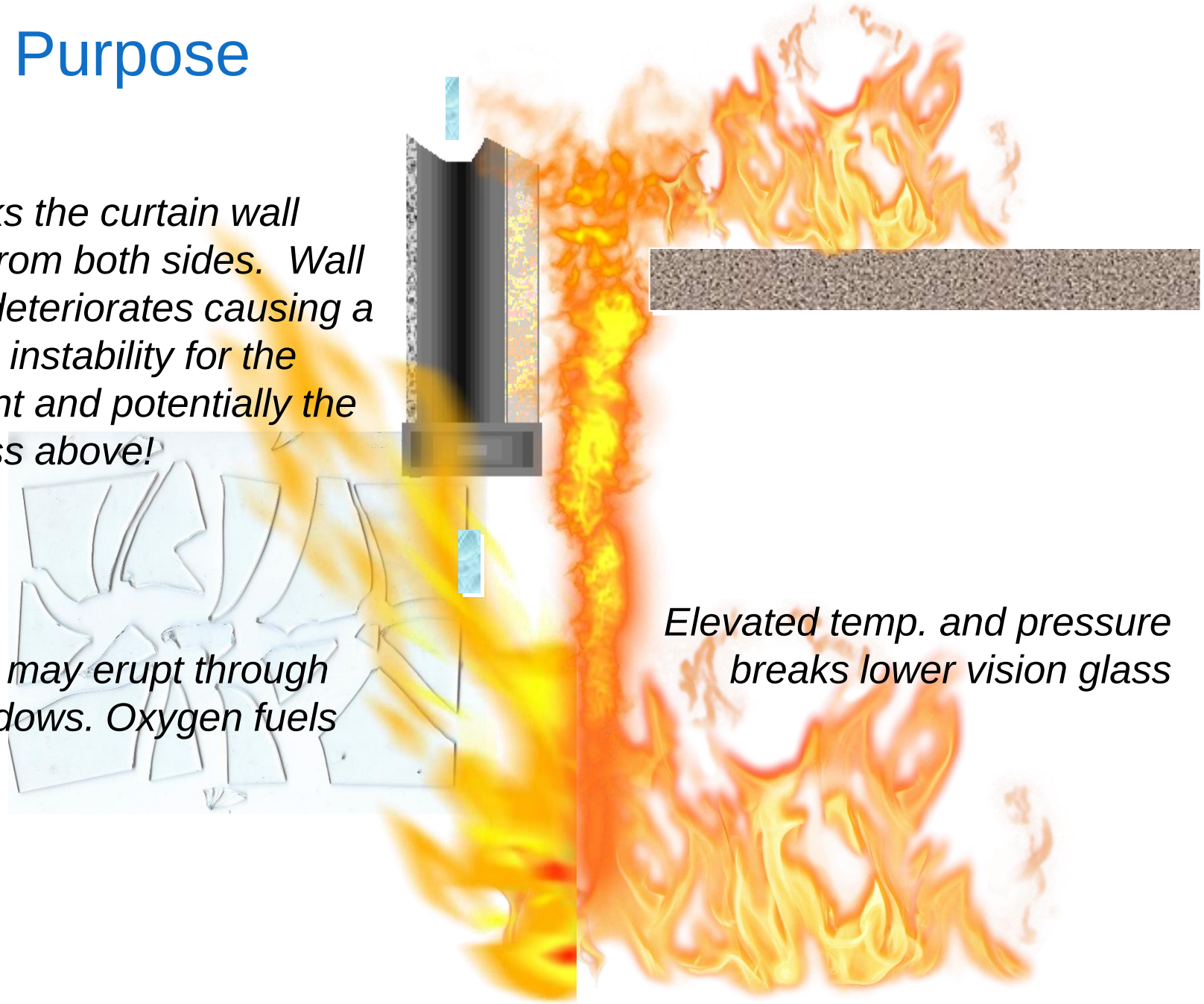


ASTM E2874 “Leap Frog” Standards

- ASTM International Standard E2874, *Test Method for Determining the Fire-Test Response Characteristics of Spandrel-Panel Assemblies Due to External Spread of Fire* published late 2019.
  - Simulates a post flashover fire exposure within a compartment venting to the exterior
    - Evaluates the ability of the spandrel-panel assembly in an exterior wall assembly, to impede the spread of fire to the interior of the room or the story immediately above it via fire spread from the exterior of a building.
    - The test sample includes the exterior wall spandrel panel assembly, fasteners, structural supports and any glazed openings.
    - Measures potential for exterior re-entry, with or without glazing, due to flame (F), temperature (T), or radiation (I) to storey immediately above fire storey via the exterior of the building.

ASTM E 2307 Purpose

Fire attacks the curtain wall structure from both sides. Wall structure deteriorates causing a premature instability for the interior joint and potentially the vision glass above!



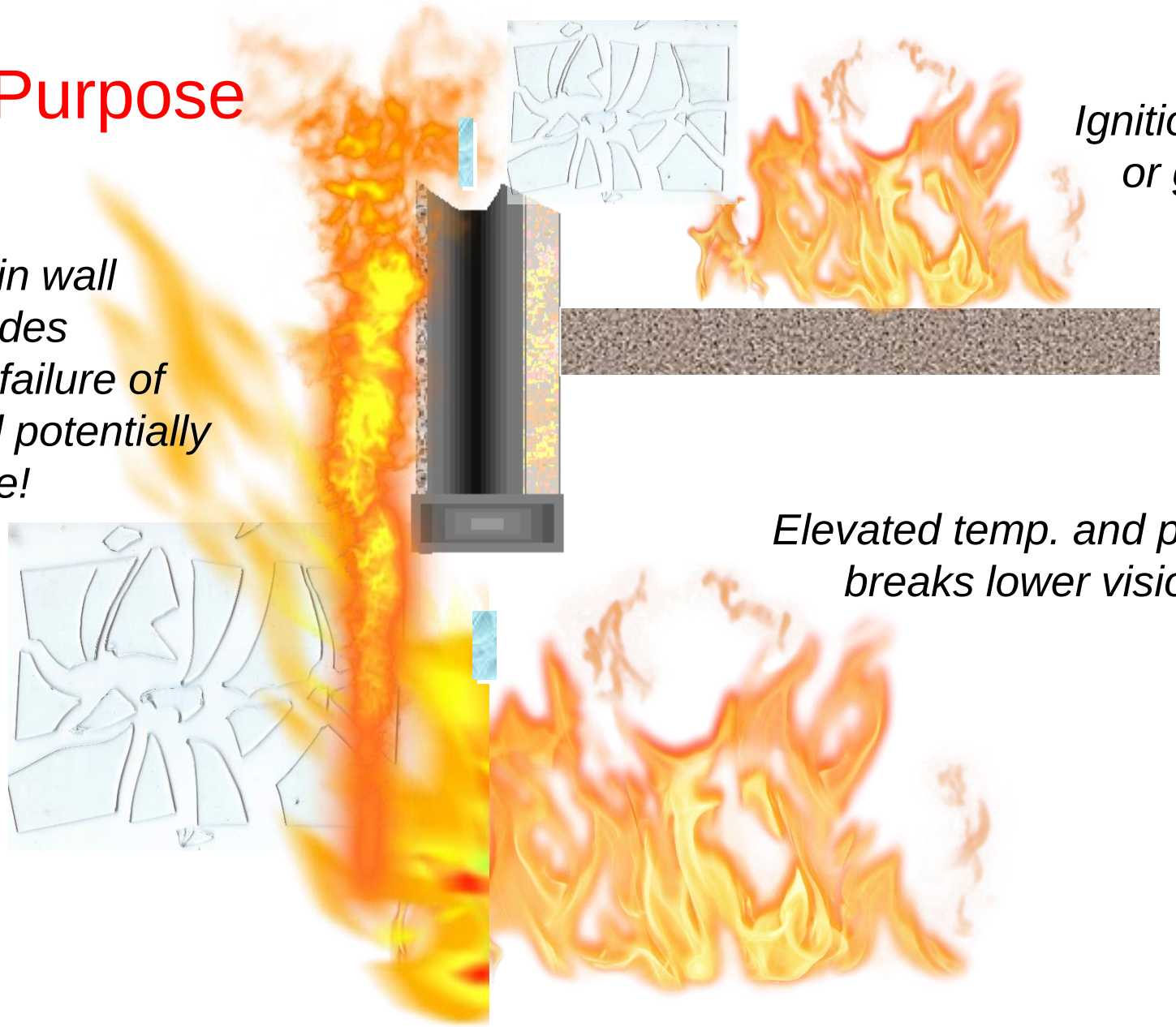
Flames may erupt through the windows. Oxygen fuels the fire.

Elevated temp. and pressure breaks lower vision glass

ASTM E 2874 Purpose

Ignition by Radiation or glass breakage

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



Elevated temp. and pressure breaks lower vision glass

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

ASTM E 2874

Vision Glass Breaks

Time to glass breakage varies widely and can be unpredictable. It can occur as early as 5 min.

ASTM E 2874

Curtain wall/spandrel system after fire test

ASTM Standard Development

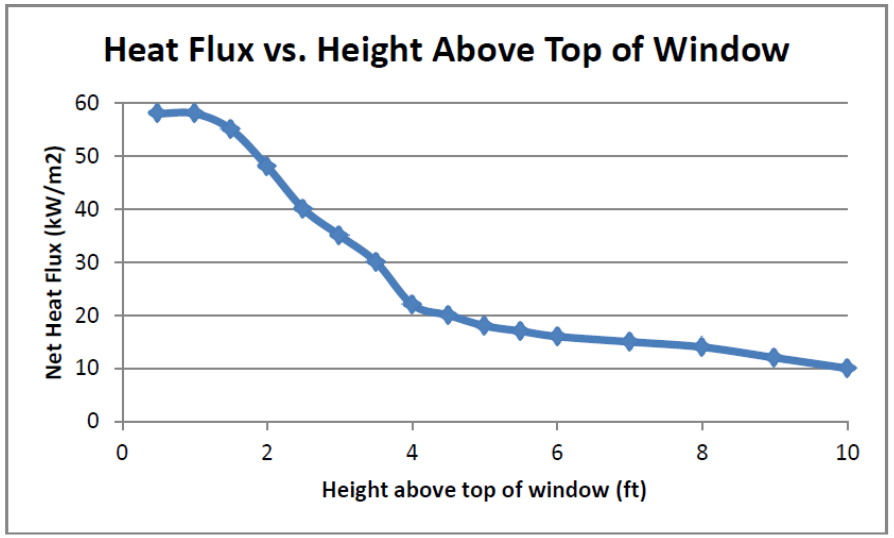
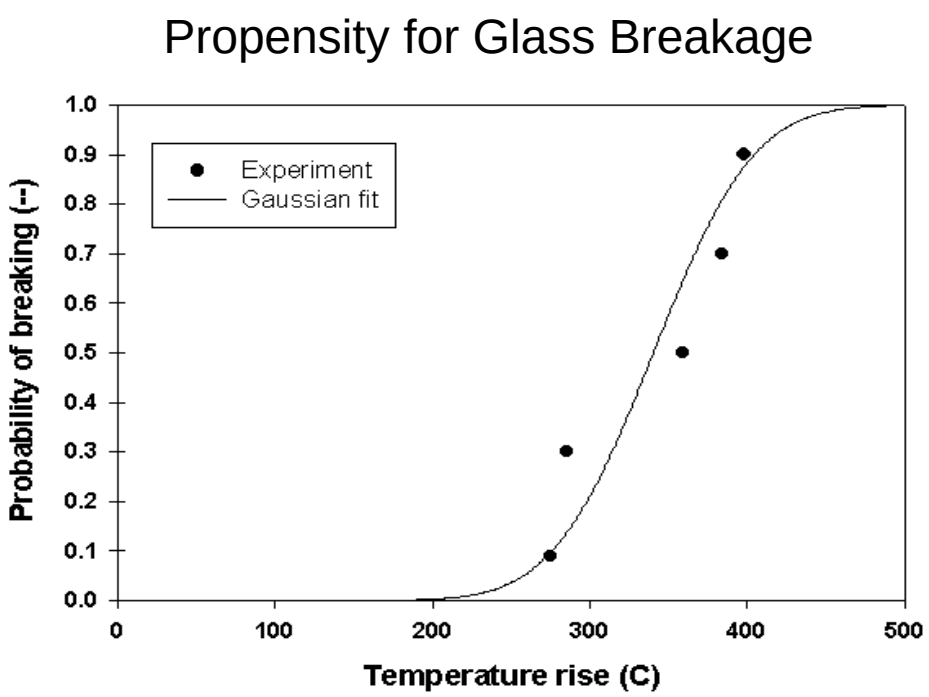


Figure 17: ASTM Test Heat Flux vs. Height above top of window

- Fire Plume
  - Plume extends up to 15-ft above floor
    - 8-ft above top of window opening
- Centerline heat flux levels
  - Avg. 35 kW/m^2 3-ft above window (peaks over 70kW/ m^2)
  - Avg. 15 kW/m^2 5-ft above window (peaks over 45kw/m^2)

The choice of pass/fail criteria selected is based on the level of heat flux required for unpiloted ignition of easy to ignite combustible materials.

Glass Breakage as a Failure Criteria



Studies have confirmed that;

- For 6mm float glass, first cracking occurs when the bulk glass temperature reaches around 110ºC (230ºF).
- This corresponds to a heat flux of around **3 kW/m²**.
- In this same study, glass fell out when exposed surface temperature reached 415 - 486ºC (779 - 907ºF), or heat flux of around 35kw/m²

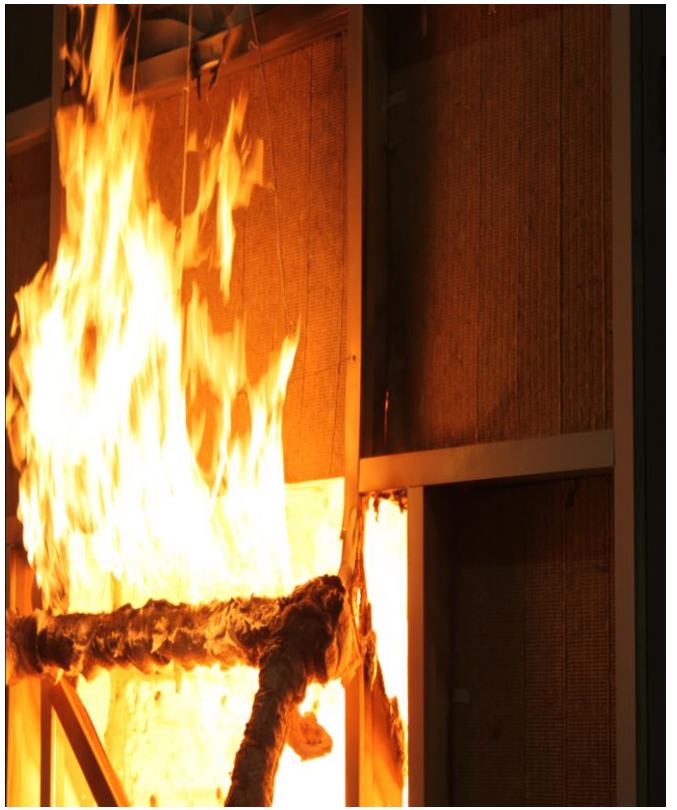
ASTM Standard Evaluation Criteria

- ***The test measures the incident heat flux on the room side of the exterior facade (i.e. spandrel, glazing), on the floor immediately above the burn room.***

- "I" Integrity Rating—The integrity rating of the spandrel-panel assembly shall be determined as the time at which one of the following conditions first occurs:
  a) The total heat flux measured by the heat flux transducers reaches 3 kW/m^2, (measured at 4 inches behind the interior face of the glazing or spandrel) or
  b) The occurrence of flames or hot gases on any portion of the unexposed surface of the test specimen sufficient to ignite the cotton pad (similar to ASTM E119).

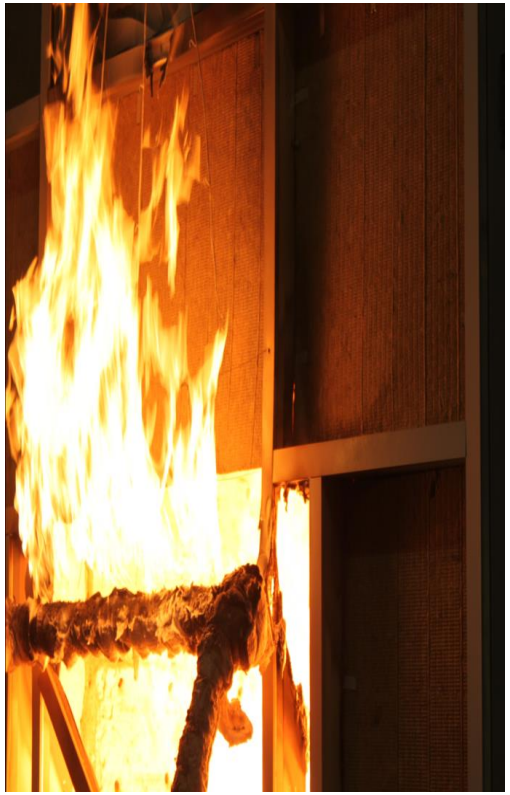
- "T" Rating - Max 250°F (139°C) average and 325°F (181°C) individual point temperature on interior surface of the exterior wall construction

- "F" ratings per ASTM E2307 are also included in the Standard.



Summary for ASTM E2874

- **When considering floor-to-floor fire spread via openings or spandrel panels, the nature of exterior wall/curtain wall designs is a critical factors that will dictate the relative capability to resist floor-to floor fire spread.**
- Key factors that impact curtain wall resistance to vertical fire spread, which need to be evaluated by testing, can include:
  - ✓ Full height or partial height vision glass or spandrel panel design
  - ✓ Nature of the glass used to construct glazing system
  - ✓ Nature of the curtain wall components (e.g. framing, spandrel panels, rain screen, air gap)
  - ✓ Vertical or horizontal projections on exterior that may deflect or enhance flame behavior
  - ✓ Building geometry at curtain wall – inclined, staggered, sloped, etc.
  - ✓ Operable windows/openings – size and orientation
  - ✓ The vertical alignment of windows/openings
- A Spandrel-Panel assembly tested to ASTM E2874 can help to impede the vertical spread of fire via exterior fire spread, from the floor of origin to the floor(s) above.



Connecting the Dots!

- Perimeter Fire Containment Systems
  - As required by the IBC and NBC
  - Tested to ASTM E2307
  - Establishes F and T Ratings
  - IBC and NBC require F Rating to be not less than the rating of floor assembly
  - Protects against flame passage through void only
  - Requires relatively small spandrel height

Connecting the Dots Cont.

- UL “Enhanced” Perimeter Fire Containment Systems
  - As originally developed by UL
  - Uses ASTM E2307 as the basic methodology
  - Expands scope to include flame passage to second floor through any path
  - Establishes Integrity and Insulation Ratings
  - Not required by the IBC or NBC
  - Protects against:
    - Flame passage through void
    - Leap-frogging
  - Requires significant spandrel height to prevent leap-frogging

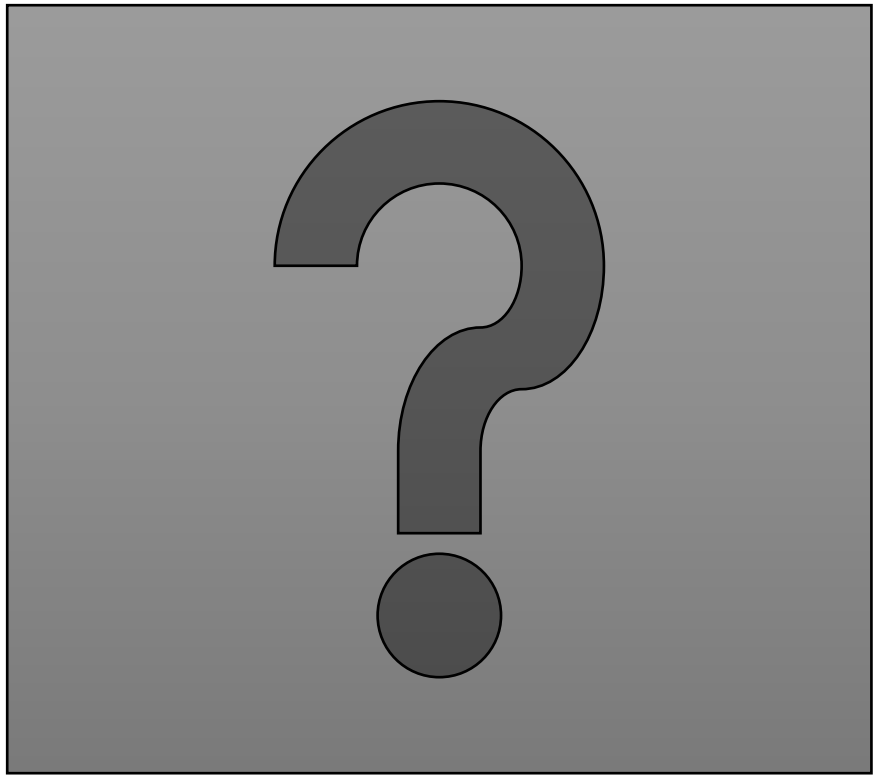
New Supplemental “Leap-Frog” Test Method Cont.

- F Rating
  - No visible flaming on interior surface of the exterior wall construction
- An attempt was made to introduce a requirement in the 2024 IBC for exterior curtain walls based on this method
- That proposal was disapproved

Connecting the Dots Cont.

- “ASTM E2874 Leap-Frog Method
  - Uses ASTM E2307 as the basic methodology
  - Expands scope to include fire performance on exterior wall
  - Establishes I, T and F Ratings
  - Not required by the IBC or NBC
  - Protects against:
    - Flame passage through void
    - Leap-frogging

Questions??



Thanks for Attending!!!

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