Perimeter Fire Containment

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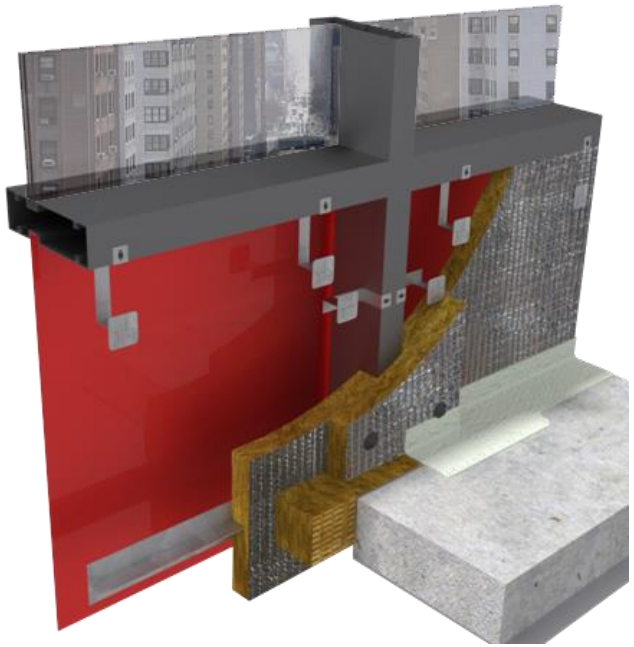
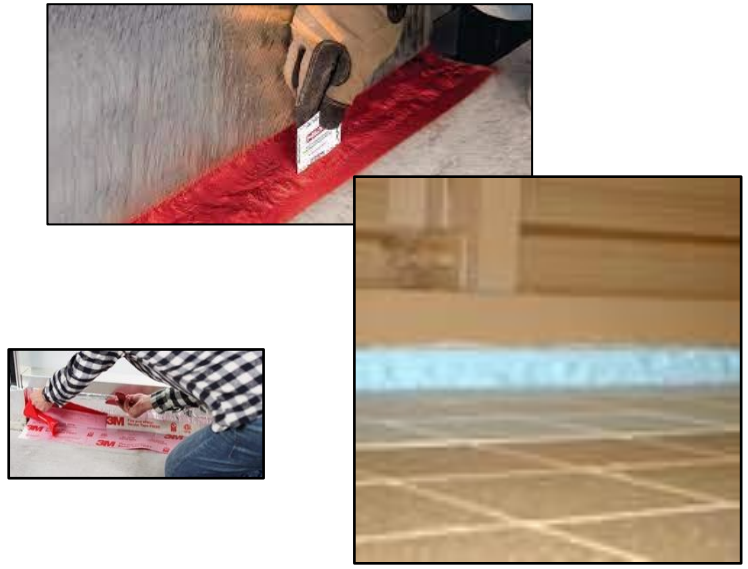
FCIA

CTI CREATIVE TECHNOLOGY INC.
FIRE PROTECTION
CONSULTING AND TRAINING

Perimeter Fire Containment

Introductory Comments



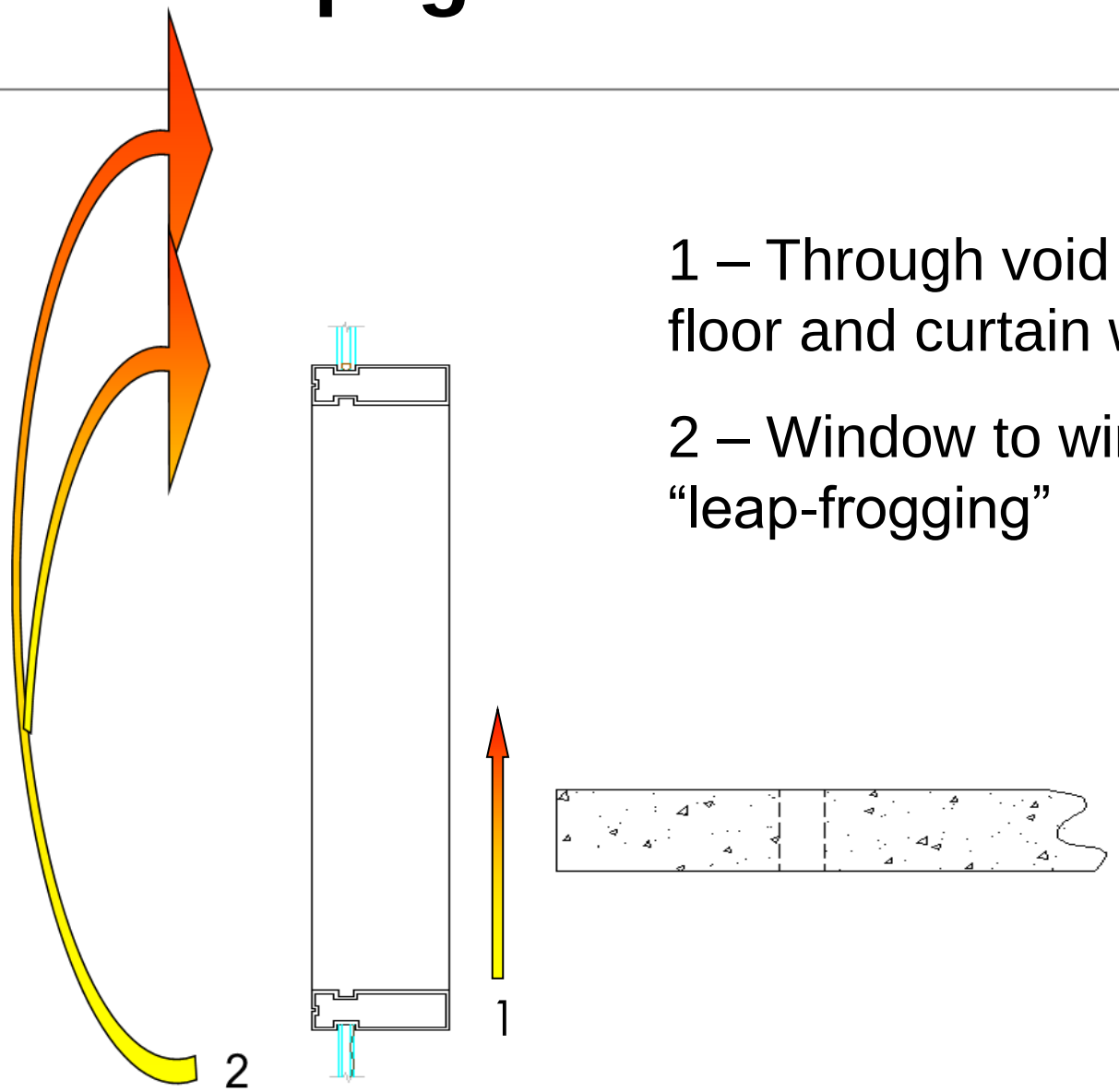


Hilti, 3M, STI, Thermafiber Images

Perimeter Fire Containment

- Two Types of Perimeter Fire Protection
  - Perimeter Fire Containment
    - Relates to floor-to-floor fire migration
    - Based on Division B, Part 3, Section 3.1.8.3 of the NBC and Sections 708.5 & 715.4 of the IBC
    - Tested to ASTM E2307
  - Vertical Flame Propagation on Exterior of Building
    - Relates to reaction to fire
    - Based on Division B, Part 3, Section 3.1.5.5 of the NBC, and Chapters 14 (Exterior Walls) and 26 (Plastics) of the IBC
    - Tested to ULC-S134 or NFPA 285 in Canada and the US, resp.
- Today's discussion relates to Perimeter Fire Containment

Paths of Fire Propagation



1 – Through void between floor and curtain wall

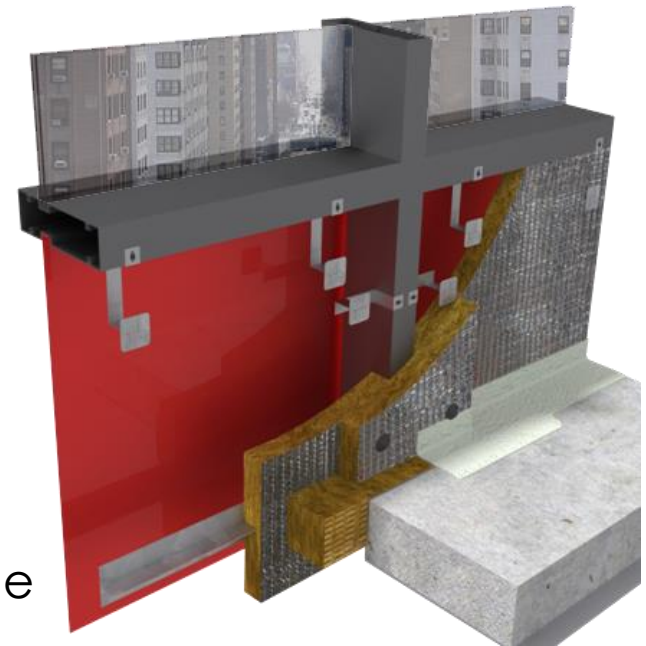
2 – Window to window “leap-frogging”

Classic Fires Where Perimeter Fire Containment Did NOT Work

- First Interstate Bank, Los Angeles, CA – Fire spread from 12th to 16th floor through improperly protected penetrations and through the perimeter void. One fatality.
- One Meridian Plaza, Philadelphia, PA – Fire spread from 22nd to 30th floor through improperly protected penetrations and through perimeter void. Three fatalities.

Lessons Learned – First Interstate Bank Fire

- Confirmed need for automatic extinguishment of fire (i.e. sprinklers)
- Need for monitored alarm
- Need for better protection of void between edge of floor slab and curtain wall
- Need for better protection of penetrations



Thermafiber Image

Perimeter Fire Containment

Redefining Perimeter Fire Containment Requirements

Designation: E 2307 – 04

An American National Standard

Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus[1]

This standard is issued under the fixed designation E 2307; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

A perimeter fire barrier system is the perimeter joint protection installed in the space between an exterior wall assembly and a floor assembly. A perimeter fire barrier system is a unique building construction detail not addressed by other fire test methods.

Among its other functions, a perimeter fire barrier system impedes the vertical spread of fire from the floor of origin to the floor(s) above, at the building's exterior perimeter and accommodates various movements such as those induced by thermal differentials, seismicity, and wind loads.

This test method describes criteria and test methods used to determine the fire resistance of perimeter fire barrier systems when subjected to standard fire exposure conditions using the intermediate-scale, multistory test apparatus (ISMA). The use of the multi-story test apparatus and this test method are intended to simulate a possible fire exposure on a perimeter fire barrier system.

1. Scope

1.1 This test method measures the performance of the perimeter fire barrier system and its ability to maintain a seal to prevent fire spread during the deflection and deformation of the exterior wall assembly and floor assembly during the fire test, while resisting fire exposure from an interior compartment fire as well as from the flame plume emitted from the window burner below. The end point of the fire resistance test is the period of time elapsing before the first condition of compliance is reached as the perimeter fire barrier system is subjected to a time-temperature fire exposure.

1.2 The fire exposure conditions used are those specified by this test method for the first 30 min of exposure and then conform to the Test Methods E 119 time-temperature curve for the remainder of the test in the test room.

1.3 This test method specifies the heating conditions, methods of test, and criteria for evaluation of the ability of a perimeter fire barrier system to maintain the fire resistance where a floor and exterior wall assembly are juxtaposed to a perimeter joint.

1.4 Test results establish the performance of perimeter fire barrier systems during the fire-exposure period and shall not be construed as having determined the suitability of perimeter fire barrier systems for use after that exposure.

1.5 This test method does not provide quantitative information about the perimeter fire barrier system relative to the rate of leakage of smoke or gases or both. While it requires that such phenomena be noted and reported when describing the general behavior of perimeter fire barrier system during the fire resistance test, such phenomena are not part of the conditions of compliance.

1.6 Potentially important factors and fire characteristics not addressed by this test method include, but are not limited to:

1.6.1 The performance of the perimeter fire barrier system constructed with components other than those tested, and

1.6.2 The cyclic movement capabilities of perimeter fire barrier systems other than the cycling conditions tested.

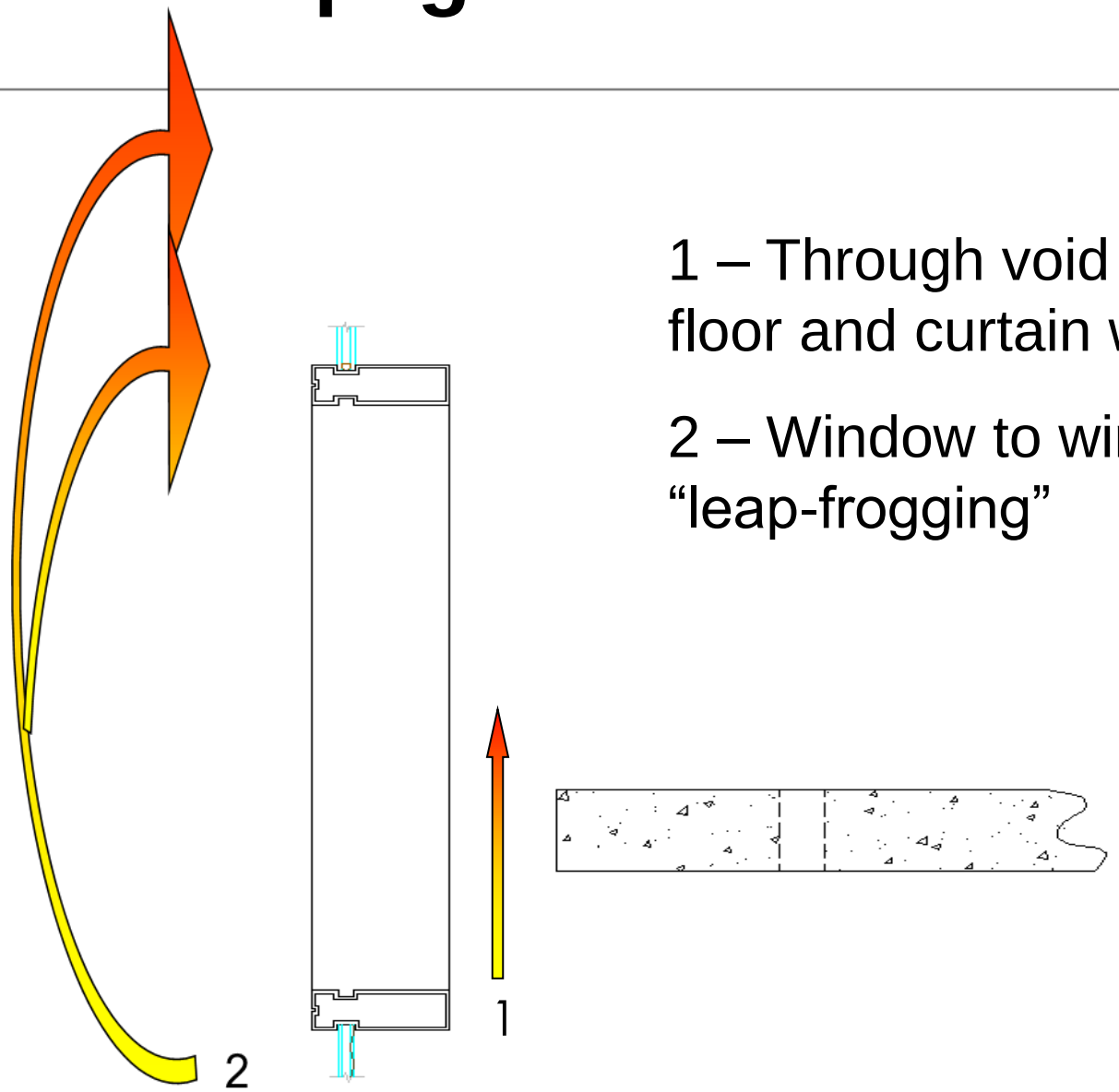
1.7 This test method is used to measure and describe the response of materials, products or assemblies to heat and flame under controlled conditions but does not by itself incorporate all factors required for the fire-hazard or fire-risk assessment of the materials, products, or assemblies under actual fire conditions.

1.8 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are for information only.

[1] This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.11 on Fire Resistance.

Current edition approved March 1, 2004. Published April 2004.

Paths of Fire Propagation



1 – Through void between floor and curtain wall

2 – Window to window “leap-frogging”

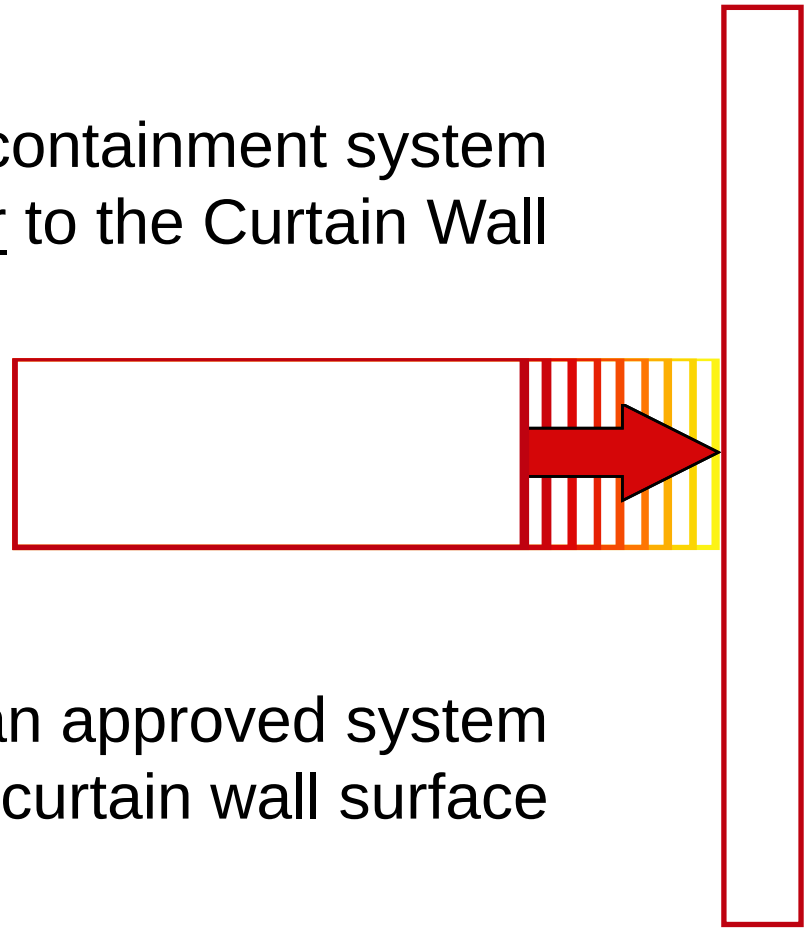
Terminology

- Path 1 – Perimeter Fire Containment
  - Alternate terminology
    - Perimeter Fire Barrier
    - Perimeter Joint System
    - Perimeter Firestopping System
    - Safing Joint System
    - Curtain Wall System
    - Etc.
- Paths 1 & 2 – “Enhanced” Perimeter Fire Containment

Perimeter Fire Containment

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

Required by the CBC & IBC!

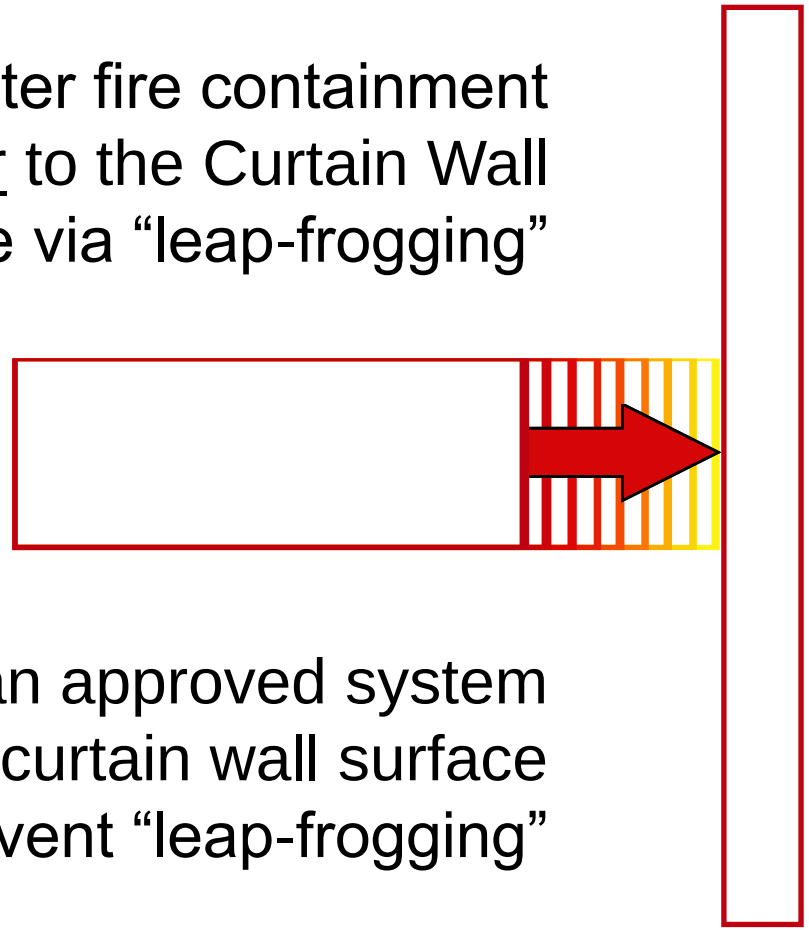


The void must be sealed with an approved system
that extends to the exterior curtain wall surface

“Enhanced” Perimeter Fire Containment

An “enhanced” perimeter fire containment system extends the Floor to the Curtain Wall and prevents flame passage via “leap-frogging”

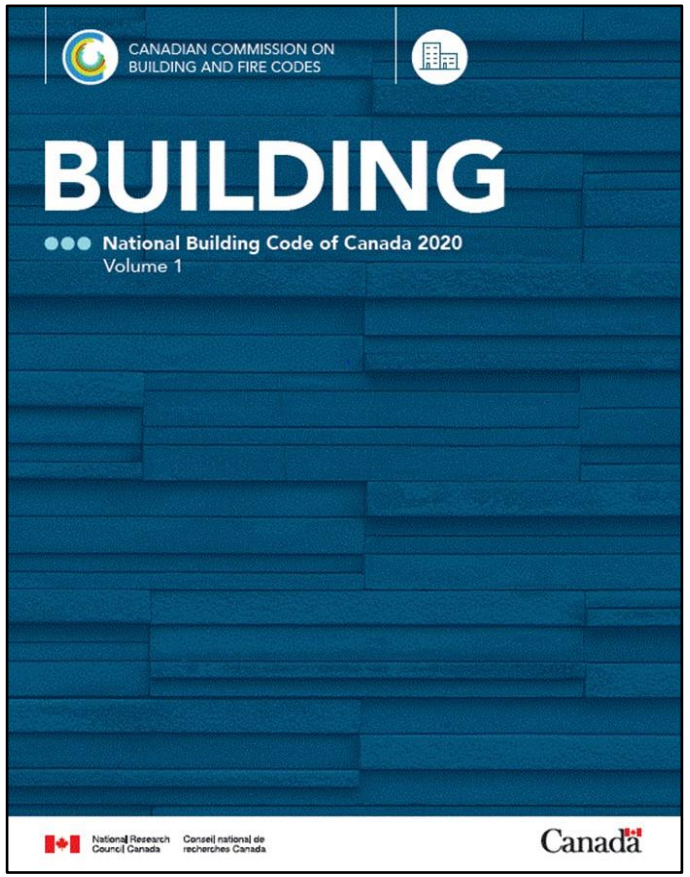
Not Yet Required by the Codes



The void must be sealed with an approved system that extends to the exterior curtain wall surface and the curtain wall must prevent “leap-frogging”

Perimeter Fire Containment

Canadian
Building Code
Requirements



NBC Requirements

- Division 3, Part 3, Section 3.1.8.3 – Continuity of Fire Separations
  - 4) Except as provided in Sentence (5), joints located in a horizontal plane between a floor and an exterior wall shall be sealed by a *firestop* that, when subjected to the fire test method in ASTM E2307, “Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-storey Test Apparatus,” has an F rating not less than the *fire-resistance rating* of the horizontal *fire separation*.
- New for the 2020 NBC
- Consistent with US based requirements

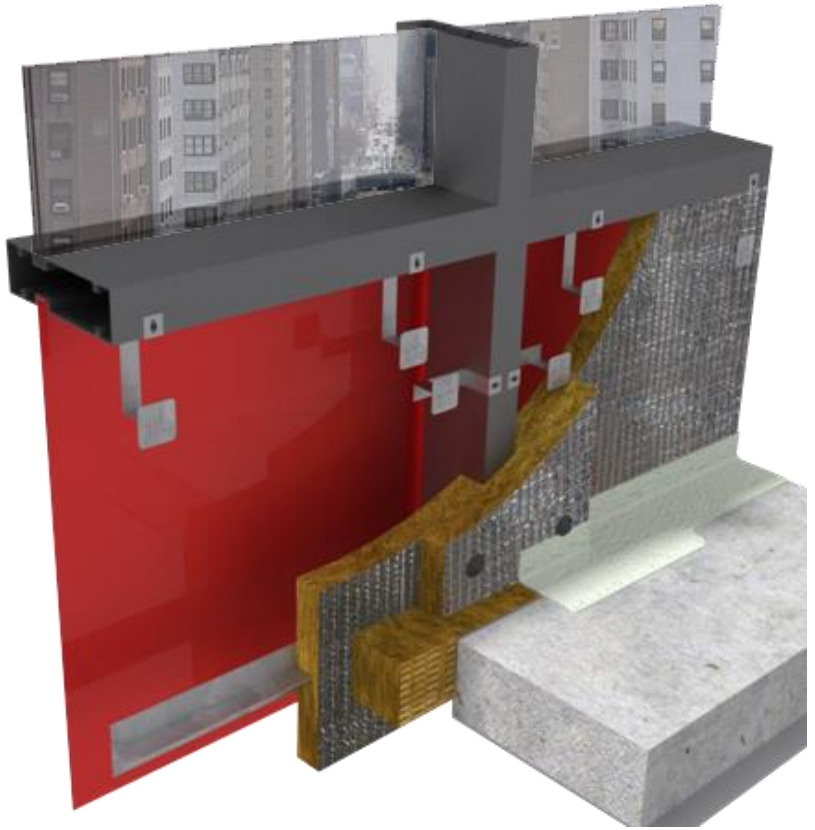
NBC Requirements Cont.

- This new NBC requirement was initiated in conjunction with changes to ULC-S115 in 2018
- 9.1.1 Perimeter Joint Firestop Systems shall be tested in accordance with the requirements in ASTM E2307, Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers using Intermediate-Scale, Multi-Storey Apparatus

Perimeter Fire Containment

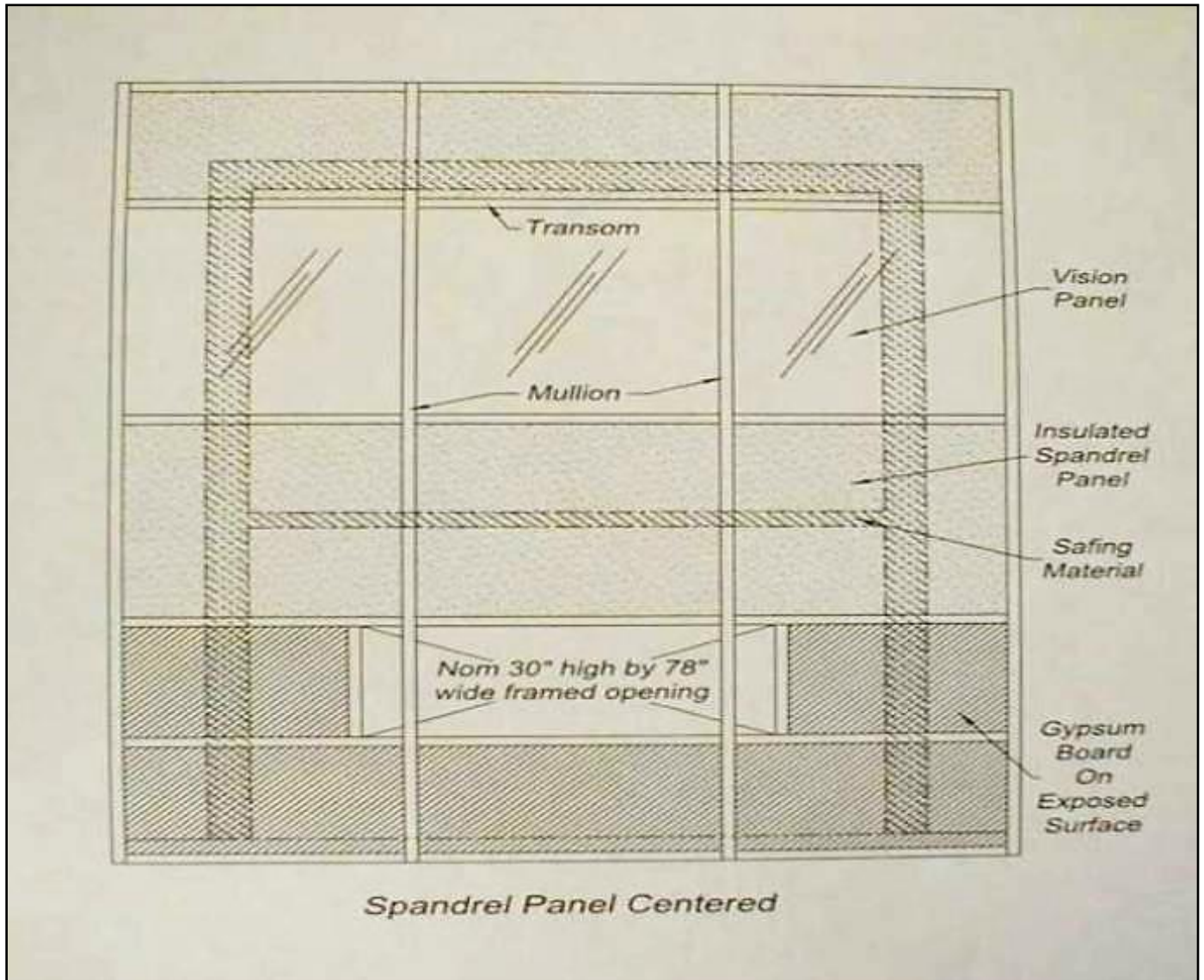
ASTM E2307 Test Method

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



Thermafiber Image

Curtain Wall Orientation



Three Elements of Perimeter Fire Containment Systems

- Floor Assembly
- Curtain Wall Assembly
- Safing and Spray Materials

First Floor - Underside of Floor

First Floor - Underside of Floor

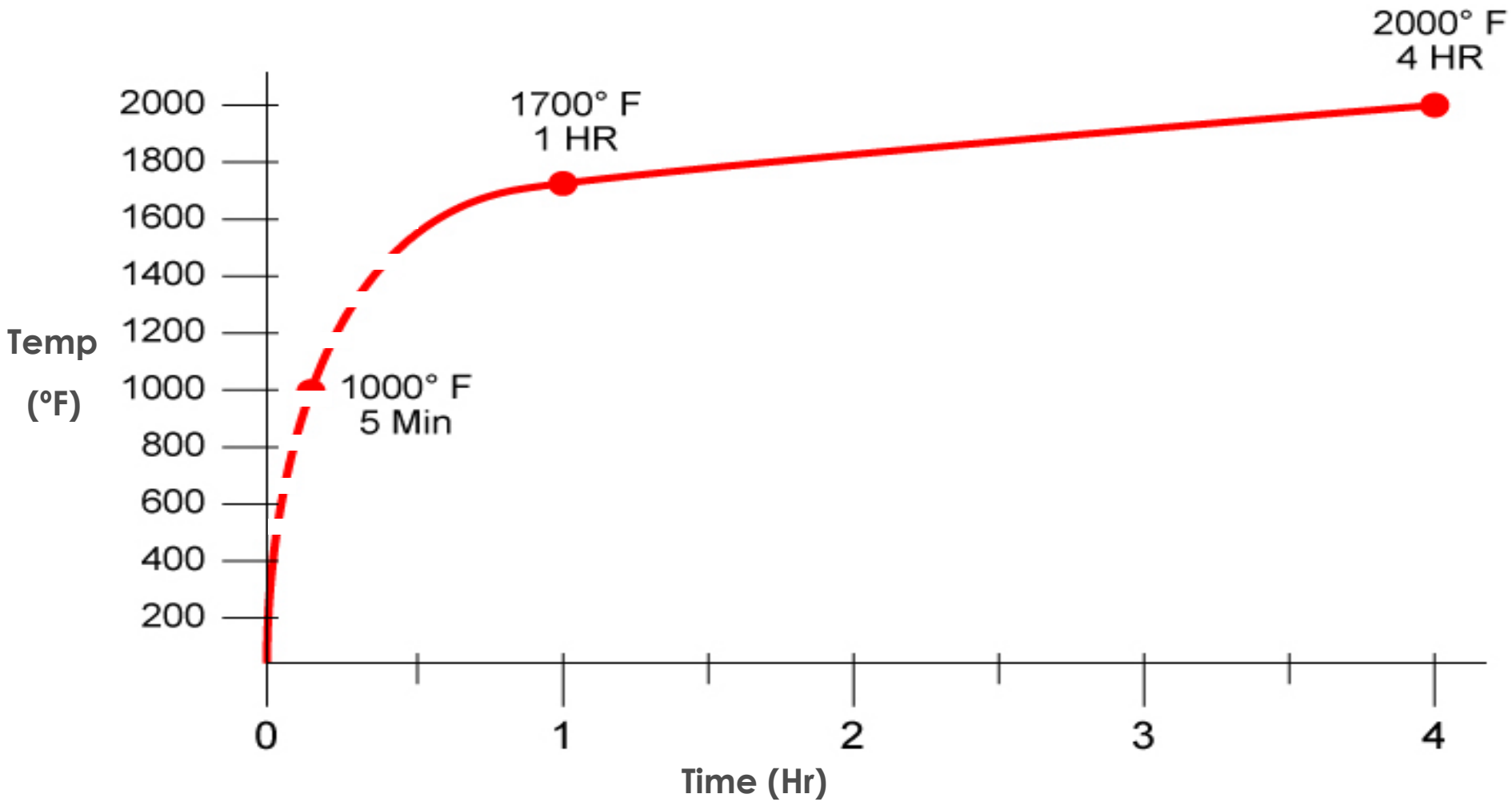
Second Floor – Top of Floor

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

Ratings – “Enhanced” Perimeter Fire Containment Systems

- Integrity Rating – Passage of Flames through any Location to Second Floor
- Insulation Rating – Passage of Flames through and Heat Transmission at any Location to Second Floor
- L Rating – Air Leakage at ambient temperature and 400ºF (Optional)

New Supplemental “Leap-Frog” Test Method

- ASTM E2874 – Standard Test Method for Determining the Fire-Test Response Characteristics of a Building Spandrel-Panel Assembly Due to External Spread of Fire
  - Developed based on believe of many that ASTM E2307’s focus on interior spread of flame was not sufficient
  - The test structure described in this new standard is similar to that described in ASTM E2307
  - Evaluates the fire performance of an exterior wall assembly for its ability to prevent the spread of fire to the interior of a room one adjacent story above via fire spread on exterior of a building

New Supplemental "Leap-Frog" Test Method Cont.

- Simulates a post flashover fire exposure within a compartment venting to the exterior of the building and spreading to the floor immediately above via the exterior of the building
- Develops three Ratings on the exterior wall construction
  - I Rating
    - No flaming on interior surface of the exterior wall construction sufficient to ignite cotton waste
    - Max 3 kW/m3 heat flux from interior surface of the exterior wall construction
  - T Rating
    - Max 139°C (250°F) average and 181°C (325°F) individual point temperature on interior surface of the exterior wall construction

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 IBC for exterior curtain walls based on this method.
- That proposal was disapproved.

Connecting the Dots!

- Perimeter Fire Containment Systems
  - As required by the NBC and IBC
  - Tested to ASTM E2307
  - Establishes F and T Ratings
  - NBC and IBC 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.

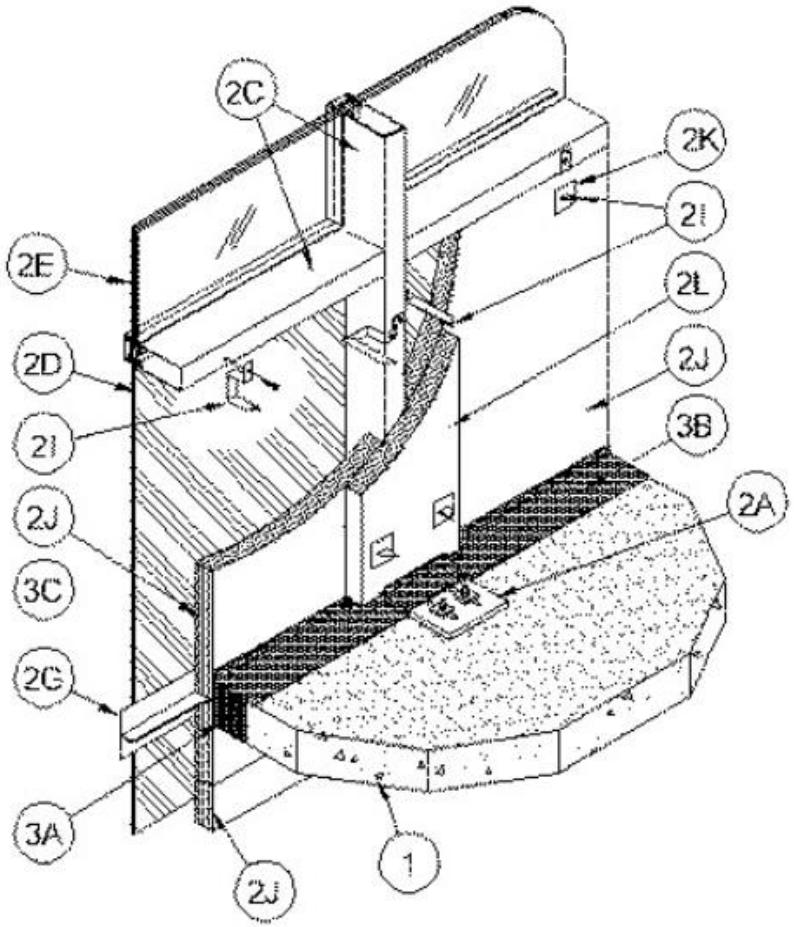
- “Enhanced” Perimeter Fire Containment Systems
  - As originally developed by UL
  - Uses ASTM E2307 as the basic methodology
  - Expands scope to include flame passage to second floor through any path
  - Establishes Integrity and Insulation Ratings
  - Not required by the NBC or IBC

Connecting the Dots Cont.

- Protects against:
  - Flame passage through void
  - Leap-frogging
- Requires significant spandrel height to prevent leap-frogging

- “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 NBC or IBC

Perimeter Fire Containment



Listings

Where Can I Find The Most Current Listing?

- Directories of the Nationally Recognized Testing Laboratories
  - FM Global Approval Guide
  - Intertek Directory of Building Products
  - UL/ULC Product iQ Online Directory

Products become systems based on testing!!!

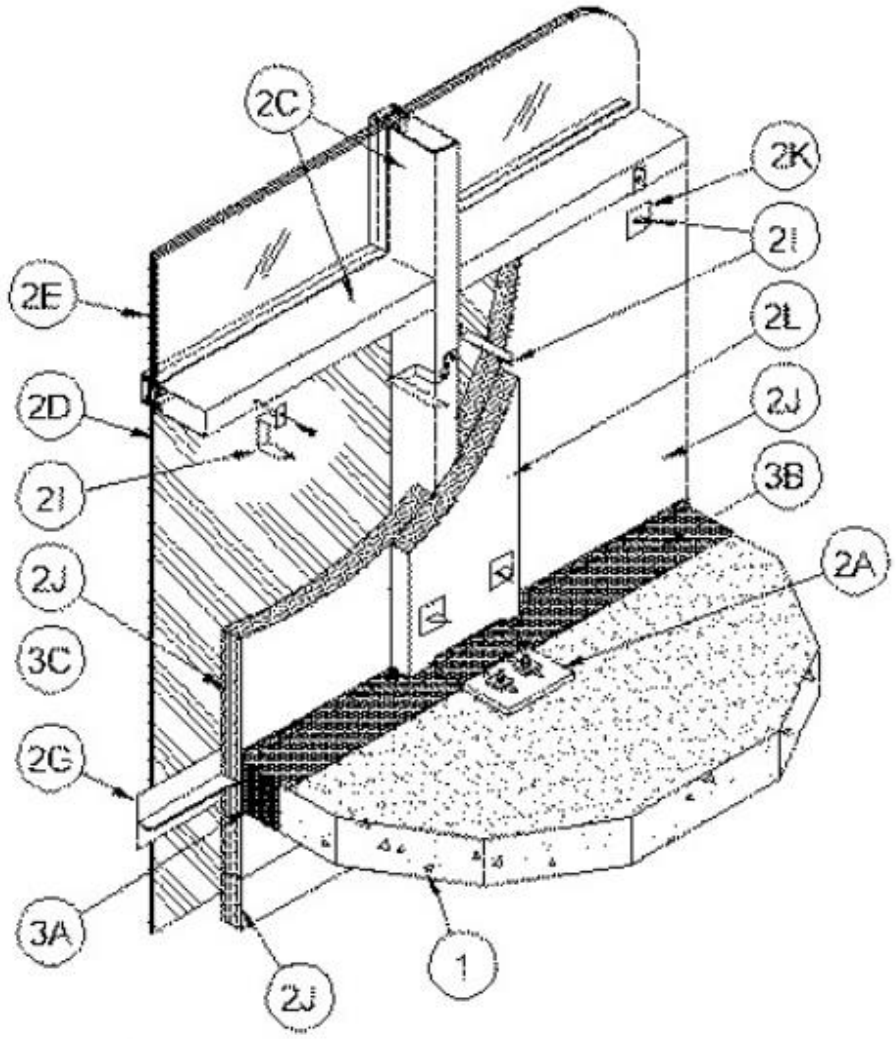
UL Product Categories For Perimeter Fire Containment

- XHDG – Perimeter Fire Containment Systems for use in the US
  - Includes approximately 229 individual systems
  - Proprietary products specified in these systems are covered in 3 individual product categories:
    - Curtain-wall Insulation (XHGU)
    - Fill, Void or Cavity Materials (XHHW)
    - Forming Materials (XHKU)
- Neither UL nor ULC has Perimeter Fire Containment Systems Certified for Canada (i.e. no XHDG7 or XHDGC systems)

UL Product Categories For Perimeter Fire Containment Cont.

- Reasonable to conclude Perimeter Fire Containment Systems listed for US application will meet the provisions of the Canadian standard and codes
  - Both countries use ASTM E2307
  - ULC-S115 modifications to ASTM E2307 test procedure make the Canadian test **more** critical than the ASTM procedure due to the need to follow the Standard Time-Temperature curve after 30 minutes. Some assemblies tested in US may not comply with this provision of ULC-S115.

System No. XHDG.CW-D-2046



Anchors

Recent Ballot to ASTM E2307:

1.6 Potentially important factors and fire characteristics not addressed by this test method include, but are not limited to:

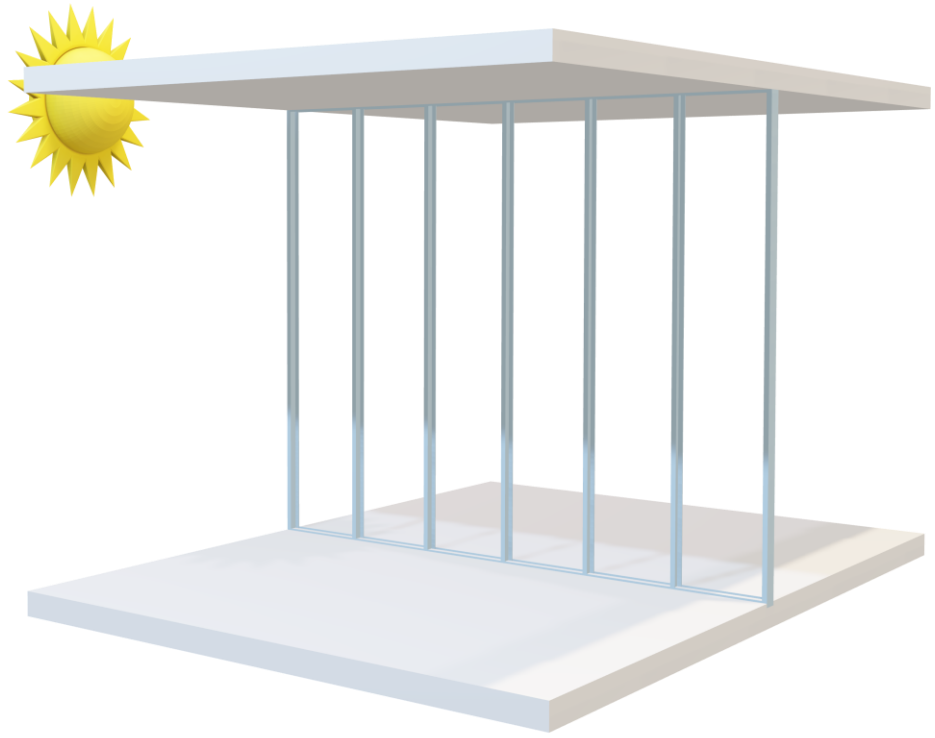
1.6.3 The structural performance of the anchor attachment for perimeter fire barriers

Interior Partition Intersecting Non-Fire Rated Exterior Wall

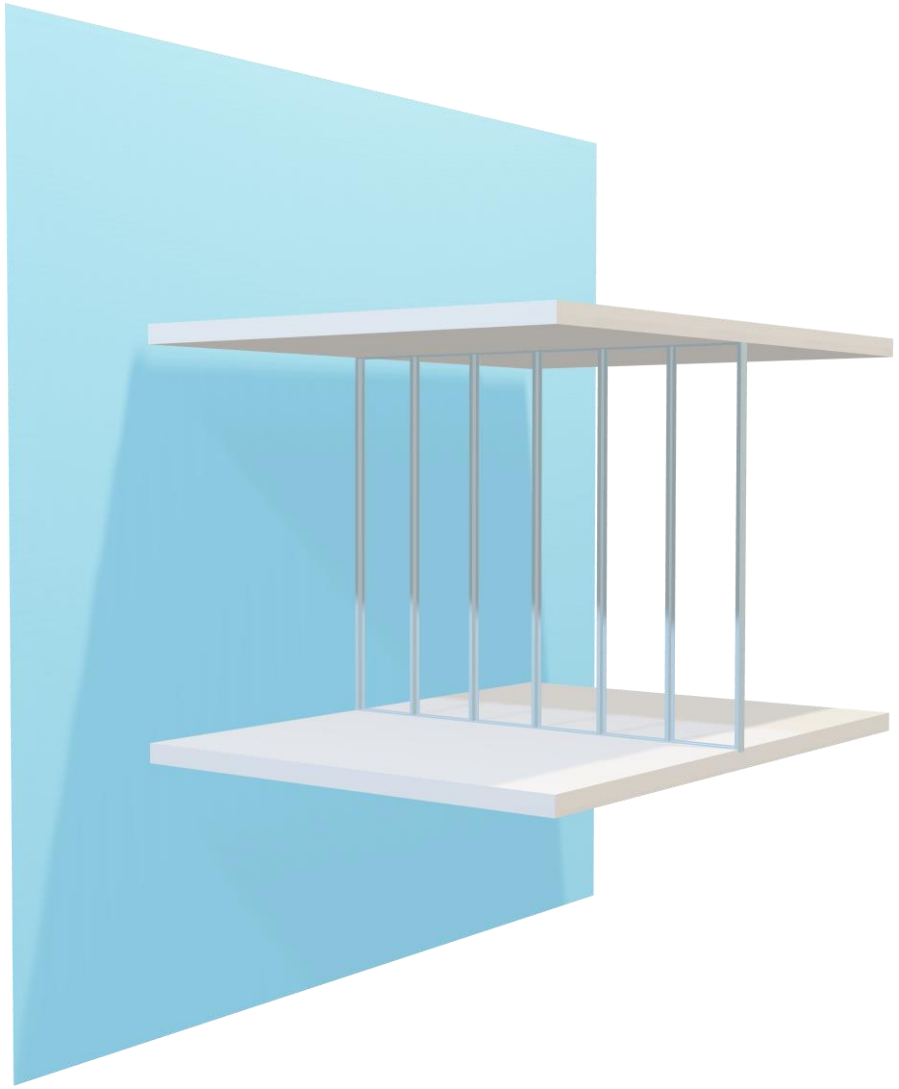
2021 International Building Code
Section 715, Joints and Voids

- 715.6 Exterior curtain wall/vertical fire barrier intersections
- Voids created at the intersection of nonfire-resistance-rated exterior curtain wall assemblies and vertical fire barriers shall be filled with an approved material or system to retard the interior spread of fire and hot gases
- No test standard to validate this performance requirement!

Interior Wall Intersection



Interior Wall Intersection



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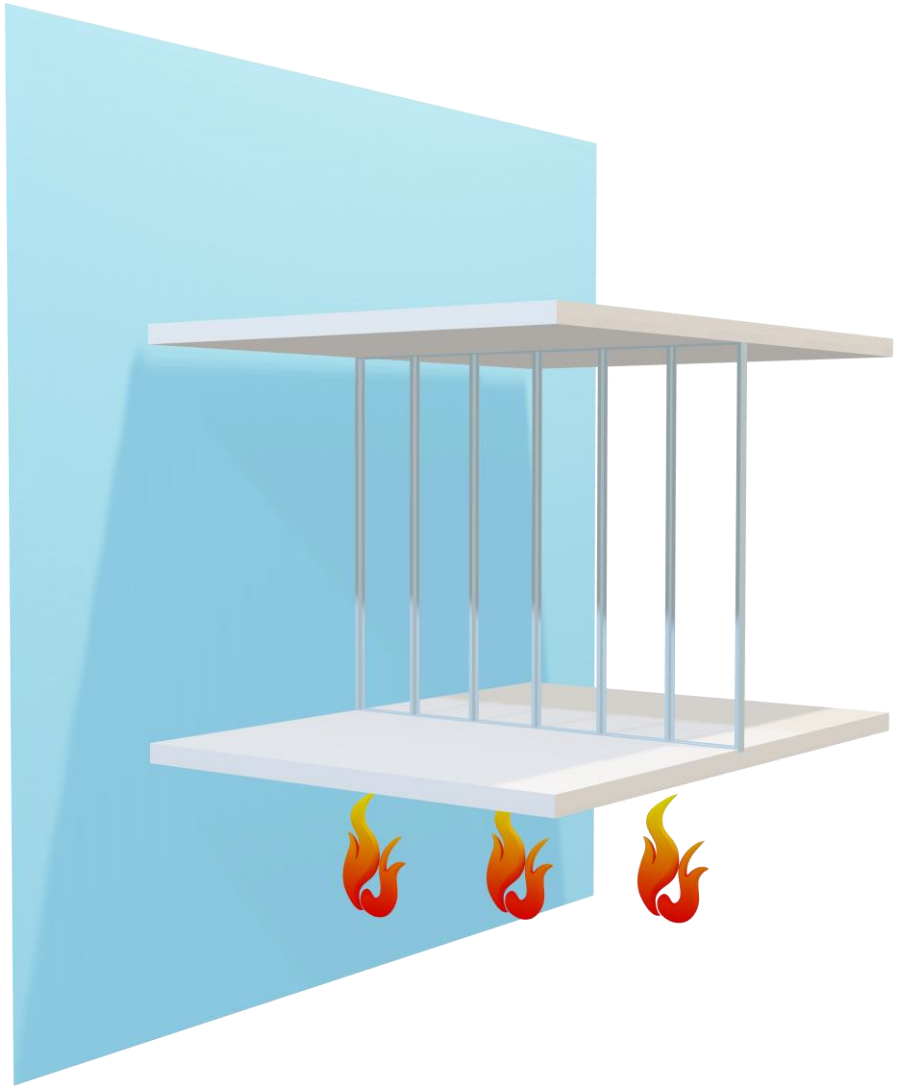

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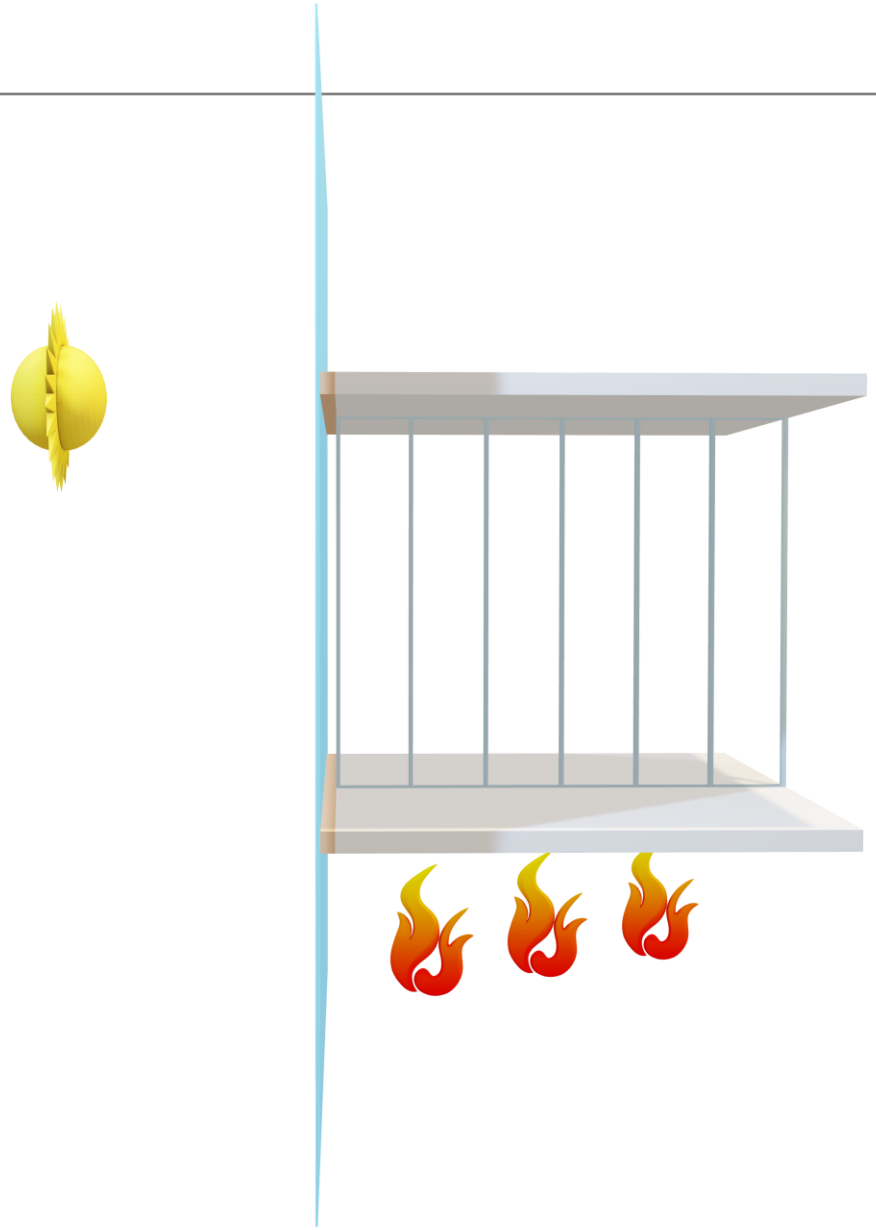

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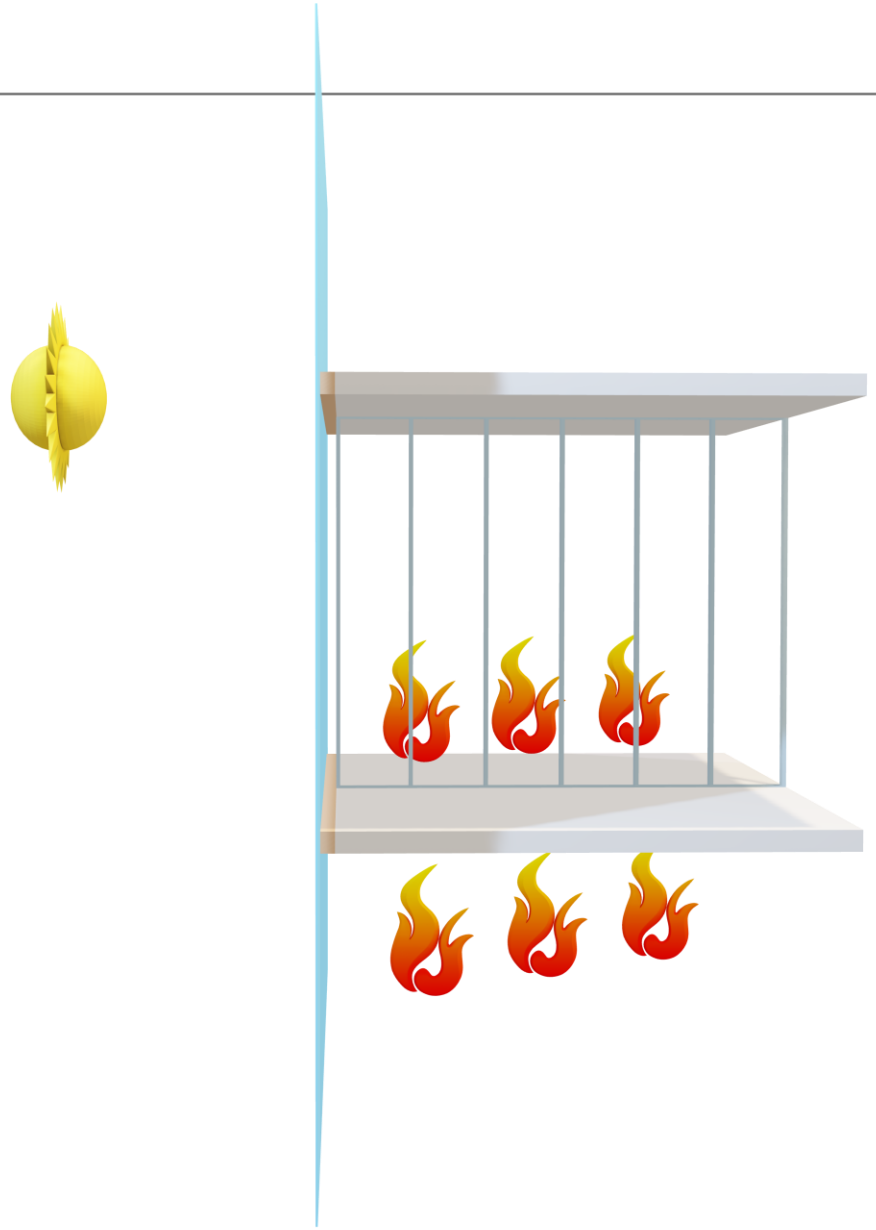

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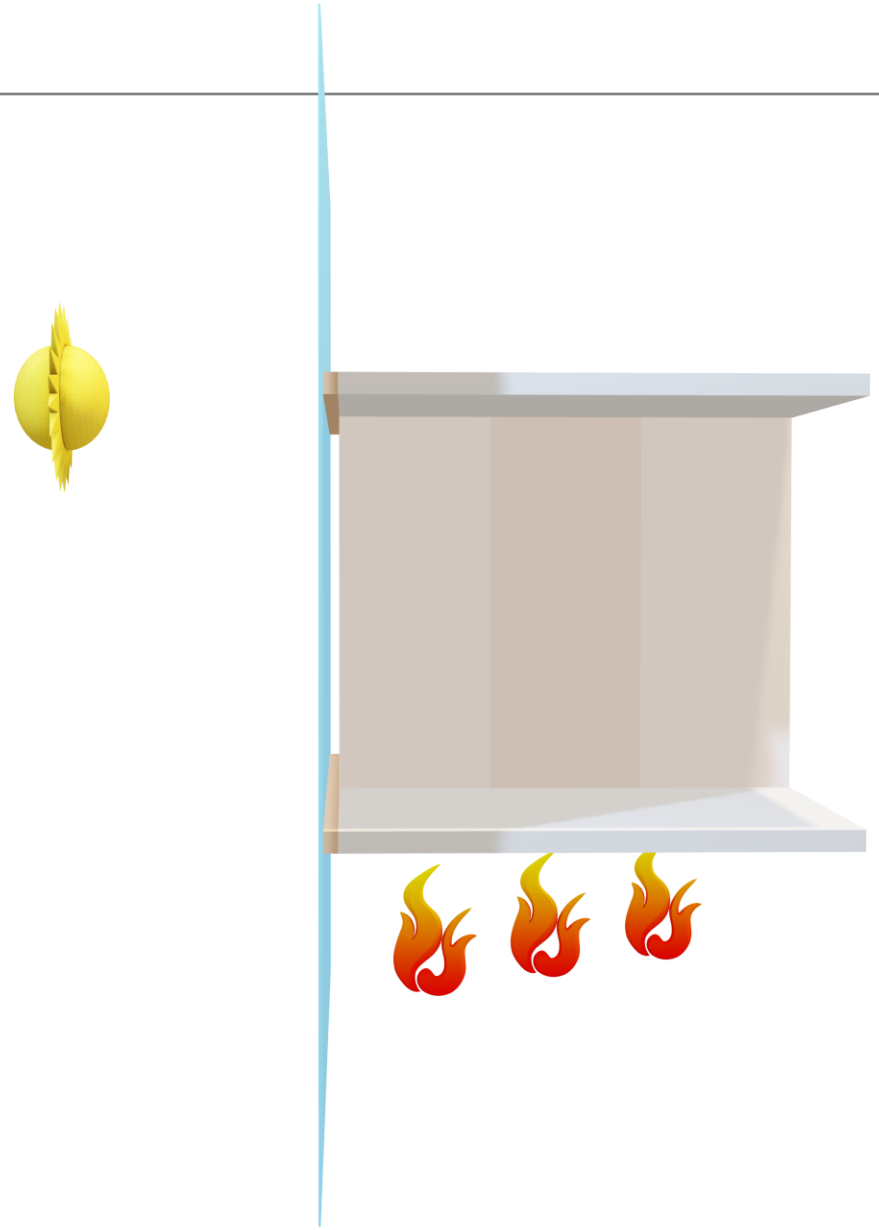

ASTM WK82055

- Determining Fire Resistance of Joint Systems Installed Between Interior Rated Wall Assemblies and Exterior Nonrated Wall Assemblies
- ASTM task group formed
- First discussion June 2022
- Is standard needed?
- Possible starting points (new standard, add to existing standard)
- Existing standards: ASTM E2837, ASTM E1966
- Technical contact: Kevin Hyland

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