NFCA – LA
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ICC’s International Building Code Ch. 7 & other Fire-Resistance-Rated Construction Highlights
John Dalton, GCP Applied Technologies, Inc.
Russ Harvey, Isolatek International
This session covers the key elements for fire-resistance-rated construction in buildings, as it relates to several chapters of 2015 & 2018 International Building Code.
Fire !!!!!

- You won’t outrun it (definitely not the smoke) – don’t sit there and assume it’s a false alarm
- You probably cannot fight it
- Have an escape plan at home and your office
- Grab the living and get out
Why the need?

Station nightclub fire – USA – 2003 – 100 fatalities
Kiss nightclub fire – Brazil – 2013 – 242 fatalities
República Cromañón nightclub fire – Argentina – 2004 – 194 fatalities

Common denominator = Code violations
IBC Requirements for the protection of Structural Steel and Foamed Plastic

- CODE LANGUAGE AFFECTING FIRE RESISTIVE MATERIALS (SFRM & IFRM)
- Chapter 2 – Definitions
- Chapter 4 – High Rise Buildings
- Chapter 5 – Separation
- Chapter 6 – Table 601
- Chapter 7 – Fire Resilient Construction
- Chapter 17 – Special Inspections
CHAPTER 2 - DEFINITIONS

PRIMARY STRUCTURAL FRAME. The primary structural frame shall include all of the following structural members:

1. The columns;
2. Structural members having direct connections to the columns, including girders, beams, trusses and spandrels;
3. Members of the floor construction and roof construction having direct connections to the columns;
4. Bracing members that are essential to the vertical stability of the primary structural frame under gravity loading shall be considered part of the primary structural frame whether or not the bracing member carries gravity loads.

The primary structural frame and secondary members must meet different standards of design and protection as specified in Chapters 6 and 7. The definitions of these two frames spell out which elements of a structure are considered primary and secondary.

SECONDARY MEMBERS. The following structural members shall be considered secondary members and not part of the primary structural frame:

1. Structural members not having direct connections to the columns;
2. Members of the floor construction not having direct connections to the columns and;
3. Bracing members other than those that are part of the primary structural frame.

This term works in conjunction with the term “primary structural frame” to distinguish which elements of a building’s structure need to receive various levels of fire resistance protection. These requirements are found in Table 601 and Sections 704.
IBC Requirements For Structural Steel

- CHAPTER 2 - DEFINITIONS

HIGH-RISE BUILDING: A building with an occupied floor located more than 75 feet (22,860 mm) above the lowest level of fire department vehicle access.

Determining what qualifies as a high-rise building is a fairly unique measurement of height. The critical measurement is from the lowest ground location where a fire department will be able to set its fire-fighting equipment to a floor level of occupied floors (including any occupied roofs). It is not a measurement from grade plane to top of the building. The basis of the measurement is analyzing the capability of fighting a fire and rescuing occupants from the outside the building. Once past a height of 75 feet (22,860 mm) above ground level, ground based fire fighting will not be sufficient [see the commentary, Section 403 and Figure 403.1(1)].
IBC – Occupancies – Chapter 3

• A – Assembly – Independent or Associated; A-1 to A-4
• B – Business; Office, Post Secondary Education
• E – Education – Through grade 12; >6 persons...with references to A-3;
• F – Factory Industrial Group – Moderate & Low Hazards
• H – Hazardous – Table 307.1(1) – Based on Hazard
• I-1 – Assisted Living under 16 occupants
• I-2 – Hospitals
• I-3 – Prison, Jails
• M – Merchantile – Retail Stores, with Hazardous limits Table 414.2.5(1)
• R-1 – Hotels
• R-2 – Apartments, Student Residences >16 residents, primarily permanent
• R-3 – Buildings <2 dwelling units, student residences, etc., primarily permanent
• R-4 – Buildings, >5, <16, ‘custodial care’. 
IBC Requirements For Structural Steel

• SECTION 403 – HIGH RISE CONSTRUCTION

403.2.4 Sprayed fire-resistant materials (SFRM). The bond strength of the SFRM installed throughout the building shall be in accordance with Table 403.2.4.

Note the use of “throughout”

<table>
<thead>
<tr>
<th>HEIGHT OF BUILDING⁸</th>
<th>SFRM MINIMUM BOND STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 420 feet</td>
<td>430 psf</td>
</tr>
<tr>
<td>Greater than 420 feet</td>
<td>1,000 psf</td>
</tr>
</tbody>
</table>

For SI: 1 foot = 304.8 mm, 1 pound per square foot (psf) = 0.0479 kW/m².

a. Above the lowest level of fire department vehicle access.
508.4.4 Separation. Individual occupancies shall be separated from adjacent occupancies in accordance with Table 508.4.

### TABLE 508.4

|-----------|------|---------------|-----|   |            |               |     |     |            |
| A', E     | N    | N             | 1   | 2 | NP          | 1             | 2   | N    | 1    | 2    | NP  |
| I-1, I-3, I-4 | —   | —             | —   | — | N           | 2             | NP  | 1    | 2    | 1    | NP  |
| I-2       | —    | —             | —   | — | N           | 2             | NP  | 1    | 2    | 1    | NP  |
| R         | —    | —             | —   | — | N           | 1             | 2   | NP  | NP   | NP   |   |
| F-2, S-2, U | —   | —             | —   | — | N           | 1             | 2   | NP  | NP   | NP   |   |
| B, F-1, M, S-1 | —   | —             | —   | — | N           | 2             | NP  | NP  | NP   | NP   |   |
| H-1       | —    | —             | —   | — | N           | 1             | NP  | NP  | NP   | NP   |   |
| H-2       | —    | —             | —   | — | N           | 1             | NP  | NP  | NP   | NP   |   |
| H-3, H-4, H-5 | —   | —             | —   | — | N           | 1             | NP  | NP  | NP   | NP   |   |

For S: 1 square foot = 0.0929 m²

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.

NS = Buildings not equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.

N = No separation required.

NP = Not permitted.

a. For Group H-5 occupancies, see Section 903.2.2.

b. The required separation from areas used only for storage of vehicles shall be reduced by 1 hour to not less than 1 hour.

c. See Section 408.1.4.

d. Commercial kitchens need not be separated from the ancillary seating areas that they serve.

e. Separation is not required between occupancies of the same classification.

### TABLE 508.4 (cont.)

<table>
<thead>
<tr>
<th>OCCUPANCY CLASSIFICATION</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>NS</td>
<td>UL</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>A-2</td>
<td>S</td>
<td>UL</td>
<td>6</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>A-3</td>
<td>S</td>
<td>UL</td>
<td>11</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>A-4</td>
<td>NS</td>
<td>UL</td>
<td>11</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>A-5</td>
<td>S</td>
<td>UL</td>
<td>12</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>NS</td>
<td>UL</td>
<td>11</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

For Group H-5 occupancies, see Section 403.8.2.2.
IBC Requirements For Structural Steel

- SECTION 508 – MIXED USE & OCCUPANCY

**508.4.1 Construction.** Required separations shall be fire barriers constructed in accordance with Section 707 or horizontal assemblies constructed in accordance with Section 712, or both, so as to completely separate adjacent occupancies.

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**Are these columns rated?**
<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>HT</td>
</tr>
<tr>
<td>Primary structural frame(^f) (see Section 202)</td>
<td>3(^a)</td>
<td>2(^a)</td>
<td>1</td>
<td>0</td>
<td>HT</td>
</tr>
<tr>
<td>Bearing walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior(^e)</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3(^a)</td>
<td>2(^a)</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td>See Table 602</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior(^d)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor construction and associated secondary members</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(see Section 202)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof construction and associated secondary members</td>
<td>1(^{1/2})</td>
<td>1(^{b,c})</td>
<td>1(^{b,c})</td>
<td>0(^c)</td>
<td>1(^{b,c})</td>
</tr>
</tbody>
</table>

\(^a\) Non-combustible construction (e.g. steel or concrete building)
a. Roof supports: Fire-resistance ratings of structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

d. An approved automatic sprinkler system in accordance with Section 903.3.1.1 shall be allowed to be substituted for 1-hour fire-resistance-rated construction, provided such system is not otherwise required by other provisions of the code or used for an allowable area increase in accordance with Section 506.3 or an allowable height increase in accordance with Section 504.2. The 1-hour substitution for the fire resistance of exterior walls shall not be permitted.

e. Not less than the fire-resistance rating required by other sections of this code.

f. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

g. Not less than the fire-resistance rating as referenced in Section 714.5.
TABLE 601 - FOOTNOTES

The 2015 version of the “20 foot Rule”

a. Roof supports: Fire-resistance ratings of structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

d. An approved automatic sprinkler system in accordance with Section 903.3.1.1 shall be allowed to be substituted for 1-hour fire-resistance-rated construction, provided such system is not otherwise required by other provisions of the code or used for an allowable area increase in accordance with Section 506.3 or an allowable height increase in accordance with Section 504.2. The 1-hour substitution for the fire resistance of exterior walls shall not be permitted.

e. Not less than the fire-resistance rating required by other sections of this code.

f. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

g. Not less than the fire-resistance rating as referenced in Section 714.5

Footnote b (elevation view)
No, footnote b does not allow for the omission of fireproofing on the columns supporting the roof construction. The omission only applies to the primary structural frame members that are part of the roof construction such as girders attached to the columns, but that fire-protection is still required on the columns.

**Note the appearance of “b” in the primary element section**
IBC – Chapter 7

701.1 Scope. The provisions of this chapter shall govern the materials, systems and assemblies used for structural fire resistance and fire-resistance-rated construction separation of adjacent spaces to safeguard against the spread of fire and smoke within a building and the spread of fire to or from buildings. [IBC 2018 701.1]
703.2 Fire-resistance ratings. The fire-resistance rating of building elements, components or assemblies shall be determined in accordance with the test procedures set forth in ASTM E119 or UL 263 or in accordance with Section 703.3. The fire-resistance rating of penetrations and fire-resistant joint systems shall be determined in accordance Sections 714 and 715, respectively. [IBC 2018 703.2]

Rich Walke, UL on testing - Later!
Fire Test Results

- Results are published as listings in the UL or Intertek Directory.
- Describes in detail how an assembly should be constructed to achieve rating.
- Lists thickness and density needed to achieve desired hourly rating.

Book published annually
Online directory updated dynamically www.ul.com/database
UL Furnace / Loading
**703.2.3 Restrained classification.** Fire-resistance-rated assemblies tested under ASTM E119 or UL 263 shall not be considered to be restrained unless evidence satisfactory to the building official is furnished by the registered design professional showing that the construction qualifies for a restrained classification in accordance with ASTM E119 or UL 263. **Restrained construction shall be identified on the construction documents.** [IBC 2018 703.2.3]

From front of UL Directory – BXUV Guide info for Fire Resistive Ratings

“Evidence shall demonstrate that an equivalent or greater degree of thermal restraint will be provided to the building assembly during a fire condition as was provided to the tested assembly during the fire test. **Restrained conditions, defined in the UL Fire Resistance Directory, for the fire test assemblies shall have an approximate stiffness (EI/L) of 700,000 – 850,000 kip-in. along the test frame and remain constant throughout the fire test.**”

Thermal Restraint ≠ Moment Restraint

**Unless you are absolutely sure - its unrestrained**
Chapter 17 - In-Place Performance Requirements for Spray Applied Fireproofing Inspections
### Fire Protection – Physical Properties

<table>
<thead>
<tr>
<th>ASTM</th>
<th>Standard Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>E605</td>
<td>Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material</td>
</tr>
<tr>
<td></td>
<td>Applied to Structural Members</td>
</tr>
<tr>
<td>E736</td>
<td>Cohesion/Adhesion of Sprayed Fire-Resistive Material Applied to Structural Members</td>
</tr>
<tr>
<td>E759</td>
<td>Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members</td>
</tr>
<tr>
<td>E760</td>
<td>Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members</td>
</tr>
<tr>
<td>E761</td>
<td>Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members</td>
</tr>
<tr>
<td>E859</td>
<td>Air Erosion of Sprayed Fire-Resistive Material Applied to Structural Members</td>
</tr>
<tr>
<td>E937</td>
<td>Corrosion of Steel by Sprayed Fire-Resistive Material Applied to Structural Members</td>
</tr>
</tbody>
</table>
BF| 1705.14 Sprayed fire-resistant materials. *Special inspections* and tests of sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be performed in accordance with Sections 1705.14.1 through 1705.14.6.

*Special inspections* shall be based on the fire-resistance design as designated in the *approved construction documents*. The tests set forth in this section shall be based on samplings from specific floor, roof and wall assemblies and structural members.

*Special inspections* and tests shall be performed after the rough installation of electrical, automatic sprinkler, mechanical and plumbing systems and suspension systems for ceilings, where applicable.
[BF] 1705.14.1 Physical and visual tests. The special inspections and tests shall include the following to demonstrate compliance with the listing and the fire-resistance rating:

1. Condition of substrates.
2. Thickness of application.
3. Density in pounds per cubic foot (kg/m³).
5. Condition of finished application.
1705.14.4 Thickness. No more than 10 percent of the thickness measurements of the sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be less than the thickness required by the approved fire-resistance design, but in no case less than the minimum allowable thickness required by Section 1705.14.4.1.

[BF] 1705.14.4.1 Minimum allowable thickness. For design thicknesses 1 inch (25 mm) or greater, the minimum allowable individual thickness shall be the design thickness minus 1/4 inch (6.4 mm). For design thicknesses less than 1 inch (25 mm), the minimum allowable individual thickness shall be the design thickness minus 25 percent. Thickness shall be determined in accordance with ASTM E605.
1705.14.4.2 Floor, roof and wall assemblies. The thickness of the sprayed fire-resistant material applied to floor, roof and wall assemblies shall be determined in accordance with ASTM E605, making not less than four measurements for each 1,000 square feet (93 m²) of the sprayed area, or portion thereof, in each story.

Sampling of an SFRM for membrane components (floors, roofs or walls) is based on the square footage of the components. The number of samples is increased in the code by using a sampling area of every 1,000 square feet (93 m²) rather than 10,000 square feet (929 m²) as is specified in ASTM E605. This is intended to provide a higher level of confidence in the performance of the installed assembly.
1705.14.5 Density. The density of the sprayed fire resistant material shall not be less than the density specified in the approved fire-resistance design. Density of the sprayed fire-resistant material shall be determined in accordance with ASTM E605. The test samples for determining the density of the sprayed fire-resistant materials shall be selected as follows:

1. From each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet or portion thereof of the sprayed area in each story.

2. From beams, girders, trusses and columns at the rate of not less than one sample for each type of structural member for each 2,500 square feet of floor area or portion thereof in each story.
Density. An additional note – use the current version of the ASTM E 605 standard.

It is clear that certain equipment (polystyrene beads) and methodologies (drying, displacement) be used for the density testing of the sprayed fire resistant material.
1705.14.6 Bond strength. The cohesive/adhesive bond strength of the cured sprayed fire-resistant material applied to floor, roof and wall assemblies and structural members shall not be less than 150 pounds per square foot (psf) (7.18 kN/m²). The cohesive/adhesive bond strength shall be determined in accordance with the field test specified in ASTM E736 by testing in-place samples of the sprayed fire-resistant material.

The adhesion of a sprayed-on material is critical to its performance. This is the key factor in minimizing the chances of the material becoming dislodged. A minimum cohesive/adhesive bond strength of 150 psf is required AIA Master Specification and the recommendations of the General Services Administration (GSA) for durability and serviceability of the material.
1705.14.6.1 Floor, roof and wall assemblies. The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet of the sprayed area, or portion thereof, in each story.

1705.14.6.2 Structural members. The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from beams, girders, trusses, columns and other structural members at the rate of not less than one sample for each type of structural member for each 2,500 square feet of floor area or portion thereof in each story.
1705.14.6.3 Primer, paint and encapsulant bond tests. Bond tests to qualify a primer, paint or encapsulant shall be conducted when the sprayed fire-resistant material is applied to a primed, painted or encapsulated surface for which acceptable bond-strength performance between these coatings and the fire-resistant material has not been determined. A bonding agent approved by the SFRM manufacturer shall be applied to a primed, painted or encapsulated surface where the bond strengths are found to be less than required values.
1705.14.6.3 Primer, paint and encapsulant bond tests. Additional comment about primed or painted steel can be found in 704.13.3.2 Primers, paints and encapsulants.

Where the SFRM is to be applied over primers, paints or encapsulants other than those specified in the listing, the material shall be field tested in accordance with ASTM E736. Where testing of the SFRM with primers, paints or encapsulants demonstrates that required adhesion is maintained, SFRM shall be permitted to be applied to primed, painted or encapsulated wide flange steel shapes in accordance with certain conditions, related to the size of the steel and the bond strength of the material to the primed steel.
1705.15 Mastic and intumescent fire-resistant coatings. Special inspections and tests for mastic and intumescent fire-resistant coatings applied to structural elements and decks shall be performed in accordance with AWCI Technical Manual 12-B.
Thank you

• john.a.dalton@gcpat.com / 617 498 4935
  • rharvey@isolatek.com / 949 300 8120
Thank you

- john.a.dalton@gcpat.com / 617 498 4935
- rharvey@isolatek.com / 949 300 8120