Code Compliance for Fire Resistance-Rated Assemblies in Light-Frame Buildings

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**Description**

Determining the proper code application for wood-frame fire assemblies can be challenging and is often further complicated with increases in a project’s size and scale. In a building environment where the ability to maximize height and area is key to cost effectiveness, designers must understand the gamut of fire protection considerations applicable to mid- and low-rise wood structures. This presentation will include code requirements, compliance options and nuances related to assembly selection for required fire-resistance-rated floor/ceiling assemblies, exterior walls, fire barriers, fire partitions, and fire walls. Topics will include distinctions between fire-resistive elements for separation vs. class of construction.
Learning Objectives

1. Apply code requirements and intent for wood-frame fire-resistance rated assemblies.
2. Discuss the differences in exterior walls, fire walls, fire barriers, and fire partitions considering performance expectations, code requirements, and appropriate application.
3. Understand the paths to achieving code-compliant, fire-resistance rated wood-frame assemblies as outlined by the 2015 IBC.
4. Recognize important nuances in the various methods for demonstrating fire-resistance including: tested assemblies, prescriptive designs, calculations, and engineering analysis.

Outline

• Code Overview
• Background
• Fire-resistance building elements
• Achieving Fire-Resistance
The IBC
 • Controls building size
 • Regulates types of materials
 • Stipulates fire-resistance

Allowable heights & areas determined by
 • Tabular values
 • Factors allowing increases
 • Frontage
 • Sprinkler Systems
 • Special Provisions IBC 510
Allowable Heights & Areas

Allowable area is based upon

- Use of building
- Type of construction
- Frontage
- Existence of sprinkler systems

Tabular areas establish *minimum* allowable building areas that can be increased by added fire safety features - frontage and/or sprinkler.

Allowable Heights & Areas

Each occupancy group presents a different level of fire and life safety risk:

- Number of occupants
- Capability of occupants
- Fuel load
Allowable Heights & Areas

Allowable heights and areas are based on a concept of equivalent risk, involving three interdependent considerations:

- Level of fire hazard likely to be associated with the occupancy
- Nature of contents associated with the use
- Level of overall fire protection provided by the
  - Type of construction
  - Setbacks of the building from other structures (exposure)
  - Sprinklers and life safety systems
  - Other code trade-offs

2015 Code Conforming Wood Design

- Special occupancies
- Fire-resistance
- Building features
- Wood in noncombustible construction types
- Structural considerations
- Precautions during construction
- Also available for 2009 and 2012 IBC
  - [http://awc.org/codes-standards/buildingcodes/ccwd](http://awc.org/codes-standards/buildingcodes/ccwd)
California SFM CCWD Limitations:

CCWD – Limitations per CBC

- Use for Group B, F, M and S since no SFM amendments
- Not used for Group A, E, H, I, L & R
  - Exception: Group A or E – 1-2 story only check table 503
- For R-2 occupancy buildings; no height, story or area increase is allowed for NFPA 13R sprinklers. Only use CCWD tables for type VA column with NFPA 13 sprinklers with the one or two story row as applicable.
- Check AHJ!!!

TABLE 504.3: Allowable Building Height (ft above Grade)

<table>
<thead>
<tr>
<th>Occupancy Classification</th>
<th>Type of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type III</td>
</tr>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>A, B, E, F, M, S, U</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>I-1 Condition 1, 1-3</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>I-1 Condition 2, 1-2</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>I-4</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>R</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>S13R</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
</tbody>
</table>
# 2015 Code Conforming Wood Design

## TABLE 504.4: Allowable Number of Stories above Grade

<table>
<thead>
<tr>
<th></th>
<th>NS</th>
<th>3</th>
<th>2</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1, A-2, A-3, A-4</td>
<td>S</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>S</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>S</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>M</td>
<td>S</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NS</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>S13R</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>R-2</td>
<td>NS</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>S13R</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

### Notes:
- NS - nonsprinklered
- S - sprinklered (NFPA 13 System)
- S13R - sprinklered NFPA 13R requirements (NFPA 13 System)
- S1 - single-story sprinklered building (NFPA 13 System)
- SM - multifamily sprinklered building (NFPA 13 System)
### Table 601 Fire-Resistance Rating Requirements For Building Elements (hours)

<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>A</td>
</tr>
<tr>
<td>Primary structural frame</td>
<td>3a</td>
<td>2a</td>
<td>2a</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Bearing walls, Exterior</td>
<td>3a</td>
<td>2a</td>
<td>3a</td>
<td>2a</td>
<td>1</td>
</tr>
<tr>
<td>Nonbearing walls and partitions, Exterior</td>
<td>See Table 602</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions, Interior</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>Roof construction and associated secondary members</td>
<td>1-1/2b</td>
<td>1b,c</td>
<td>1b,c</td>
<td>0c</td>
<td>1b,c</td>
</tr>
</tbody>
</table>

### Exterior Walls

#### Table 602

<table>
<thead>
<tr>
<th>FIRE SEPARATION DISTANCE = X (m)</th>
<th>TYPE OF CONSTRUCTION</th>
<th>OCCUPANCY GROUP</th>
<th>OCCUPANCY GROUP 1, 2, 3</th>
<th>OCCUPANCY GROUP A, B, E, I, 2, 1, R, S, U, P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1a</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5 ≤ X &lt; 10</td>
<td>JA, LB</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>IB, VB, CB</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>X ≥ 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
- Table 601 provides fire-resistance ratings for building elements based on their type and occupancy group.
- Table 602 outlines fire-separation requirements for exterior walls based on the distance between them.
Fire Partition (708)

• A vertical assembly of materials designed to restrict the spread of fire in which openings are protected.

• Not a fire barrier and not a fire wall.

• Wall assemblies for:
  • Separation walls for Group I-1, R-1, R-2 and R-3 per section 420.2
  • Walls separating tenant spaces in covered and open mall buildings per section 402.4.2.1
  • Corridor walls per section 1020.1
  • Elevator lobby separation per section 3006.2
  • Egress balconies per section 1019.2

Fire Partition (708)

• A vertical assembly of materials designed to restrict the spread of fire in which openings are protected. cont.

• Of materials permitted by the building type of construction

• Fire-resistance rating 708.3 not less than 1 hour.

• See exceptions for corridor walls, dwelling unit separations, and sleeping unit separations
Fire Barrier (707)

- A fire-resistance-rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained
- Not a fire wall
- Of materials permitted by the building type of construction
- Fire-resistance rating 707.3 - specific ratings as indicated for shaft enclosures, interior exit stairways and ramp, enclosed exit access stairways, exit passageway, horizontal exit, atriums, incidental uses, control areas, separated occupancies, fire areas

Fire Barrier (707)

Fire-resistance rating for separation of fire areas per table 707.3.10

<table>
<thead>
<tr>
<th>OCCUPANCY GROUP</th>
<th>FIRE-RESISTANCE RATING (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-1, H-2</td>
<td>4</td>
</tr>
<tr>
<td>F-1, H-3, S-1</td>
<td>3</td>
</tr>
<tr>
<td>A, B, E, F-2, H-4, H-5, I, M, R, S-2</td>
<td>2</td>
</tr>
<tr>
<td>U</td>
<td>1</td>
</tr>
</tbody>
</table>

BUILDING AREA = FIRE AREA 1 + FIRE AREA 2
Separation of Occupancies

**TABLE 509.4**

<table>
<thead>
<tr>
<th>OCCUPANCY</th>
<th>A, E</th>
<th>I-1, I-2, I-4</th>
<th>I-2</th>
<th>R^2</th>
<th>F-2, S-2, U</th>
<th>R^2, F-1, M, S-1</th>
<th>H-1</th>
<th>H-2</th>
<th>H-2, H-4</th>
<th>H-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
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<td>N</td>
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<td>N</td>
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<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>2</td>
<td>NP</td>
<td>NP</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>NP</td>
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<td>NP</td>
<td>2</td>
<td>NP</td>
<td>NP</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>2</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

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 separate requirement.
NP = Not permitted.
a. See Section 410.
b. The required separation from areas used only for private or pleasure vehicles shall be reduced by 1 hour but not to less than 1 hour.
c. See Section 409.3.4.
d. Separation is not required between occupancies of the same classification.
e. See Section 422.2 for ambulatory care facilities.

Automatic Sprinkler Systems (903)

[F] 903.2.7 Group M. An automatic sprinkler system shall be provided throughout buildings containing a Group M occupancy where one of the following conditions exists:

1. A Group M fire area exceeds 12,000 square feet (1115 m²).
2. A Group M fire area is located more than three stories above grade plane.
3. The combined area of all Group M fire areas on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m²).
4. A Group M occupancy used for the display and sale of upholstered furniture or mattresses exceeds 5,000 square feet (464 m²).
Shaft Enclosures (713)

• Constructed as fire barriers (713.2) and continuity provisions are the same (713.5)
• Of materials permitted by the building type of construction (713.3)
• Openings and penetrations are not permitted except those necessary to serve the shaft. (713.7 and 713.8)
• 713.11 and 713.12 for special provision for enclosure at the top and bottom of the shaft.
• Fire resistance rating: Shaft enclosures shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more; not less than 1 hour where connecting less than four stories; and not less than the rating of the floor penetrated. (713.4)

Fire Walls (706)

• Define separate buildings for allowable building size (706)
  • Requires continuity from foundation through the roof and constructed to allow collapse on either side under fire conditions without collapse of the wall.
  • Not smoke barriers, smoke partitions or horizontal assemblies
  • Table 706.4 gives required ratings based on occupancy

<table>
<thead>
<tr>
<th>GROUP</th>
<th>FIRE-WALL FIRE-RESISTANCE RATINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, E, H-4, I, R-1, R-2, U</td>
<td>3*</td>
</tr>
<tr>
<td>F-1, H-3*, H-5, M, S-1</td>
<td>3</td>
</tr>
<tr>
<td>H-1, H-2</td>
<td>4*</td>
</tr>
<tr>
<td>F-2, S-2, R-3, R-4</td>
<td>2</td>
</tr>
</tbody>
</table>

a. In Type II or V construction, walls shall be permitted to have a 2-hour fire-resistance rating.
b. For Group H-1, H-2 or H-3 buildings, also see Sections 415.7 and 415.8.
Fire Walls (706.3)

- **Type V construction**
  - Fire walls may be wood frame

- **Types I, II, III and IV construction**
  - Fire walls must be of noncombustible materials in accordance with Section 706.3

Smoke Barriers (709)

- A continuous membrane, either vertical or horizontal, such as a wall, floor or ceiling assembly, that is designed and constructed to restrict the movement of smoke.

- **Vertical and horizontal smoke barriers**
  - Of materials permitted by the building type of construction
  - Mostly required in Hospital and Healthcare Facilities
  - **1 hour fire-resistance rating** Exception: Smoke barriers constructed of minimum 0.10-inch-thick (2.5 mm) steel in Group I-3 buildings. (709.3)
Horizontal Assemblies (711)

- A fire-resistance-rated floor or roof assembly of materials designed to restrict the spread of fire in which continuity is maintained.

- Of materials permitted by the building type of construction

- Fire-resistance rating - specific ratings as indicated 711.2.4 but not less than that for building type of construction: separating mixed occupancies, fire areas, dwelling units and sleeping units, smoke compartments, incidental uses, other separations.

Outline

- Code Overview
- Background
- Fire-resistance building elements
- Achieving Fire-Resistance
Methods for Determining Fire-Resistance (703)

(703.2) Tested fire assembly (ASTM E 119 or UL 263)

(703.3)

1. Fire-resistance designs documented in approved sources
2. Prescriptive assemblies using of fire-resistance-rated designs in Section 721
3. Calculation of fire-resistance per Section 722
4. Engineering analysis based on a comparison of building element, component or assembly designs that have been tested
5. Alternative protection methods per Section 104.11
6. Fire-resistance designs certified by an approved agency

Fire Tests

Tested fire assembly (ASTM E 119)

Fire Test

American Wood Council
ASTM E119 Fire Endurance Test
• 5-Ply CLT (approx. 7” thick)
• 5/8” Type X GWB each side
• Sought 2 hour rating
• RESULTS: 3 hours 6 minutes

Half-lapped – middle of panel

Fire Test

National Frame Building Association
ASTM E119 Fire Endurance Test
• 4-Ply 2x6 (approx. 6” thick)
• 2x4 girts at 16” o.c.
• 4 layers 5/8” Type X GWB each side
• RESULTS: 3 hours 47 minutes

See Frame Building News
January 2014
“NFBA ATTAIN CERTIFICATION FOR 2- AND 1-HOUR FIRE-RATED WALLS”
Documented in Approved Source

• Based on testing to the ASTM E 119 or UL 263 standard
• Choose listed assemblies from fire-resistance publications or directories

Documented in Approved Source

Fire-resistance designs - AWC Design for Code Acceptance Pubs -
Documented in Approved Source

DCA 3
Fire-Resistive Wood Wall and Floor/Ceiling Assemblies

- ASTM E 119 or UL 263
- NFPA 251

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Documented in Approved Source

**WS4-1.1 One Hour Fire-Resistive Wood-Frame Wall Assembly**

2x4 Wood Stud Wall - 100% Design Load - ASTM E 119/NFPA 251
Documented in Approved Source

**WS6-2.1 Two-Hour Fire-Resistive Wood-Frame Wall Assembly**

2x6 Wood Stud Wall – 100% Design Load – ASTM E 119/NFPA 251

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Documented in Approved Source

**APA Technical Topics**

**Load-Bearing Fire-Rated Wall Assemblies with OSB and Plywood Sheathing**

APA TT-063B

[Website Link](www.apawood.org)
Prescriptive Fire-Resistance Rated Assemblies

Fire-resistance of certain wood assemblies is prescribed in Section 721 based on testing using ASTM E 119 or UL 263

<table>
<thead>
<tr>
<th>FLOOR OR ROOF CONSTRUCTION</th>
<th>ITEM NUMBER</th>
<th>CEILING CONSTRUCTION</th>
<th>THICKNESS OF FLOOR OR ROOF SLAB (inches)</th>
<th>MINIMUM THICKNESS OF CEILING (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 hours</td>
<td>3 1/2 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Wood I-joint (minimum I-joint depth 9 1/2&quot; with a minimum flange depth of 1 1/2&quot; and a minimum flange cross-sectional area of 2.25 square inches; minimum web thickness of 3/16&quot; @ 24&quot; o.c.) Unfaced fiberglass insulation or mineral wool insulation is installed between the I-joints supported on the upper surface of the flange by stay wires spaced 12&quot; o.c.</td>
<td>28.1</td>
<td>Base layer of 5/8&quot; Type C gypsum wallboard attached directly to I-joints with 1 1/2&quot; Type S drywall screws spaced 12&quot; o.c. with ends staggered. Minimum 0.015&quot; thick hat-shaped 1/16&quot;-inch furring channel 16&quot; o.c. (channels doubled at wallboard end joints), placed perpendicular to the joint and attached to each joint by 1/2&quot; Type S drywall screws after the base layer of gypsum wallboard has been applied. The middle and face layers of 5/8&quot; Type C gypsum wallboard applied perpendicular to the channel with end joints staggered. The middle layer is fastened with 1&quot; Type S drywall screws spaced 12&quot; o.c. The face layer is applied parallel to the middle layer but with the edge joints offset 24&quot; from those of the middle layer and fastened with 1/2&quot; Type S drywall screws 8&quot; o.c. The joints shall be taped and covered with joint compound.</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Prescriptive Fire-Resistance-Rated Assemblies

Fire-resistance of certain wood assemblies is prescribed in Section 721 based on testing using ASTM E 119 or UL 263

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>ITEM NUMBER</th>
<th>CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; x 4&quot; wood studs 10' on center with two layers of 1/2&quot; regular gypsum wallboard each side, 6d common or wallboard nails at 8&quot; on center first layer, 5d common or wallboard nails at 8&quot; on center second layer with laminating compound.</td>
<td>721.1.4.a</td>
<td>— — 5</td>
</tr>
<tr>
<td>2&quot; x 4&quot; wood studs 10' on center with two layers 1/2&quot; Type X gypsum wallboard applied vertically or horizontally each side, joints staggered. Nail base layer with 6d common or wallboard nails at 8&quot; on center face layer with 6d common or wallboard nails at 8&quot; on center.</td>
<td>721.1.4.b</td>
<td>— — 5 1/2</td>
</tr>
<tr>
<td>2&quot; x 4&quot; fire retardant treated wood studs spaced 24&quot; on center with one layer of 1/2&quot; Type X gypsum wallboard applied with face paper grain (long dimension) parallel to studs. Wallboard attached with 6d common or wallboard nails at 7&quot; on center.</td>
<td>721.1.4.c</td>
<td>— — 4 1/2</td>
</tr>
</tbody>
</table>

Calculated Resistance (703.3)

- Fire-resistance of wood frame assemblies also may be calculated based on the known fire-resistance of the components, using the provisions of Section 722.6
- 1.0 hour maximum

722.6 Wood assemblies. The provisions of this section contain procedures by which the fire-resistance ratings of wood assemblies are established by calculations.
Calculated Fire Resistance (722.6)

DCA 4
Component Additive Method (CAM) for Calculating and Demonstrating Assembly Fire Endurance

722.6 Wood assemblies. The provisions of this section contain procedures by which the fire-resistance ratings of wood assemblies are established by calculations.

Calculated Fire Resistance (722.6)

CAM Membrane Table
Time Assigned to Protective Membranes
• IBC Table 722.6.2(1)
Calculated Fire Resistance (722.6)

**CAM Wood Component Table**
Assigned Times for Wood Components
IBC Table 722.6.2(2)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>TIME ASSIGNED TO FRAME (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood studs 16 inches o.c.</td>
<td>20</td>
</tr>
<tr>
<td>Wood floor and roof joints 16 inches o.c.</td>
<td>10</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm.

a. This table does not apply to studs or joists spaced more than 16 inches o.c.
b. All studs shall be nominal 2 x 4 and all joints shall have a nominal thickness of not less than 2 inches.
c. Allowable spans for joints shall be determined in accordance with Sections 2308.4.2.1, 2308.7.1 and 2308.7.2.

Calculated Fire Resistance (722.6)

**CAM Wall Membranes**
Membranes on Exterior Face of Walls
IBC Table 722.6.2(3)

<table>
<thead>
<tr>
<th>sheathing</th>
<th>paper</th>
<th>exterior finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16-inch T &amp; G lumber</td>
<td>Sheathing paper</td>
<td>Lumber siding</td>
</tr>
<tr>
<td>3/8-inch exterior glue wood structural panel</td>
<td></td>
<td>Wood shingles and shakes</td>
</tr>
<tr>
<td>1/2-inch gypsum wallboard</td>
<td></td>
<td>1/8-inch semi-rigid fiberboard</td>
</tr>
<tr>
<td>1/2-inch gypsum wallboard</td>
<td></td>
<td>1/8-inch fiberboard</td>
</tr>
<tr>
<td>1/2-inch fiberboard</td>
<td></td>
<td>1/8-inch exterior-grade wood structural panels</td>
</tr>
</tbody>
</table>

None | — | 1/8-inch exterior-grade wood structural panels |

For SI: 1 inch = 25.4 mm.
a. Any combination of sheathing, paper and exterior finish is permitted.
Calculated Fire Resistance (722.6)

CAM Cavity Insulation Table
Assigned Times for Insulation of Cavity
• IBC Table 722.6.2(5)

<table>
<thead>
<tr>
<th>TIME ASSIGNED FOR ADDITIONAL PROTECTION</th>
<th>DESCRIPTION OF ADDITIONAL PROTECTION</th>
<th>FIRE RESISTANCE (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add to the fire-resistance rating of wood stud walls if the spaces between the studs are completely filled with glass fiber mineral wool batts weighing not less than 2 pounds per cubic foot (0.6 pound per square foot of wall surface) or rockwool or slag material wool batts weighing not less than 3.3 pounds per cubic foot (1 pound per square foot of wall surface), or cellulose insulation having a nominal density not less than 2.6 pounds per cubic foot.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For SI: 1 pound/cubic foot = 16.0385 kg/m³.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CAM Example 1

Interior Wall

5/8 inch Type X gypsum wallboard = 40 minutes
Wood studs = 20 minutes
Combined Assembly Fire Resistance Rating = 60 minutes

Figure 1 Interior Wall
CAM Example 2

Floor/Ceiling with Wood Joists

![Diagram showing the structure with wood joists.](image1)

<table>
<thead>
<tr>
<th>Component</th>
<th>Fire Resistance Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch Type X Gypsum wallboard</td>
<td>25 minutes</td>
</tr>
<tr>
<td>1/2 inch Type X Gypsum wallboard</td>
<td>25 minutes</td>
</tr>
<tr>
<td>Wood joists</td>
<td>10 minutes</td>
</tr>
<tr>
<td><strong>Combined Assembly Fire Resistance Rating</strong></td>
<td><strong>60 minutes</strong></td>
</tr>
</tbody>
</table>

**Figure 2** Floor/Ceiling Assembly

CAM Example 3

Floor/Ceiling with I-joists

![Diagram showing the structure with I-joists.](image2)

<table>
<thead>
<tr>
<th>Component</th>
<th>Fire Resistance Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8 inch Type X Gypsum wallboard</td>
<td>40 minutes</td>
</tr>
<tr>
<td>5/8 inch Type X Gypsum wallboard</td>
<td>40 minutes</td>
</tr>
<tr>
<td><strong>Combined Assembly Fire Resistance Rating</strong> (limited to 1 hour per IBC 722.6.1.1)</td>
<td><strong>60 minutes</strong></td>
</tr>
</tbody>
</table>

**Figure 3** Floor/Ceiling Assembly with Prefabricated Wood I-joists

Copyright 2016 American Wood Council. All rights reserved
Calculated Fire-Resistance

Fire-resistance up to **two hours**

- Columns
- Beams
- Tension Members
- ASD only

Products

- Lumber
- Glulam
- SCL
- Decking
- CLT

---

Fire Design of Exposed Wood Members

Beam Fire Test
ASTM E 119
Calculated Fire-Resistance (722)

Chapter 16 of the National Design Specification® (NDS®)

Calculated Resistance (722)

Technical Report No. 10 (TR10)

- contains background and examples for the method
TR-10 Design Example

TR10 contains:
- decking
- beam
- column
- CLT
- etc

Fire-Resistance of Exposed Wood

16.3 Wood Connections
- Where fire endurance is required, connectors and fasteners shall be protected from fire exposure
  - Wood
  - Fire-rated gypsum board
Connections

Beam-to-column (Protection provided by membrane)

Connections

Concealed beam-to-column
Connections

Figure 3-5 Ceiling construction

Beam supporting one hour rated ceiling

Connections

Covered column connection

Figure 3-7 Column connections – covered
Connections

Concealed beam-to-girder connection

Figure 3-8 Beam to girder – concealed connection
Source: AWC TR-10

Engineering Analysis

NFBA UL V304 2- and 1-Hour Walls
• UL engineering evaluation

<table>
<thead>
<tr>
<th>Gypsum Layers and Fastener Length and Spacing</th>
<th>Length of screw @ horizontal spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hourly wall</td>
<td>3-hour</td>
</tr>
<tr>
<td>Layers per side</td>
<td>4</td>
</tr>
<tr>
<td>1st layer</td>
<td>2&quot; @ 24&quot;</td>
</tr>
<tr>
<td>2nd layer</td>
<td>2-1/2&quot; @ 24&quot;</td>
</tr>
<tr>
<td>3rd layer</td>
<td>3&quot; @ 24&quot;</td>
</tr>
<tr>
<td>4th layer</td>
<td>4&quot; @ 12&quot;</td>
</tr>
</tbody>
</table>

Table 1. UL V304: Gypsum Layers and Fastener Specifications

See Frame Building News January 2014
“NFBA ATTAINS CERTIFICATION FOR 2- AND 1-HOUR FIRE-RATED WALLS”
Columns within Wall Assembly

2018 IBC 704.2 and 704.3  No additional fireproofing required for the column in the assembly

• 704.2 Column protection (IBC 2018 text)
  • “Exception: Columns that meet the limitations of Section 704.4.1”

• 704.4.1 Light-frame construction (IBC 2018 text)
  • “Studs, columns, and boundary elements that are integral elements in walls of light-frame construction, and are located entirely between the top and bottom plates or tracks shall be permitted to have required fire-resistance ratings provided by the membrane protection provided for the wall.”
Structural Stability 705.6

May be used in almost all occupancies.

803.1.1 Interior wall and ceiling finish materials. Interior wall and ceiling finish materials shall be classified in accordance with ASTM E 84 or UL 723. Such interior finish materials shall be grouped in the following classes in accordance with their flame spread and smoke-developed indexes.

- Class A: Flame spread index 0-25; smoke-developed index 0-450.
- Class B: Flame spread index 26-75; smoke-developed index 0-450.
- Class C: Flame spread index 76-200; smoke-developed index 0-450.

Exception: Materials tested in accordance with Section 803.1.2.
### Wood Interior Finish Classification System

#### Nonsprinklered Buildings: Minimum Interior Finish Classification by Occupancy

<table>
<thead>
<tr>
<th>Location</th>
<th>Minimum Interior Finish Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Exit enclosures and exit passageways&lt;sup&gt;c&lt;/sup&gt;</td>
<td>A, B, E, I, M, R-1, R-4</td>
</tr>
<tr>
<td>Corridors</td>
<td>A&lt;sup&gt;d&lt;/sup&gt;, I-2, I-3, I-4</td>
</tr>
</tbody>
</table>

(Table 803.11)

---

#### Sprinklered Buildings: Minimum Interior Finish Classification by Occupancy<sup>a, b</sup>

<table>
<thead>
<tr>
<th>Location</th>
<th>Minimum Interior Finish Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Exit enclosures and exit passageways&lt;sup&gt;d&lt;/sup&gt;</td>
<td>I-3</td>
</tr>
<tr>
<td>Corridors</td>
<td>I-3</td>
</tr>
</tbody>
</table>

(Table 803.11)
Wood Interior Finish (803)

- Most wood species qualify as Class C or Class B.
- Wood boards and panels may meet Class A criteria when pressure treated with a fire-retardant chemical.
- AWC’s DCA-1 documents the performance.

Flame Spread

<table>
<thead>
<tr>
<th>Class I or A</th>
<th>0 - 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>fire retardant treated wood</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class II or B</th>
<th>26 - 75</th>
</tr>
</thead>
<tbody>
<tr>
<td>redwood</td>
<td>pine (other than lodge pole, ponderosa &amp; red)</td>
</tr>
<tr>
<td>cedar</td>
<td>spruce</td>
</tr>
<tr>
<td>douglas-fir</td>
<td></td>
</tr>
<tr>
<td>hem-fir</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class III or C</th>
<th>76 - 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>most other wood species</td>
<td></td>
</tr>
<tr>
<td>softwood plywood</td>
<td></td>
</tr>
<tr>
<td>hardwood plywood</td>
<td></td>
</tr>
<tr>
<td>particleboard</td>
<td></td>
</tr>
</tbody>
</table>
Smoke Developed Index

A smoke-developed index was also measured for some of the wood products listed in DCA 1. None of the products tested exceeded the limiting value of 450 commonly used in building code regulations.

Wood Interior Finish – Exceptions

• Traditional wood floor covering is exempt from interior floor finish requirements (804.1).
• Exposed portions of Type IV structural members also exempt (803.3).
Questions?

• This concludes The American Institute of Architects Continuing Education Systems Course

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