



## Building Code Requirements Regarding the Use of Fire Retardant Treated Lumber in Floor/Ceiling and Roof/Ceiling Assemblies Bearing on Exterior Walls of Type III Buildings

DRR No. 1703-10

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#### DIVISION: 06 00 00 – WOOD, PLASTICS, AND COMPOSITES

Section: 06 02 00 – Design Information

Section: 06 11 00 – Wood Framing

Section: 06 17 53 – Shop-Fabricated Wood Trusses

#### 1. Code Compliance Topic:

- 1.1. Requirements for the use of Fire Retardant Treated (FRT) Lumber in floor/ceiling and roof/ceiling assemblies bearing on exterior walls of Type III buildings.
- 1.2. For the most recent version of this report, visit [drjengineering.org](http://drjengineering.org). For more detailed state professional engineering and code compliance legal requirements and references, visit [drjengineering.org/statelaw](http://drjengineering.org/statelaw). DrJ is fully compliant with all state professional engineering and code compliance laws.
- 1.3. This report is based on practical scientific research (literature review, testing, analysis, etc.). This research report complies with the following sections of the building code:
  - 1.3.1. [IBC Section 104.11.1](#) and [Section 1703.4.2](#) – "**Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved sources.*"
  - 1.3.2. [IBC Section 202](#) – "**APPROVED SOURCE.** An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses."

#### 2. Applicable Codes and Standards:<sup>1</sup>

- 2.1. 2009, 2012, and 2015 International Building Code (IBC)

<sup>1</sup> Unless otherwise noted, all references in this research report are from the 2015 version of the codes and the standards referenced therein, including, but not limited to, ASCE 7, SDPWS and WFCM. This product also complies with the 2000-2012 versions of the IBC and IRC and the standards referenced therein. As required by law, where this research report is not approved, the building official shall respond in writing, stating the reasons this research report was not approved.

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### 3. Background:

- 3.1. [IBC Section 601](#) classifies buildings based on the type of construction used to build the structure from Type I to Type V. This report focuses on Type III construction.
- 3.1.1. Each type has a different allowable height, allowable number of stories, and allowable area limitations as shown in the [IBC Tables 504.3](#), [504.4](#), and [506.2](#)
- 3.1.2. Type I is the most fire-resistant and Type V is the least fire-resistant. Each Type of construction, except Type IV, has an A or B designation based on the fire-resistance protection applied to building elements. Group A buildings require additional fire-resistant protection compared to buildings constructed under the Group B requirements. These requirements are shown in *IBC*, [Table 601 \(Figure 1\)](#) and [Table 602 \(Figure 2\)](#).
- 3.1.3. The five different classifications exist due to their different limitations and regulations. Some buildings may consist of two different construction types, but the building will be classified as the lower of the two types present unless they incorporate special features allowing each section to be built in accordance with its Use and Occupancy. These special features typically include a method of separating the occupancies with walls specially designed to resist the movement of a fire from one compartment to another. Regardless, a building only fits the classification when it is within the limitations and meets all the requirements of that particular construction type.

| <b>TABLE 601 FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)</b> |                               |                  |                  |                |                  |   |                     |                  |   |
|--|-------------------------------|------------------|------------------|----------------|------------------|---|---------------------|------------------|---|
| BUILDING ELEMENT   | TYPE I                        |                  | TYPE II          |                | TYPE III         |   | TYPE IV             | TYPE V           |   |
|  | A                             | B                | A                | B              | A                | B | HT                  | A                | B |
| Primary structural frame <sup>f</sup> (see Section 202)                            | 3 <sup>a</sup>                | 2 <sup>a</sup>   | 1                | 0              | 1                | 0 | HT                  | 1                | 0 |
| Bearing walls  |                               |                  |                  |                |                  |   |                     |                  |   |
| Exterior <sup>e, f</sup>   | 3                             | 2                | 1                | 0              | 2                | 2 | 2                   | 1                | 0 |
| Interior   | 3 <sup>a</sup>                | 2 <sup>a</sup>   | 1                | 0              | 1                | 0 | 1/HT                | 1                | 0 |
| Nonbearing walls and partitions  | See Table 602                 |                  |                  |                |                  |   |                     |                  |   |
| Exterior   |                               |                  |                  |                |                  |   |                     |                  |   |
| Nonbearing walls and partitions  |                               |                  |                  |                |                  |   |                     |                  |   |
| Interior <sup>d</sup>  | 0                             | 0                | 0                | 0              | 0                | 0 | See Section 602.4.6 | 0                | 0 |
| Floor construction and associated secondary members (see Section 202)              | 2                             | 2                | 1                | 0              | 1                | 0 | HT                  | 1                | 0 |
| Roof construction and associated secondary members (see Section 202)               | 1 <sup>1/2</sup> <sup>b</sup> | 1 <sup>b,c</sup> | 1 <sup>b,c</sup> | 0 <sup>c</sup> | 1 <sup>b,c</sup> | 0 | HT                  | 1 <sup>b,c</sup> | 0 |

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary 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. Not less than the fire-resistance rating required by other sections of this code.

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

f. Not less than the fire-resistance rating as referenced in Section 704.10.

**Figure 1: 2015 IBC Table 601 Fire Resistance Rating Requirements for Building Elements**

| <b>TABLE 602 FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE<sup>a, d, g</sup></b> |                      |                                |  |   |
|---|----------------------|--------------------------------|--|---|
| FIRE SEPARATION DISTANCE = X (feet)   | TYPE OF CONSTRUCTION | OCCUPANCY GROUP H <sup>e</sup> | OCCUPANCY GROUP F-1, M, S-1 <sup>f</sup> | OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U <sup>h</sup> |
| X < 5 <sup>b</sup>  | All                  | 3                              | 2  | 1   |
| 5 ≤ X < 10  | IA                   | 3                              | 2  | 1   |
|   | Others               | 2                              | 1  | 1   |
| 10 ≤ X < 30   | IA, IB               | 2                              | 1  | 1 <sup>c</sup>  |
|   | IIB, VB              | 1                              | 0  | 0   |
|   | Others               | 1                              | 1  | 1 <sup>c</sup>  |
| X ≥ 30  | All                  | 0                              | 0  | 0   |

For SI: 1 foot = 304.8 mm.

a. Load-bearing exterior walls shall also comply with the fire-resistance rating requirements of Table 601.

b. See Section 706.1.1 for party walls.

c. Open parking garages complying with Section 406 shall not be required to have a fire-resistance rating.

d. The fire-resistance rating of an exterior wall is determined based upon the fire separation distance of the exterior wall and the story in which the wall is located.

e. For special requirements for Group H occupancies, see Section 415.6.

f. For special requirements for Group S aircraft hangars, see Section 412.4.1.

g. Where Table 705.8 permits nonbearing exterior walls with unlimited area of unprotected openings, the required fire-resistance rating for the exterior walls is 0 hours.

h. For a building containing only a Group U occupancy private garage or carport, the exterior wall shall not be required to have a fire-resistance rating where the fire separation distance is 5 feet (1523 mm) or greater.

Figure 2: 2015 IBC Table 602 Fire Resistance Requirements for Exterior Walls

- 3.2. Type III construction states that *exterior walls* are required to be of noncombustible materials or FRT lumber. All other components of the building including interior walls, roofs, and floors may be combustible.
- IBC 602.3 Type III.** Type III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by this code. Fire-retardant-treated wood framing complying with [Section 2303.2](#) shall be permitted within exterior wall assemblies of a 2-hour rating or less.
- 3.2.1. Some examples of noncombustible materials are concrete, brick, masonry, ceramic tiles, metals (except aluminum), magnesium, glass, mineral wool, rock wool, and more.
- 3.2.1.1. According to [IBC 703.5.1](#), noncombustible materials must pass testing according to *ASTM E136*. The commentary X1.2 of *ASTM E136* gives more background information. See [Appendix A](#).
- 3.2.2. An example of a combustible material when speaking of building construction is untreated wood.
- IBC 202 COMBUSTIBLE FIBERS:** Readily ignitable and free-burning materials.
- 3.3. Any code compliance issues not specifically addressed in this section are outside the scope of this evaluation.

4. Discussion:

4.1. By definition, the exterior wall is:

**IBC 202 EXTERIOR WALL.** A wall, bearing or nonbearing, that is used as an enclosing wall for a building, other than a *fire wall*, and that has a slope of 60 degrees (1.05 rad) or greater with the horizontal plane.

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- 4.2. Floor/ceiling assemblies are oriented horizontally and have a zero or near zero slope. Roof/ceiling assemblies are generally horizontal as well, although they may be sloped up to 60 degrees. Once a roof/ceiling assembly is sloped 60 degrees or more, it is no longer a roof/ceiling assembly, but by definition is a wall.
  - 4.2.1. For the remainder of this analysis we will refer to floor/ceiling assemblies, although the principles apply to roof/ceiling assemblies as well.
- 4.3. In platform framing, the horizontal floor/ceiling assembly bears on the exterior walls below and the exterior wall above bears on the floor ceiling assembly. The floor/ceiling assembly is separate and distinct from the exterior wall assembly.
- 4.4. The code addresses the wall assembly and the floor/ceiling assembly separately, with separate fire resistance requirements for each.
- 4.5. The floor/ceiling assembly is not part of the wall assembly as referenced in the code. They must be considered separately.
  - 4.5.1. While the floor system does bear on the wall, it is not considered part of the wall assembly.
  - 4.5.2. The fire resistance of the structure can be seen as a compartmentalized approach where the floor and ceiling provide resistance, which is independent of the wall resistance. The location of intersection does not change the minimum required rating of the independent assemblies.
  - 4.5.3. While FRT lumber is required in the exterior wall assembly, it is not required in the floor/ceiling assembly. The floor ceiling assembly is permitted to use combustible material in accordance with [IBC Section 602.3](#)
  - 4.5.4. [Figure 3](#) is an example of a code compliant intersection of a floor/ceiling assembly with an exterior wall in a building using Type III construction. In this example, the exterior wall is constructed with FRT lumber and is a 2-hour fire resistance rated wall. The intersecting floor/ceiling assembly is constructed with untreated lumber, as is the floor sheathing and the blocking between the trusses. The floor trusses and floor sheathing are part of the floor/ceiling assembly and are NOT required to be FRT lumber. The blocking is part of the floor/ceiling assembly because it is required to transfer loads from the floor diaphragm to the top plate of the wall and therefore the blocking is NOT required to be FRT lumber.

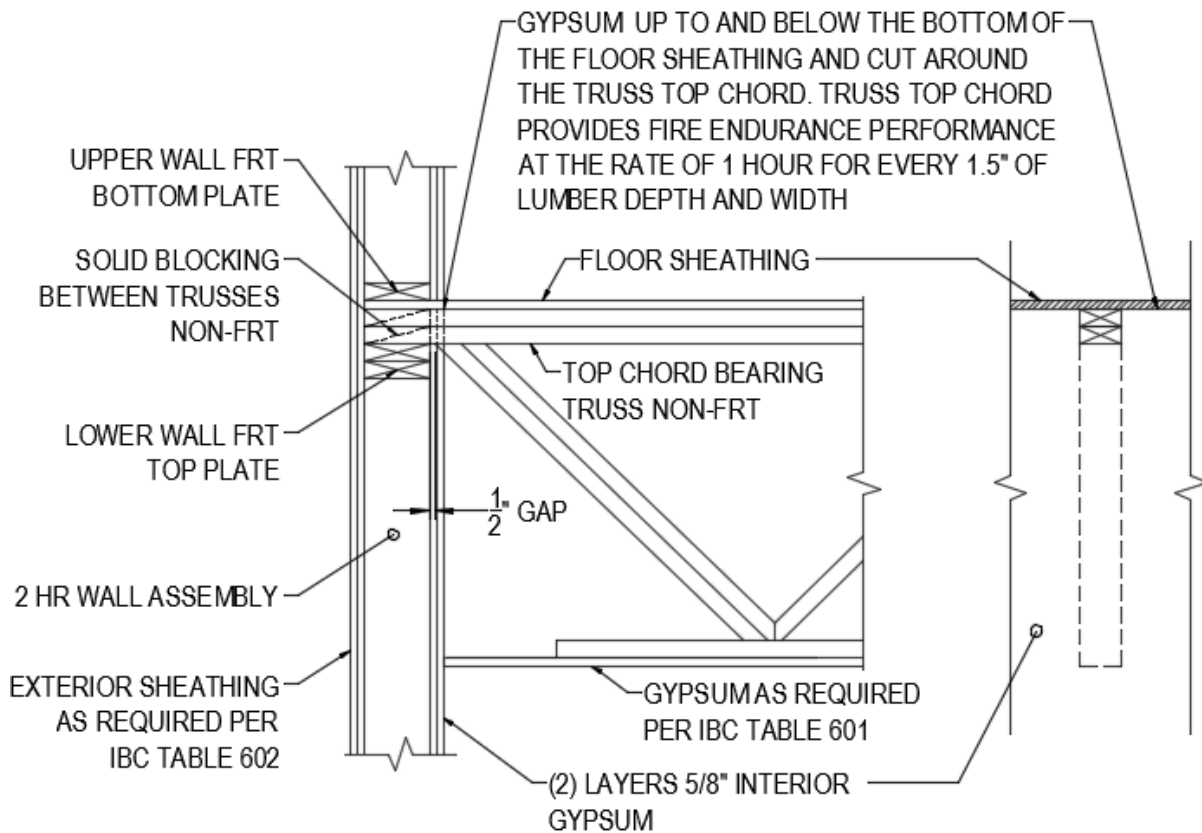


Figure 3: Top Chord Bearing Truss Intersects Rated Exterior Wall Assembly

4.5.5. Another key point is that lumber stacked in blocking has natural fire resistance characteristics. According to [IBC Section 703.2](#) the fire-resistance can be determined in accordance with [ASTM E119](#).

**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 with Sections 714 and 715, respectively.

4.5.5.1. [Chapter 17 of Wood Handbook—Wood as an Engineering Material](#) refers to the results of the standard ASTM E119 fire-test exposures. In 17-11 solid wood directly exposed to fire chars at a rate of 1-1/2" per hour, so the 3 inches of blocking has 2 hours of fire endurance performance. Heavy timber is a good example of the type of solid wood performance to expect in a stacked set of lumber elements such as the blocking.

4.5.6. Note also the intersection of the exterior wall assembly and the floor ceiling assembly must utilize a fire-resistant joint system as required in [IBC Section 715](#).

**715.1 General.** Joints installed in or between fire-resistance rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies shall be protected by an approved *fire-resistant joint system* designed to resist the passage of fire for a time period not less than the required *fire-resistance rating* of the wall, floor or roof in or between which the system is installed. *Fire-resistant joint systems* shall be tested in accordance with Section 715.3.

4.5.6.1. The intent of this section is to provide a stop for the passage of fire. In the case of the Type IIIA construction where the wall is a 2-hour rated wall and the floor/ceiling assembly is a 1-hour rated assembly, protection for 2 hours is required since it is the worst case of the two adjoining assemblies.

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**4.5.7.** As an alternate to the assembly shown in figure 3 above, one could run the interior gypsum up to the bottom side of the truss double top plate (top of the exterior wall plate). This makes installing the gypsum and the trusses easier.

**4.5.7.1.** In this case, the joints in the blocking between trusses would need to be fire stopped to prevent passage of flame between the members. The blocking itself is thick enough to withstand the fire resistance requirements based on well-established char rates of 1-½" per hour discussed in Section 4.5.5.1.

**4.6.** [IBC Section 104.11](#) and [IRC Section R104.11](#) ([IFC Section 104.9](#) is similar) state:

**104.11 Alternative materials, design and methods of construction and equipment.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code. ... Where the alternative material, design or method of construction is *not approved*, the *building official* shall respond in writing, stating the reasons the alternative was *not approved*.<sup>2</sup>

**4.7.** This detail has been evaluated with the codes listed in [Section 2](#), and is compliant with all known state and local building codes. Where there are known variations in state or local codes that are applicable to this evaluation, they are listed here:

**4.7.1.** No known variations

**4.8.** This DRR uses professional engineering law, the building code, ANSI/ASTM consensus standards and generally accepted engineering practice as its criteria for all testing and engineering analysis. DrJ's professional engineering work falls under the jurisdiction of each state Board of Professional Engineers, when signed and sealed.

## 5. Findings:

- 5.1.** The building code treats exterior wall assemblies and floor/ceiling assemblies separately with regard to the requirements for the use of FRT lumber.
- 5.2.** Exterior walls in Type III buildings are required to be non-combustible with the exception that FRT lumber is permitted in these assemblies.
- 5.3.** Floor/ceiling assemblies may be constructed of any material permitted by code including untreated lumber. FRT lumber is NOT required. This includes the floor trusses, floor sheathing, and blocking between the trusses.
- 5.4.** The intersection of the floor/ceiling assembly with the Exterior wall assembly must utilize a fire joint system in accordance with [IBC Section 715](#).

## 6. Conditions of Use:

**6.1.** Where required by the authority having jurisdiction (AHJ) in which the project is to be constructed, this report shall be submitted at the time of permit application.

**6.2.** Design

**6.2.1.** Building Designer Responsibility

**6.2.1.1.** Unless the AHJ allows otherwise, the Construction Documents shall be prepared by a Building Designer (e.g., Owner, Registered Design Professional, etc.) for the Building and shall be in accordance with [IRC Section R106](#) and [IBC Section 107](#).

**6.2.1.2.** The Construction Documents shall be accurate and reliable and shall provide the location, direction and magnitude of all applied loads and shall be in accordance with [IRC Section 301](#) and [IBC Section 1603](#).

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<sup>2</sup> The last sentence is adopted language in the 2015 codes.

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### 6.2.2. Construction Documents

6.2.2.1. Construction Documents shall be submitted to the Building Official for approval and shall contain the plans, specifications and details needed for the Building Official to approve such documents.

### 6.3. Responsibilities

- 6.3.1. The information contained herein is a product, engineering or building code compliance research report performed in accordance with the referenced building codes, testing and/or analysis through the use of accepted engineering procedures, experience and good technical judgment.
- 6.3.2. DrJ research reports provide an assessment of only those attributes specifically addressed in the Products Evaluated or Code Compliance Process Evaluated section.
- 6.3.3. The engineering evaluation was performed on the dates provided in this DRR, within DrJ's professional scope of work.
- 6.3.4. The actual design, suitability and use of this research report for any particular building is the responsibility of the Owner or the Owner's authorized agent, and the report shall be reviewed for code compliance by the Building Official.

## 7. References

- 7.1. *ANSI/TPI 1 National Design Standard for Metal Plate Connected Wood Truss Construction*, 2014, Truss Plate Institute.
- 7.2. *ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*
- 7.3. International Building Code; International Code Council; 2015.
- 7.4. The Wood Products Council, 2016, "Practical, Code-Compliant Detailing for Mid-Rise Wood Structures." from <http://www.woodworks.org/wp-content/uploads/15LL11-Practical-Code-Compliant-Detailing-for-Mid-Rise-Wood-Structures.pdf>
- 7.5. Forest Products Laboratory. 1999. *Wood Handbook—Wood as an Engineering Material*. Gen. Tech. Rep. FPL–GTR–113. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 463 p. <https://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr113/ch17.pdf>

## 8. Review Schedule:

- 8.1. This research report is subject to periodic review and revision. For the most recent version of this report, visit [drjengineering.org](http://drjengineering.org).
- 8.2. For information on the current status of this report, contact [DrJ Engineering](http://DrJEngineering.com).

**Appendix A**  
**Commentary to ASTM E136**

**X1.2 Definition**

**X1.2.1** Most dictionaries have defined “noncombustible” in simple terms, such as that used in the 1920 edition of the National Building Code promulgated by the National Board of Fire Underwriters (NBFU): Incombustible materials or construction are those that “will not ignite or burn when subjected to fire.” In 1943 the same code redefined incombustible construction as “assemblies which do not involve materials of such kind or quantity or so contained as to burn during exposure in a test fire or continue flaming or ignite after the furnace is shut off.”

**X1.2.2** About this same time Committee C05 (now E05) and the New York City Building Code suggested adding a reference of 649°C (1200°F) as the fire exposure temperature. By 1949 the term “incombustible” was changed to noncombustible in the National Building Code without definition. The first edition of the BOCA Basic Building Code (1950) defined a noncombustible material as “any material which will neither ignite or actively support combustion in air at a temperature of 649°C [1200°F] during an exposure of five minutes in a vented tube or vented crucible furnace.”

**X1.2.3** The 1955 edition of the NBFU National Building Code established a definition for noncombustible materials that was subsequently adopted by other model codes, the Life Safety Code<sup>4</sup>, and most local codes. The adopted definition was as follows:

Noncombustible as applied to a building construction material means a material that, in the form in which it is used, falls in one of the following groups (a) through (c). It does not apply to surface finish materials nor to the determination of whether a material is noncombustible from the standpoint of clearances to heating appliances, flues or other sources of high temperature. No material shall be classed as noncombustible which is subject to increase in combustibility or flame spread rating beyond the limits herein established, through the effects of age, moisture or other atmospheric condition. Flame spread rating as used herein refers to ratings obtained in accordance with Test Method E84.

a) Materials no part of which will ignite and burn when subjected to fire. Any material that liberates flammable gas when heated to a temperature of 750°C (1382°F), for 5 min shall not be considered noncombustible within the meaning of this paragraph.

b) Materials having a structural base of noncombustible material, as defined in (a), with a surfacing not over 1/8-in. thick that has a flame spread rating not higher than 50.

c) Materials, other than as described in (a) or (b), having a surface flame spread rating not higher than 25 without evidence of continued progressive combustion and of such composition that surfaces that would be exposed by cutting through the material in any way would not have a flame spread rating higher than 25 without evidence of continued progressive combustion.

**X1.2.4** In adopting this definition, NBFU stated that it was based on a determination of which materials “could be properly classed as noncombustible and then fixing the qualifying conditions in the definition to include these materials.” The definition was considered to apply to materials used for the walls, roofs, or other structural parts of buildings, but not to surface finish materials and not to the determination of whether a material is noncombustible from the standpoint of clearances to heating appliances, flues, or other sources of high temperature.

**X1.2.5** After Test Method E136 was promulgated, (initially as a tentative in 1958, then as a full standard in 1965), many building codes replaced either part (a) of the NBFU definition or the entire definition with the specification that materials shall have been successfully tested in accordance with Test Method E136. In 1973, the American Insurance Association (successor to NBFU) introduced a definition of a limited combustible material and redefined a noncombustible material as one that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat.

**X1.2.6** To avoid misinterpretation in the use of the term “noncombustible”, Committee E05 has decided to limit the use of this term, and it was eliminated from the title and text of Test Method E136 in 1979. The current title provides a more specific description of the restricted nature of the test method.

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<sup>3</sup> “Definition of Noncombustible Building Construction Material,” *Special Interest Bulletin No. 294*, revised August 1967, American Insurance Assn., New York, NY.

<sup>4</sup> “Life Safety Code,” *NFPA 101*, National Fire Protection Assn., Quincy, MA 1976.