

**CONST-181**

# **Building Code Interpretation:**

## **Non-Structural**

# Building Code History - Introduction

The modern form of a building code. That is, a code of rules and regulations laid out in book form, for ease of reference and uniformity of application, in the post-industrial world.

This is the Code of Hammurabi, which did include rules for buildings and construction, but this is not what we're studying today!



Deuteronomy 22:8 – “*When you build a new house, make a parapet around your roof so that you may not bring the guilt of bloodshed on your house if someone falls from the roof.*”

Even the Bible has what some would consider “building codes” – but again, not what we’re studying today.

# Insurance Companies and Fire Underwriters

By the end of the 1800's, insurance companies, mainly fire underwriters, discovered the need for reasonable building regulation after numerous large-scale fires damaged and destroyed cities across the nation.

## The 1835 Great Fire of New York

*“...one of three fires that rendered extensive damage to New York City in the 18th and 19th centuries. The fire occurred in the middle of an economic boom, covering 17 city blocks, killing two people, and destroying hundreds of buildings, with an estimated \$20 million of property damage (equivalent to \$528 million in 2019).”*

*([https://en.wikipedia.org/wiki/Great\\_Fire\\_of\\_New\\_York](https://en.wikipedia.org/wiki/Great_Fire_of_New_York))*

## The St. Louis Fire of 1849

*“...a devastating fire that occurred on May 17, 1849 and destroyed a significant part of St. Louis, Missouri and many of the steamboats using the Mississippi River and Missouri River.[1] This was the first fire in United States history in which it is known that a firefighter was killed in the line of duty).”*

*[[https://en.wikipedia.org/wiki/St.\\_Louis\\_Fire\\_\(1849\)](https://en.wikipedia.org/wiki/St._Louis_Fire_(1849))]*

# Insurance Companies and Fire Underwriters

The 1835 Great  
Fire of New York



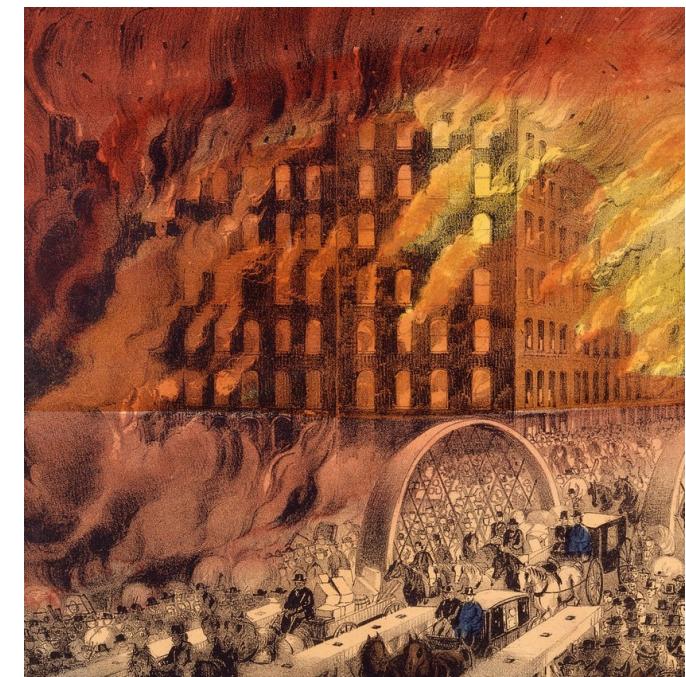
# Insurance Companies and Fire Underwriters

## The San Francisco Fire of 1851

*“...a catastrophic conflagration that destroyed as much as three-quarters of San Francisco, California.”*  
[\(\[https://en.wikipedia.org/wiki/San\\\_Francisco\\\_Fire\\\_of\\\_1851\]\(https://en.wikipedia.org/wiki/San\_Francisco\_Fire\_of\_1851\)\)](https://en.wikipedia.org/wiki/San_Francisco_Fire_of_1851)

## The Great Chicago Fire, 1871

*“...a conflagration that burned in the American city of Chicago during October 8–10, 1871. The fire killed approximately 300 people, destroyed roughly 3.3 square miles of the city, and left more than 100,000 residents homeless.”*  
[\(\[https://en.wikipedia.org/wiki/Great\\\_Chicago\\\_Fire\]\(https://en.wikipedia.org/wiki/Great\_Chicago\_Fire\)\)](https://en.wikipedia.org/wiki/Great_Chicago_Fire)





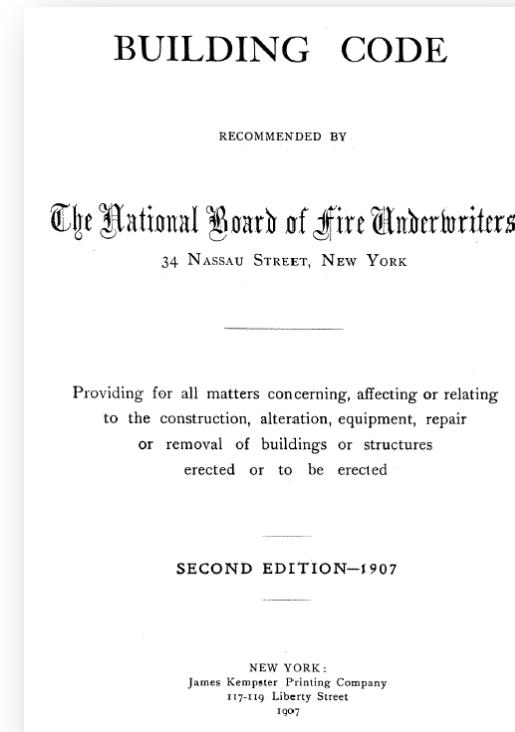
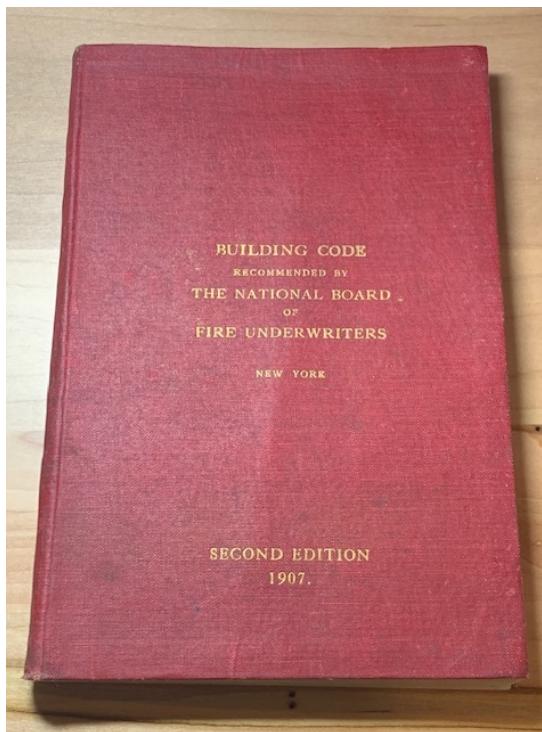
## **Insurance Companies and Fire Underwriters**

There were no City or State enforced building codes at that time, but it became very clear in the second half of the 19<sup>th</sup> century that building standards and regulations were necessary to provide for the health, safety, and welfare of the public due to fire hazards inherent in dense urban cities filled with combustible construction.

Before municipal regulation, insurance companies used their own incentives to push for safer buildings.

In essence, if you wanted your building insured, you would have to comply with the insurance company's rules and regulations.

# Fire Underwriters Building Code – 1905-1976



First edition  
printed in 1905  
  
Developed into  
the "National  
Building Code,"  
with the final  
edition published  
in 1976.

# Fire Underwriters Building Code - 1907

## FOREWORD

In the belief that safe and good construction of buildings should be universally recognized as of the utmost importance, this Building Code, prepared and recommended by the undersigned Committee, is based on broad principles which have been sufficiently amplified to provide for varying local conditions in towns as well as in cities.

The benefits to be derived from uniform building laws throughout the country lead the Committee to urge the adoption of this code in its entirety. In small towns or cities where there is no Department of Buildings, it might be enforced through a Bureau of Buildings under the jurisdiction of the Fire Department, the words: "Commissioner of Buildings" being changed to "Superintendent" or "Inspector of Buildings." In like manner other provisions may be changed to meet local requirements, at the same time maintaining essential recommendations.

In presenting this Building Code, the Committee realizes that perfection has not been attained. It soliciting criticisms, it became apparent that changes might be made indefinitely. The Committee, therefore, decided to present the Code in this form, knowing that the National Board of Fire Underwriters will closely follow the evolution of building construction and the introduction of new materials and patent devices and through amended editions be able in future to suggest to the public the newest and safest methods of construction.

Thousands of human lives and millions of dollars' worth of property have been sacrificed by the criminal folly of erecting unsafe or defective buildings. So long as those in authority permit such buildings to be erected, neither life nor property can be safe. A remedy safeguarding both may be found in this book. The vital importance of its principles should arouse municipal authorities everywhere to a realizing sense of their duty and to the grave responsibility that rests upon them to enact and enforce adequate building laws for the protection of life and property.

The Committee fully appreciates the assistance of those who have contributed suggestions and especially the valuable help rendered by F. C. Moore, former Chairman of the Committee, and Captain John Stephen Sewall, Corps of Engineers

United States Army, who have willingly given the benefit of their expert knowledge and large experience.

C. G. SMITH, Chairman,

GEORGE R. CRAWFORD, B. R. STILLMAN,  
C. S. HOLLINSHEAD, N. S. BARTOW,  
A. G. McILWAINE, Jr., E. T. CAIRNS,  
Committee on Construction of Buildings,  
National Board of Fire Underwriters.

## BUILDING CODE

*The City Council of the city of . . . . . do ordain as follows :*

### PART I.

#### A REMEDIAL ORDINANCE

##### SECTION 1.

This Ordinance to be Known and Cited as the Building Code.

The following provisions shall constitute and be known as The Building Code, and may be cited as such and presumptively provides for all matters concerning, affecting or relating to the construction, equipment, alteration, repair or removal of buildings or structures erected or to be erected in the city of . . . . .

##### SECTION 2.

Building Code a Remedial Ordinance.

This ordinance is hereby declared to be remedial, and is intended to secure the beneficial interests and purposes thereof.



# Fire Underwriters Building Code - 1907

No classification of  
Construction Types, or  
Occupancy Groups

## THE BUILDING CODE.

### PART I.

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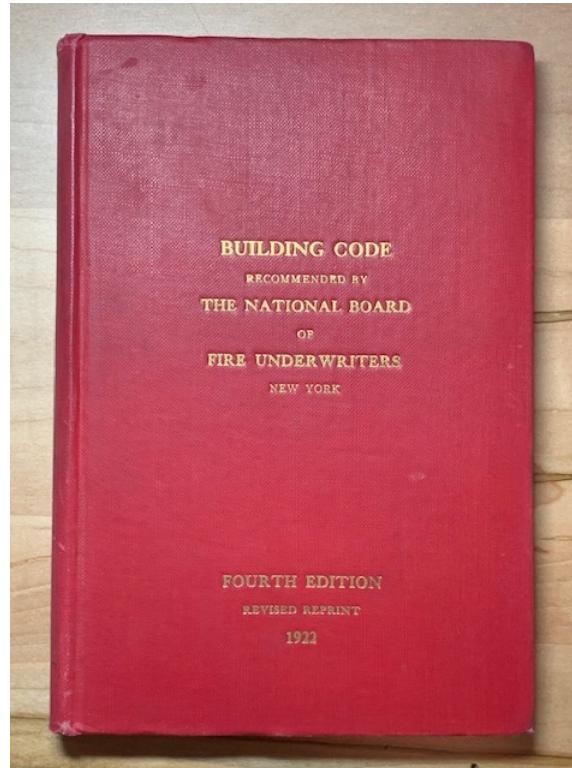
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# Fire Underwriters Building Code - 1922



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As this code continued to develop, ideas such as classifying a building by its use ("occupancy") and what it's made of (construction type) became standards for building classification.



# Fire Underwriters Building Code - 1922

## PART III.

### CLASSIFICATION OF BUILDINGS.

#### Section 10. Classification of Buildings by Construction.

1. For the purposes of this Code buildings shall be classified according to the method of construction as follows:

- I. Frame Construction.
- II. Non-Fireproof Construction.
  - a. Ordinary Construction.
  - b. Mill Construction.
- III. Fireproof Construction.

2. *Frame Construction.* A building having the exterior walls or portions thereof of wood; also a building with wooden framework veneered with brick, stone, terra cotta, or concrete; or covered with plaster, stucco, or sheet metal, shall be classed as a frame building.

*Frame buildings, Secs. 187-192.*

3. *Non-Fireproof Construction.* The term "Non-Fireproof Construction" shall apply to all buildings or structures having exterior masonry walls with floors and other interior construction wholly or in part of wood.

(a) *Ordinary Construction.* A building having masonry walls, with floors and partitions of wooden joist and stud construction. The supporting posts and girders may be of wood, or of metal protected as required in Section 114.

(b) *Mill Construction.* (Sometimes called "Slow-burning Construction.") A building having masonry walls, and heavy timber interior construction. See Section 102.

4. *Fireproof Construction.* Buildings of masonry, steel, or reinforced concrete construction in accordance with Sections 110 to 173, shall be considered fireproof.

## Three Construction Types, Three Occupancy Groups

#### Section 11. Classification of Buildings by Occupancy.

1. All buildings shall be classified according to their occupancy or use under one of the three following groups: Public Buildings, Residence Buildings, and Business Buildings. These groups shall be further sub-divided into six classes, two in each group, designated as A, B, C, D, E and F, as follows:

##### I. Public Buildings:

- Class A,
- Class B.

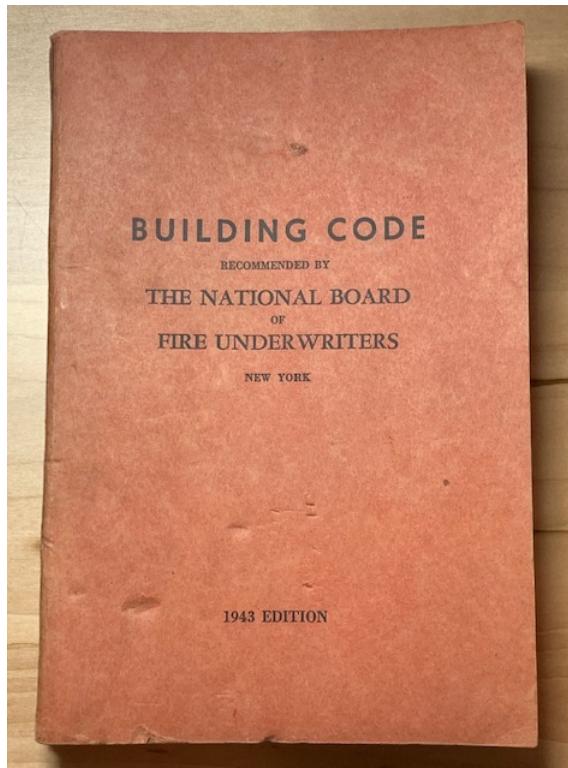
##### II. Residence Buildings:

- Class C,
- Class D.

##### III. Business Buildings:

- Class E,
- Class F.

# Fire Underwriters Building Code - 1943



## ARTICLE I

### ADMINISTRATION

#### SECTION 100. SCOPE.

1. **Short title.** This ordinance shall be known and may be cited as "THE BUILDING CODE."

2. **Matter covered.** This ordinance presumptively provides for matters concerning, affecting or relating to the construction, alteration, repairs, removal, demolition, equipment, use and occupancy, location and maintenance of buildings or structures, erected or to be erected in the municipality, except in so far as such matters are otherwise provided for in the municipal charter, in other statutes or ordinances, or in rules duly promulgated under the provisions of this ordinance.

**NOTE.**—The name of the municipality adopting this ordinance should be substituted in this paragraph for the term "municipality." Wherever the term occurs elsewhere in the text it might well be retained so long as the term is defined. See §200—Definitions.

3. **Ordinance remedial.** This ordinance is hereby declared to be remedial, and shall be construed to secure the beneficial interests and purposes thereof, which are public safety, health and welfare, through structural strength and stability, means of egress, adequate light and ventilation and safety to life and property from fire and hazards incident to the design, construction, alteration, repair, removal or demolition of buildings or structures.

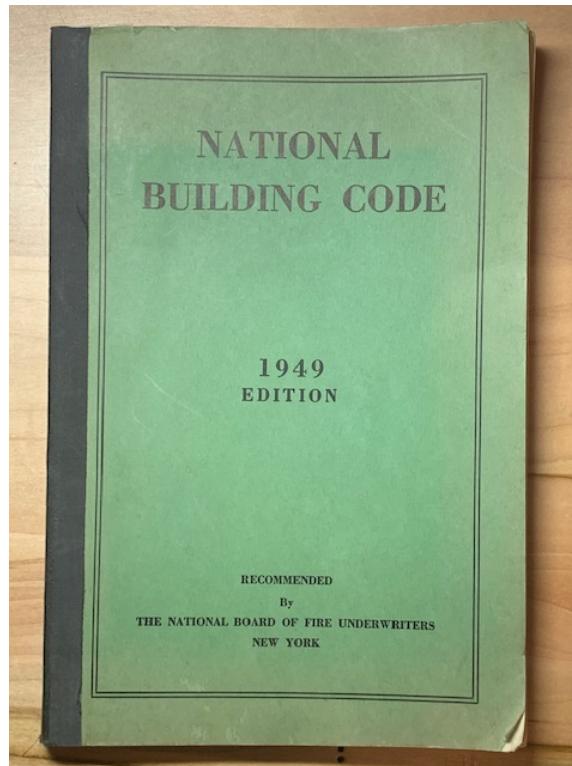
# Fire Underwriters Building Code - 1943

Section 403

## ALLOWABLE HEIGHTS OF BUILDINGS. See §1702 re sprinklers and §403-8 for exceptions.

Classes of Occupancy	CLASSES OF CONSTRUCTION						
	Fireproof	Semi-Fireproof	Heavy Timber	Ordinary	Light Noncombustible	Frame	Unprotected Metal
Public(a) Buildings	No Limit	75 Feet		Three Stories Nor More Than 35 Feet Churches—Two Stories Nor More Than 45 Feet Schools—Two Stories Theatres—See Note (d) below		Two Stories Nor More Than 30 Feet	One Story
Institutional Buildings	No Limit	75 Feet		Two Stories Nor More Than 35 Feet See Note (d) below		One Story Nor More Than 35 Feet See Note (d) below	One Story
Residence Buildings	No Limit	75 Feet	75 Feet	Three Stories Nor More Than 45 Feet See Note (b) below	Three Stories Nor More Than 45 Feet	Two Stories Nor More Than 35 Feet Dwellings Not to Exceed Three Stories	One Story
Business(a) Buildings	No Limit	75 Feet	75 Feet	Four Stories Nor More Than 50 Feet		25 Feet	One Story
Storage(a) Buildings	No Limit	50 Feet See Note (c) below	35 Feet See Note (c) below	35 Feet See Note (c) below		One Story Nor More Than 25 Feet	One Story

# Fire Underwriters National Building Code - 1949



## CLASSIFICATION OF OCCUPANCIES AND CONSTRUCTION.

### SECTION 300. CLASSIFICATION OF OCCUPANCIES.

1. Classes designated. For the purposes of this code, buildings are classified, with respect to occupancy and use, as public buildings, institutional buildings, residence buildings, business buildings and storage buildings.

(a). Public building means a building in which persons congregate for civic, political, educational, religious, social or recreational purposes; including among others,

armories	court houses	museums
assembly halls	dance halls	passenger stations
auditoriums	exhibition buildings	recreation piers
bath houses	grandstands	restaurants
bowling alleys	gymnasiums	schools
churches	lecture halls	skating rinks
city halls	libraries	stadiums
club rooms	lodge rooms	theatres
colleges	motion picture	
	theaters	

(b). Institutional building means a building in which persons are harbored to receive medical, charitable or other care or treatment, or in which persons are held or detained by reason of public or civic duty, or for correctional purposes; including among others,

asylums	infirmaries	penal institutions
homes for the aged	jails	reformatories
hospitals	nurseries	sanitariums
houses of correction	orphanages	

Construction Types and Occupancy Groups continued to develop over the decades.

# Fire Underwriters National Building Code - 1949

(c). **Residence building**, except when classed as an institutional building, means a building in which sleeping accommodations are provided; including among others,

apartments	dormitories	multifamily houses
club houses	dwellings	studios
convents	hotels	tenements
	lodging houses	

(d). **Business building** means a building occupied for the transaction of business, for the rendering of professional services, for the display or sale of goods, wares or merchandise, or for the performance of work or labor; including among others,

bakeries	gasoline service	power plants
banks	stations	radio stations
barber shops	ice plants	smoke houses
chemical laboratories	laboratories	stores
creameries	laundries	telephone exchanges
electric substations	markets	television stations
factories	office buildings	work shops
	open air stores	

(e). **Storage building** means a building for the housing, except for purely display purposes, of airplanés, automobiles, railway cars or other vehicles of transportation, for the sheltering of horses, live stock or other animals, or exclusively for the storage of goods, wares or merchandise, not excluding in any case offices incidental to such uses; including among others,

barns	garages	grain elevators
cold storage	gasoline bulk	hangars
freight depots	stations	storage warehouses

2. **Mixed Occupancy.** Where a minor portion of a building is used for office, study, studio or other similar purpose, the building shall be classified as to occupancy on the basis of the major use. In other cases where a building is occupied for two or more purposes not included in one class, the provisions of this code applying to each class of occupancy shall apply to such parts of the building as come within that class; and if there should be conflicting provisions, the requirements securing the greater safety shall apply.

3. **Doubtful classification.** In case a building is not specifically provided for, or where there is any uncertainty as to its classification, its status shall be fixed by a duly promulgated rule giving due regard to safety.

# Fire Underwriters National Building Code - 1949

## SECTION 301. CLASSIFICATION OF CONSTRUCTION.

1. Types designated. For the purposes of this code, construction as used in buildings shall be classified as follows:

- (a). Fireproof Construction.
- (b). Semifireproof Construction.
- (c). Heavy Timber Construction.
- (d). Ordinary Construction.
- (e). Noncombustible Construction.
- (f). Wood Frame Construction.
- (g). Unprotected Metal Construction.

From three construction types in 1922 to seven construction types in 1949

## SECTION 301. CLASSIFICATION OF CONSTRUCTION.

1. Types designated. For the purposes of this code, construction as used in buildings shall be classified as follows:

- Type 1A (a). Fireproof Construction.
- Type 1B (b). Semifireproof Construction.
- Type IV (c). Heavy Timber Construction.
- Type III (d). Ordinary Construction.
- Type II-A (e). Noncombustible Construction.
- Type V (f). Wood Frame Construction.
- Type II-B (g). Unprotected Metal Construction.



General equivalents; not exact

General Equivalents to current construction types

# Chapter 1 & 35: Learning Objective

To obtain an understanding of the administrative provisions of the International Building Code.

- Understand the scope and purpose of the code,
- Duties of the building official
- Issuance of permits
- Inspection procedures
- Special inspections
- Existing buildings and referenced standards.

# Chapter 1 & 35: Learning Objective

One rainy day in June of 1917, a Dan Rice Circus group was headed along Route 30, as Old Ridge Road was known then, traveling from Sodus to Wolcott for the next show. With every good circus, there are big animals, and what would a circus be without an entertaining elephant? When the travelers got to the bridge over Sodus Bay, the elephant refused to walk across the bridge. The animal trainers could not convince the elephant to cross, so ultimately the group took the elephant on an alternate route through back farmland roads to Wolcott. A newspaper article in the June 1917 Lake Shore News related that the Sodus Bay Bridge was in poor condition and the elephant did not believe it safe to cross.

# Chapter 1 & 35: Learning Objective

- Elephant Cross the Bridge



Source: 2021 IBC

# IBC Appendix

If there is a conflict in the code between a general requirement and a specific requirement, the \_\_\_\_\_ requirement shall apply.

- a. general
- b. specific
- c. least restrictive
- d. most restrictive

# **Class 2: Chapter 3, Section 508/509: Learning Objective**

## 302.1 Occupancy Classification

- Assembly (see Section 303): Groups A-1, A-2, A-3, A-4 and A-5.
- Business (see Section 304): Group B.
- Educational (see Section 305): Group E.
- Factory and Industrial (see Section 306): Groups F-1 and F-2.
- High Hazard (see Section 307): Groups H-1, H-2, H- 3, H-4 and H-5.
- Institutional (see Section 308): Groups I-1, I-2, I-3 and I-4.
- Mercantile (see Section 309): Group M.
- Residential (see Section 310): Groups R-1, R-2, R-3 and R-4.
- Storage (see Section 311): Groups S-1 and S-2.
- Utility and Miscellaneous (seeSection312):GroupU

# 303.1 Occupancy Classification

## Group A-1

Motion picture theaters  
Theaters  
Symphony and  
concert halls

## Group A-3

Amusement arcades  
Art galleries  
Bowling alleys  
Places of worship  
Community halls  
Conference rooms  
Exhibition halls  
Lecture halls  
Libraries  
Museums  
Passenger stations

## Group A-4

Arenas  
Skating rinks  
Swimming pools  
Tennis courts

## Group A-2

Banquet halls  
Casino gaming areas  
Night clubs  
Restaurants  
Taverns

## Group A-5

Amusement park  
structures  
Bleachers  
Grandstands  
Stadiums

Unique conditions are represented by the classifications of Groups A-1, A-2, A-4 and A-5. However, the category Group A-3 includes a variety of broad and diverse assembly uses. It is not uncommon to find high combustible loading in Group A-3 occupancies.

# 304.1 Occupancy Classification: Group B

## Group B

- Ambulatory care facilities
- Animal hospitals, kennels and ponds
- Banks
- Barber and beauty shops
- Car wash
- Civil administration
- Clinic-outpatient
- Educational occupancies above the 12th grade
- Food processing  $\leq$  2,500 sf
- Laboratories; testing and research
- Motor vehicle showrooms
- Post offices
- Print shops
- Professional services
- Radio and television stations
- Training and skill development

## 305.1 Occupancy Classification: Group E

- Educational Group E occupancy includes, among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade. This group includes buildings and structures or portions thereof occupied by more than five children older than 2½ years of age who receive educational, supervision or personal care services for fewer than 24 hours per day.
- Educational occupancies include classroom uses for students of high school age and younger.
- Education facilities limited to use by older students, such as college classrooms, are classified as Group B occupancies; however, a Group A classification should be considered for lecture halls and similar large occupant load spaces.

# 306.1 Occupancy Classification: Group F

## Group F-1

- Aircraft
- Appliances
- Automobiles
- Bakeries
- Business machines
- Carpets and rugs
- Clothing
- Electric generation
- ESS (dedicated use)
- Food processing > 2,500 sf
- Furniture
- Laundries
- Millwork
- Paper mills or products
- Plastic products
- Printing or publishing
- Refuse incineration
- Textiles
- Water/sewer treatment
- Woodworking

## Group F-2

- Brick and masonry
- Ceramic products
- Foundries
- Glass products
- Gypsum
- Ice
- Metal products

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Classification as a Group F-2 occupancy is strictly limited because of the restrictions placed on such uses. The fabrication or manufacture of noncombustible materials, as well as their finishing, packaging or processing operations, cannot involve a significant fire hazard.

## 307.1 Occupancy Classification: Group H

- High-hazard Group H occupancy includes, among others, the use of a building or structure, or a portion thereof, that involves the manufacturing, processing, generation or storage of materials that constitute a physical or health hazard in quantities in excess of those allowed in control areas complying with Section 414, based on the maximum allowable quantity limits for control areas set forth in Tables 307.1(1) and 307.1(2).
- There is only one fundamental type of Group H occupancy—that which is designated based solely on excessive quantities of hazardous materials contained therein. The quantities of hazardous materials that necessitate a Group H classification vary, based on the type, quantity, condition (use or storage) and environment of the materials. Where the use does not exceed the maximum allowable quantities set forth in the code, a classification other than Group H is appropriate.

## 307.1 Occupancy Classification: Exceptions to Group H

Four other options are available to further increase the quantities of hazardous materials in any building:

- Provide additional control areas as limited by Table 414.2.2,
- Provide one or more fire walls in conformance with Section 706,
- Apply the allowances for unlimited quantities in Section 307.1.1,
- Construct the building as required for a Group H occupancy.

# 309.1 Occupancy Classification: Group I

## **Group I-1**

Alcohol and drug centers  
Assisted living facilities  
Congregate care facilities  
Group homes  
Halfway houses  
Residential board and care facilities  
Social rehabilitation facilities

## **Group I-2**

Foster care facilities  
Detoxification facilities  
Hospitals  
Nursing homes  
Psychiatric hospitals

## **Group I-3**

Correctional centers  
Detention centers  
Jails  
Prerelease centers  
Prisons  
Reformatories

## **Group I-4**

Adult day care  
Child day care

# 309.1 Occupancy Classification: Group M

## **Group M**

- Department stores
- Drug stores
- Greenhouses (display and sale)
- Markets
- Motor fuel-dispensing facilities
- Retail or wholesale stores
- Sales rooms

# 310 Occupancy Classification: Group R

## Group R-1

Boarding houses (transient)  
    > 10 occupants  
Congregate living facilities (transient) > 10 occupants  
Hotels (transient)  
Motels (transient)

## Group R-2

Apartment houses  
Congregate living facilities (nontransient)  
    > 16 occupants  
Hotels (nontransient)  
Live/work units  
Motels (nontransient)  
Vacation timeshare properties

## Group R-3

Buildings with  $\leq$  two dwelling units  
Care facilities  $\leq$  5 persons receiving care  
Congregate living facilities (nontransient)  $\leq$  16 occupants  
Congregate living facilities (transient)  $\leq$  10 occupants  
Lodging houses with  $\leq$  5 guest rooms and  $\leq$  10 occupants

## Group R-4

Alcohol and drug centers  
Assisted living facilities  
Congregate care facilities  
Convalescent facilities  
Group homes  
Halfway houses  
Residential board and custodial care facilities  
Social rehabilitation facilities

# 311 Occupancy Classification: Group S

## Group S-1

Aerosols products  
Level 2 and Level 3  
Aircraft repair hangar  
Bags; cloth, burlap, paper  
Belting; canvas, leather  
Books  
Paper in rolls  
Cardboard and cardboard boxes  
Clothing  
Furniture  
Grains  
Lumber  
Motor vehicle repair garages  
Self-service storage facility  
Tires, bulk storage of  
Tobacco, cigars, cigarettes  
Upholstery and mattresses

## Group S-2

Aircraft hangar  
Asbestos  
Cement in bags  
Chalk and crayons  
Dairy products  
Dry cell batteries  
Electric motors  
Food products  
Fresh fruits and vegetables  
Frozen foods  
Glass  
Gypsum board  
Meats  
Metals  
Open parking garages  
Enclosed parking garages  
Porcelain and pottery

# 312 Occupancy Classification: Group U

Group U
Agricultural buildings
Barns
Carports
Fences more than 7 feet in height
Livestock shelters
Private garages
Retaining walls
Sheds
Stables
Tanks
Towers

## 508.1 Occupancy Classification: Mixed Occupancies

- Each portion of a building shall be individually classified in accordance with Section 302.1. Where a building contains more than one occupancy group, the building or portion thereof shall comply with the applicable provisions of Section 508.2 (Accessory Occupancies), 508.3 (Nonseparated Occupancies), 508.4 (Separated Occupancies), or 508.5 (Live/Work Units), or a combination of these sections. See the exceptions for: (1) occupancies separated in accordance with Section 510 (Special Provisions), and (2) Group H- 1, H-2 and H-3 occupancies required by Table 415.6.5 to be located in a separate and detached building.
- It is not uncommon for two or more distinct occupancy classifications to occur in the same building. Where such conditions exist, the code requires that such multiple occupancies be either (1) isolated from each other using fire-resistive separation elements (fire barriers and/or horizontal assemblies), or (2) imposed with special provisions that eliminate the need for such fire separations.

# **Class 3: Chapter 6 Type of Construction**

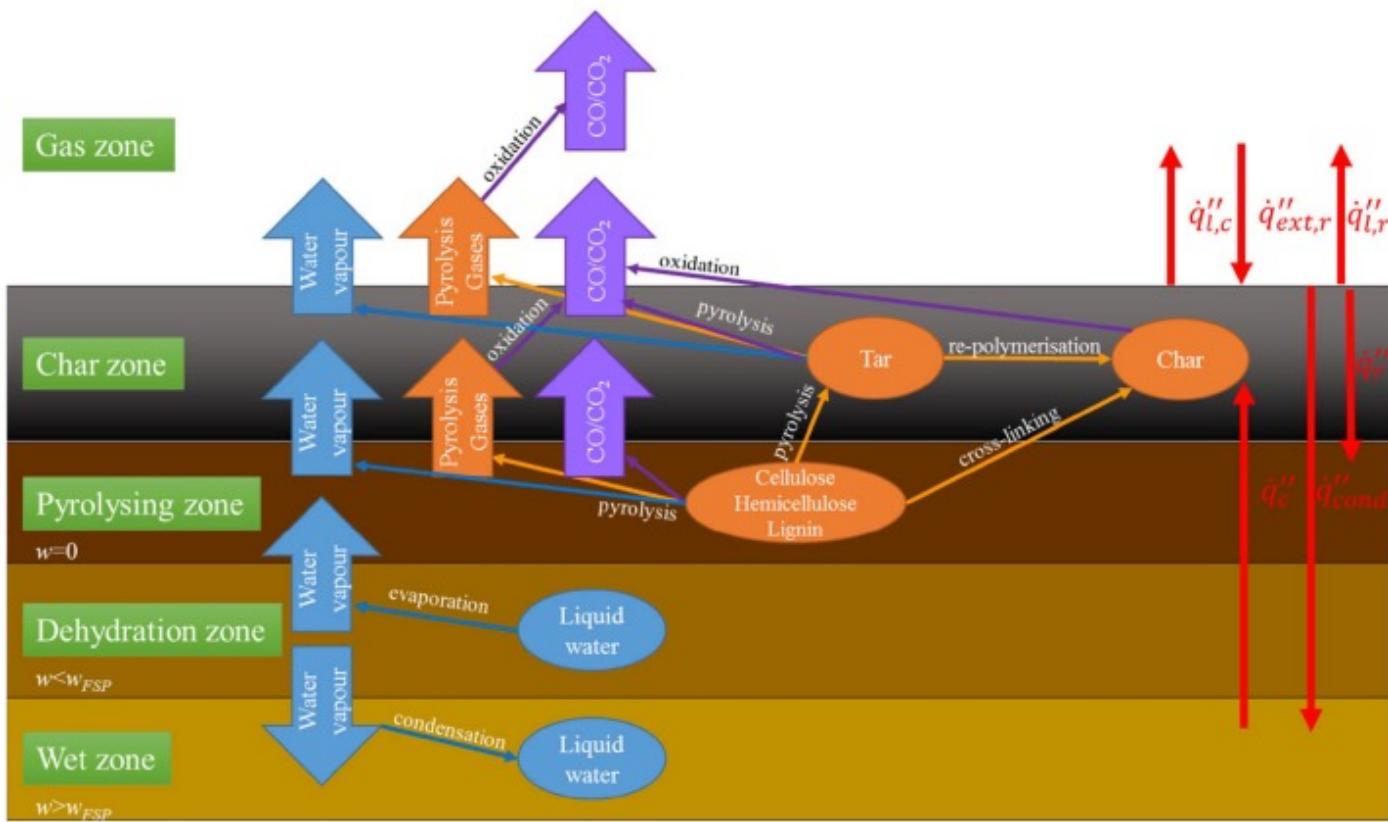
# 602.1 Construction Classification

<b>Noncombustible</b>	Exterior and interior (bearing or nonbearing) walls, floors, roofs and structural elements are to be of noncombustible materials	I	A	B
		II	A	B
<b>Noncombustible or combustible</b>	Exterior walls are to be of noncombustible materials	III	A	B
		IV	A	B
	V	A	B	C
				HT

It is the intent of the *International Building Code* that each building be classified as a single type of construction. The construction materials and the degree to which such materials are protected determine the classification based on the criteria of Table 601 and Chapter 6.

Source: 2021 IBC

# Wood and hours



**Figure 1. Chemical and physical processes within a burning timber sample;  $\dot{q}_{l,c}''$  is the surface heat losses by convection,  $\dot{q}_{l,r}''$  is the surface heat losses by radiation,  $\dot{q}_{ext,r}''$  is the external heat flux,  $\dot{q}_r''$  is in-depth radiation,  $\dot{q}_{cond}''$  is conduction into the sample, and  $\dot{q}_c''$  is convective heat transfer through cracks in the sample.**

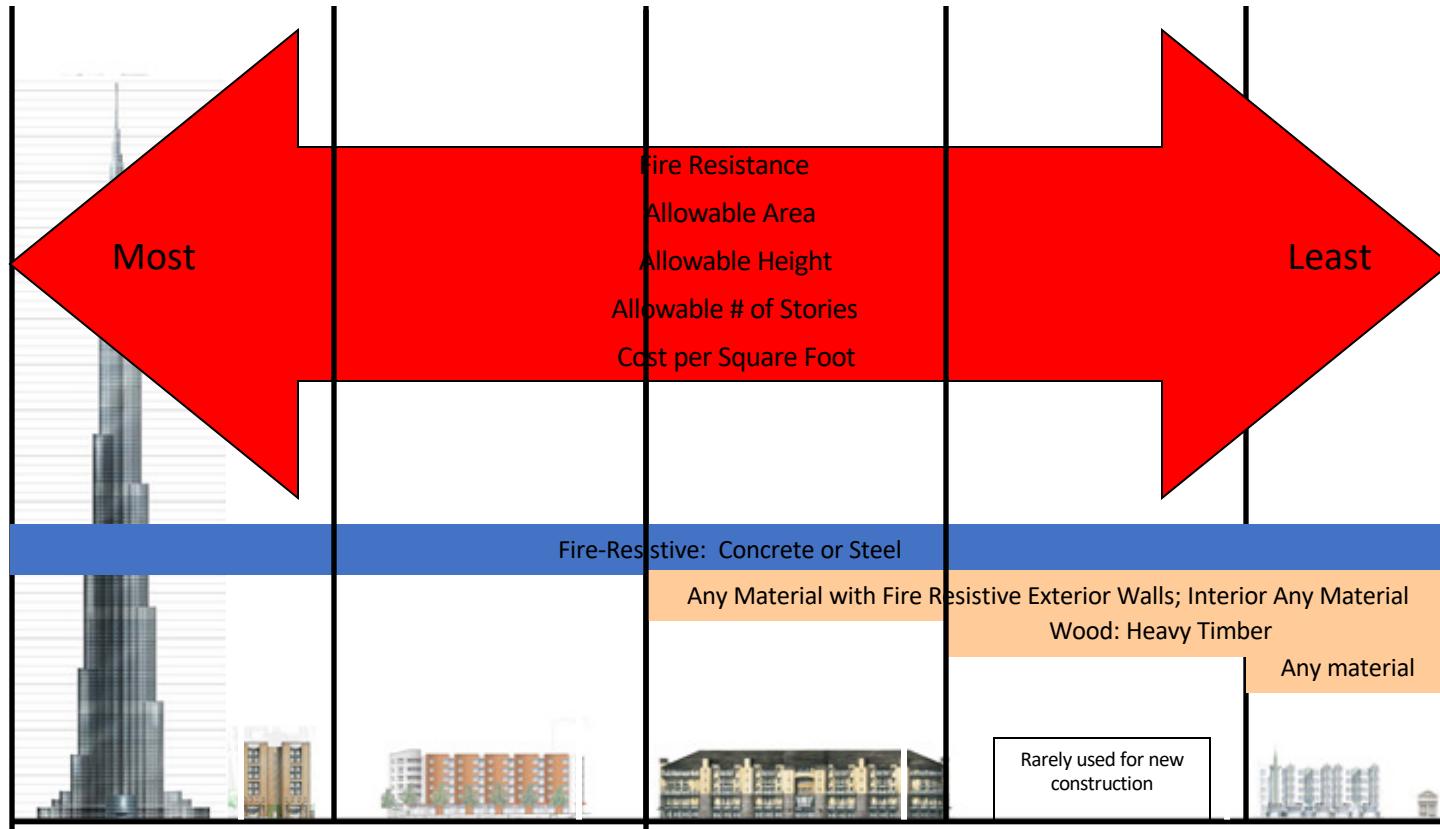
# Wood and hours



Test 1-3 compartment 3 hours and 6 minutes after ignition.  
NIST

Source: 2021 IBC

## 1. The Five Basic Construction Types

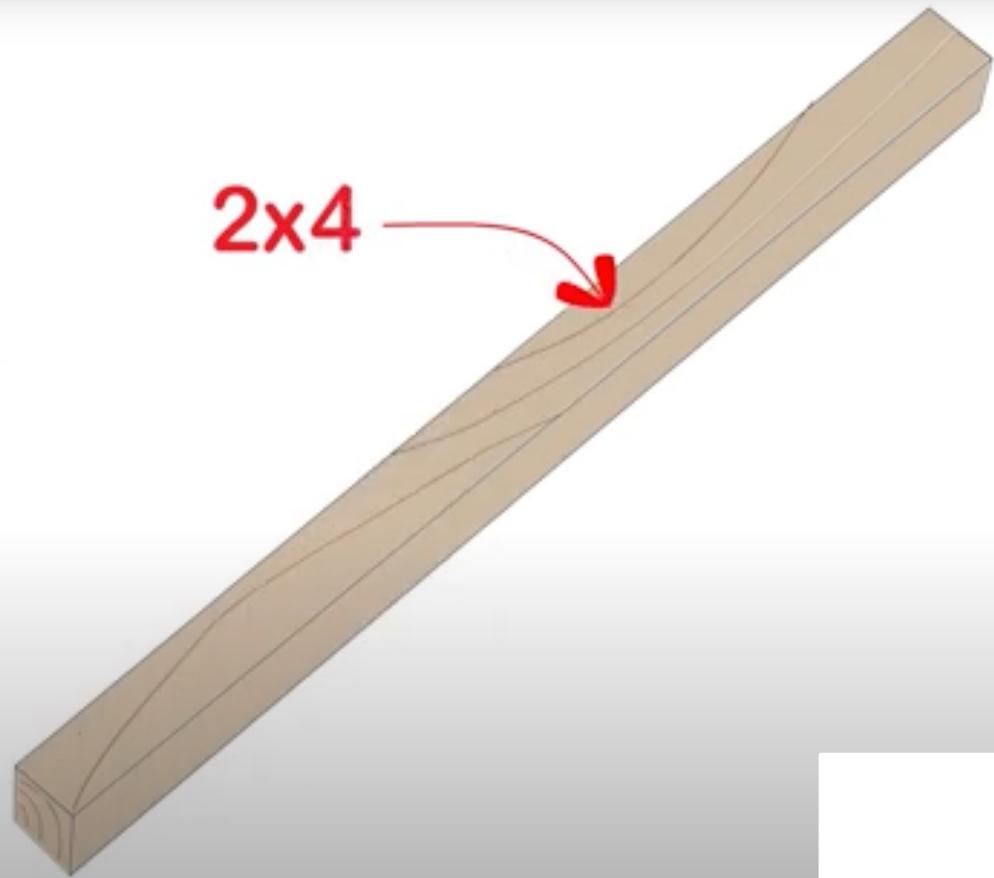


# T601, 202 Primary Structural Frames

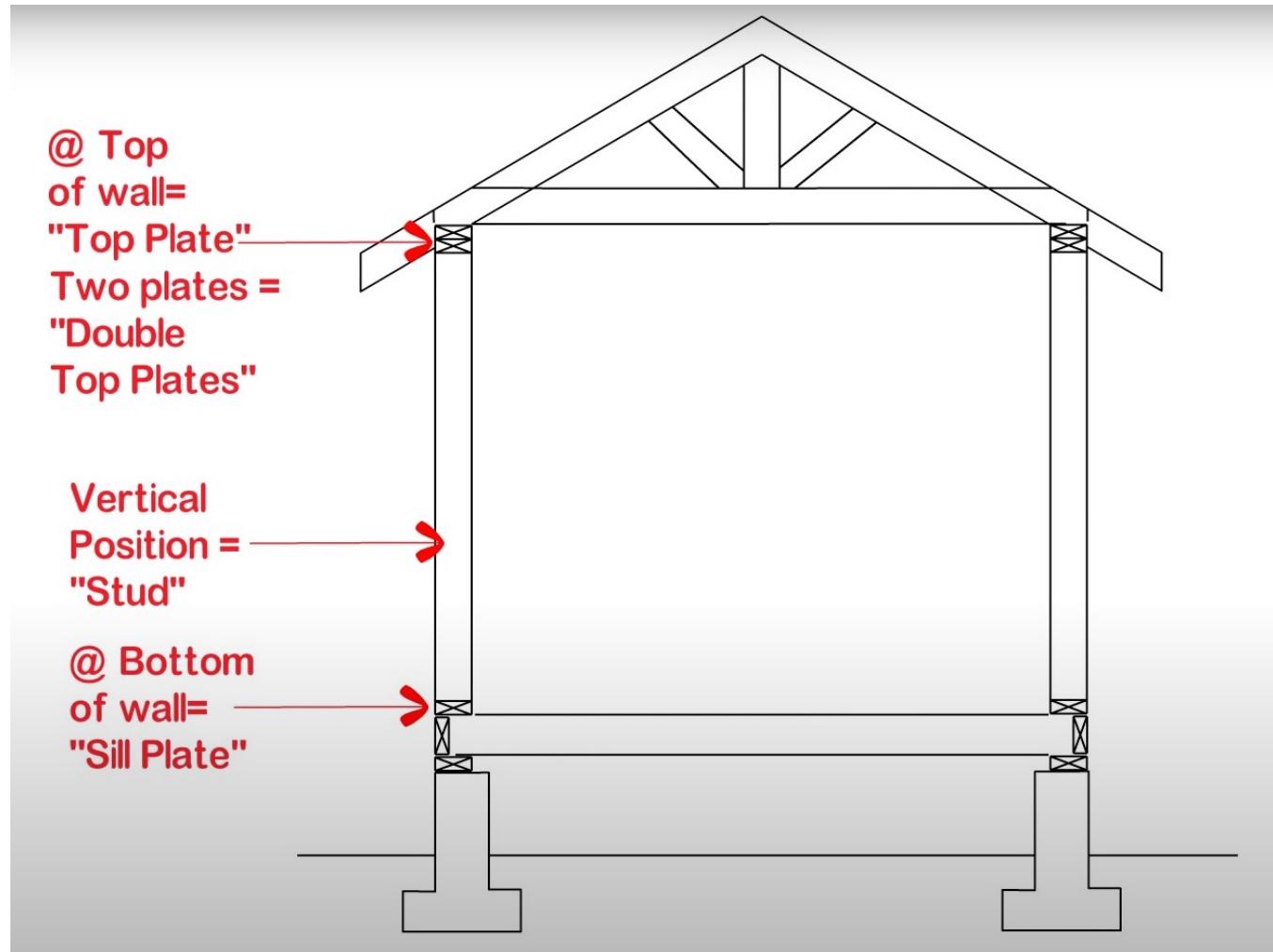
**Joist?**

**Rafter?**

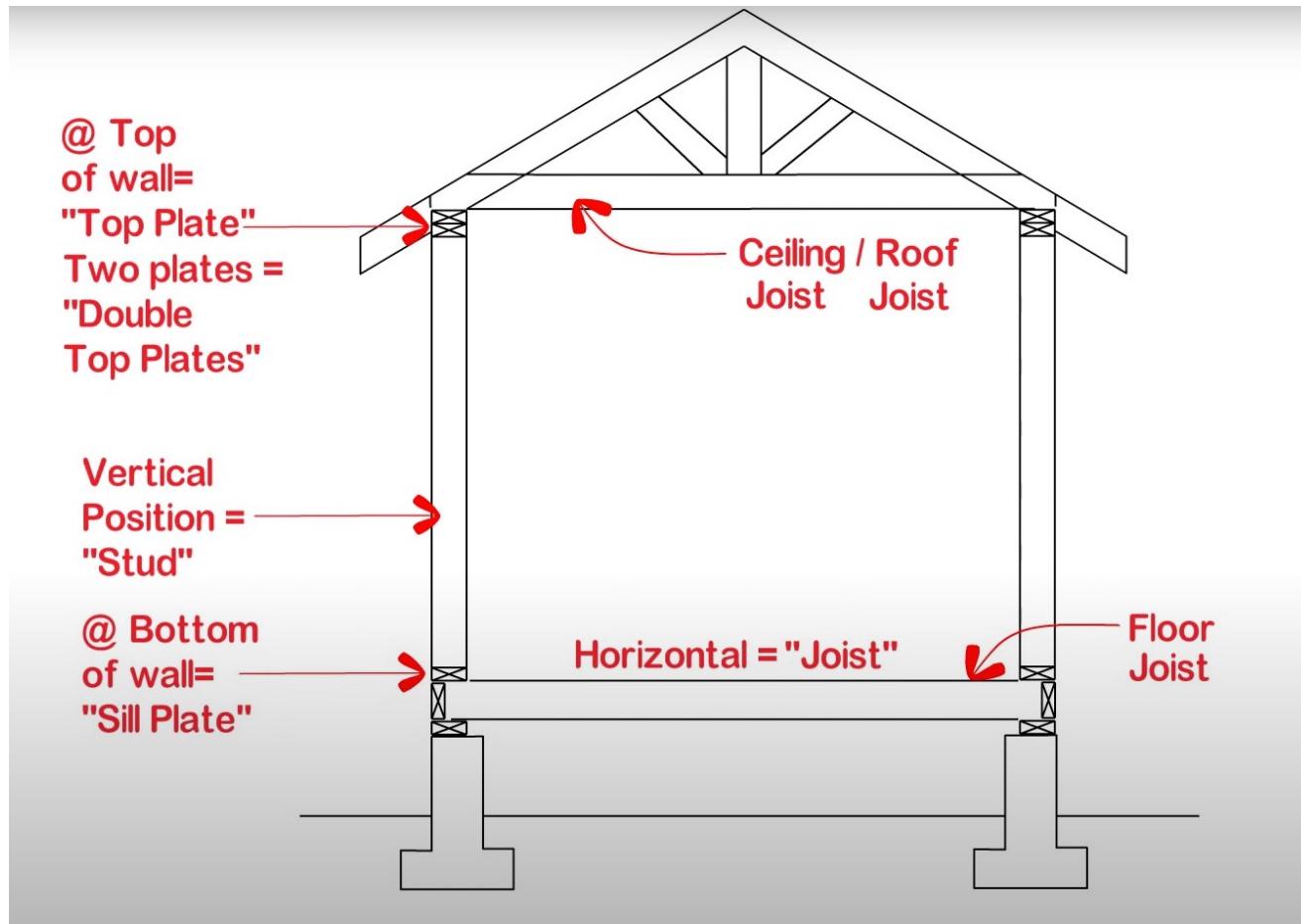
**2x4**



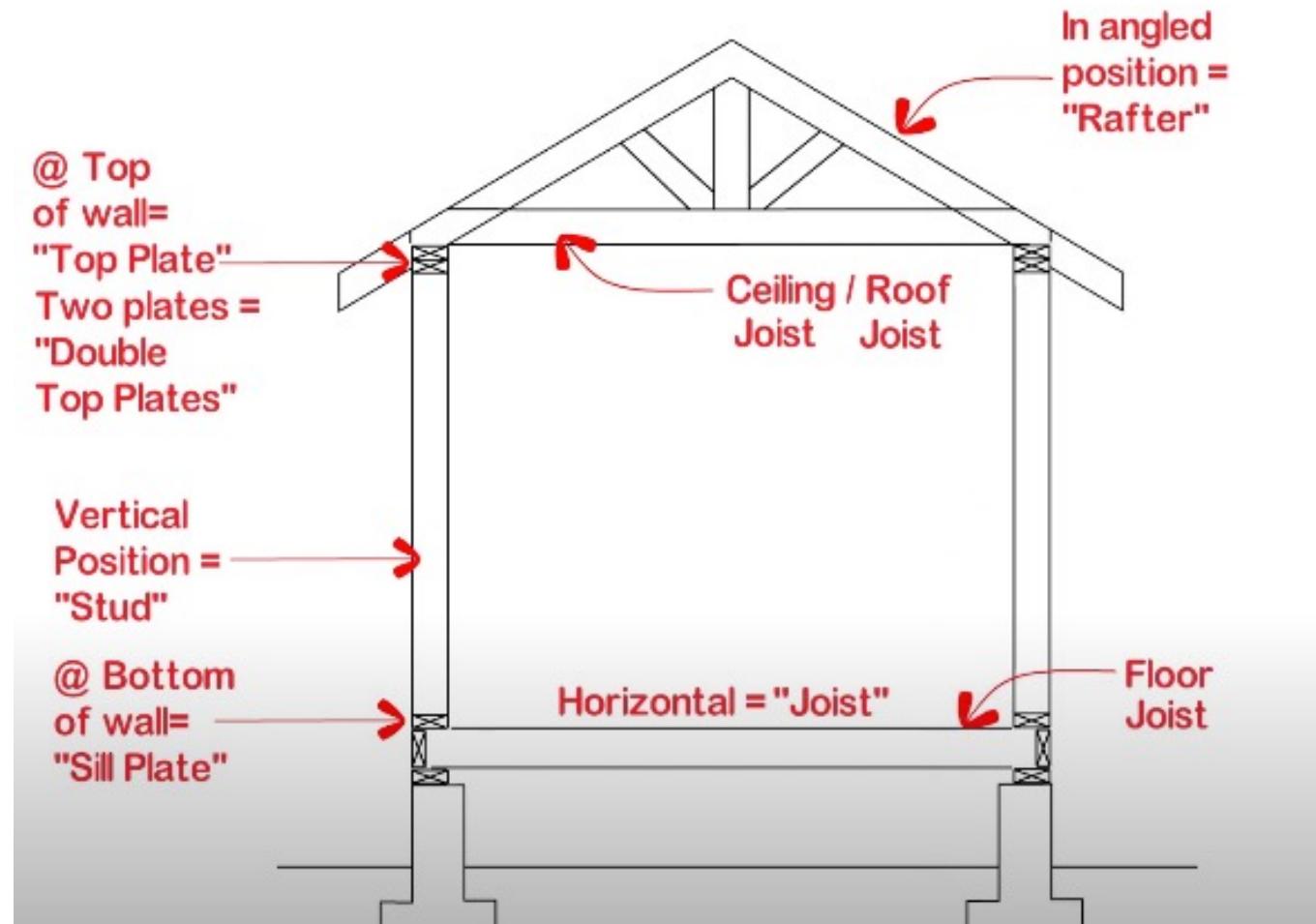
# T601, 202 Primary Structural Frames



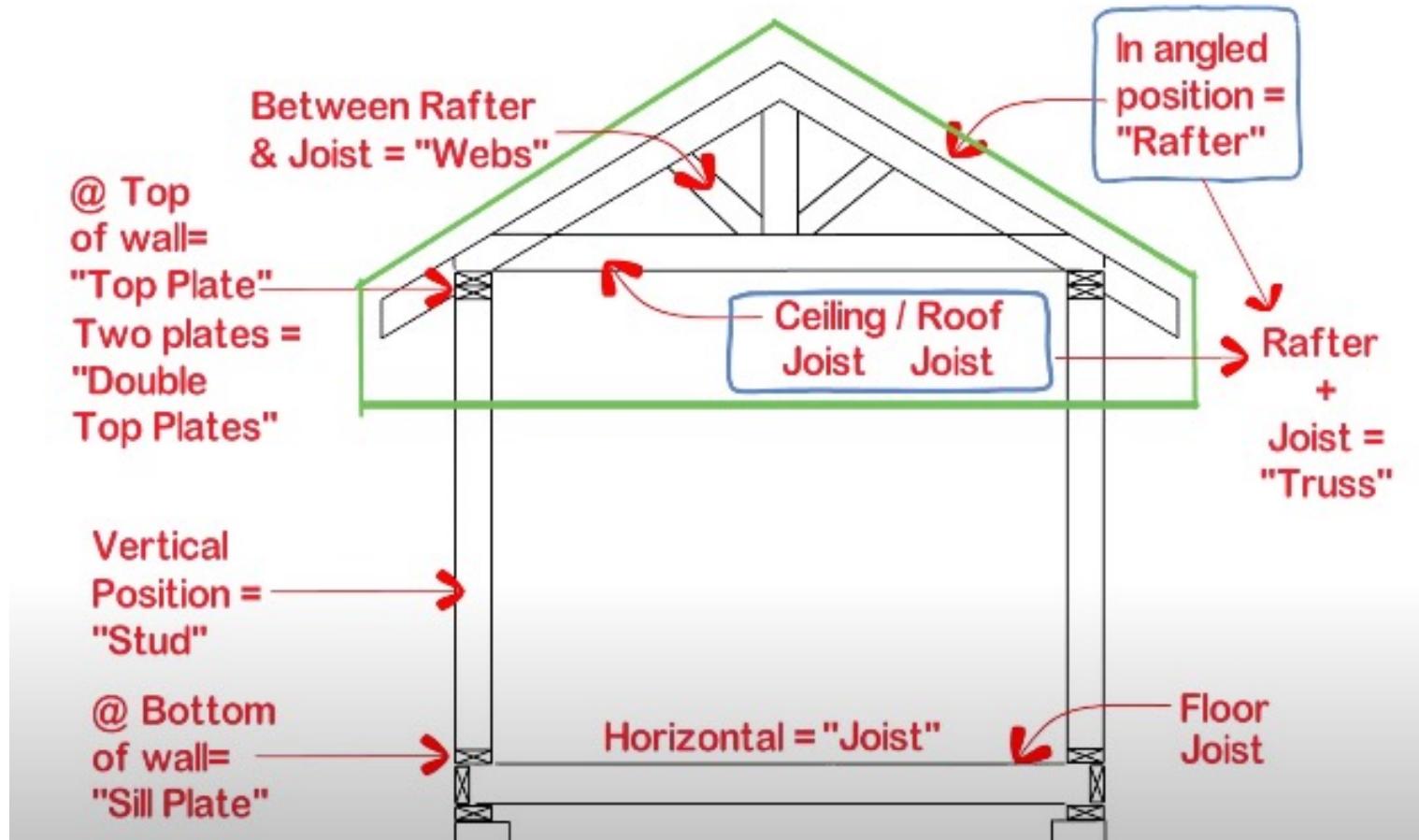
# T601, 202 Primary Structural Frames



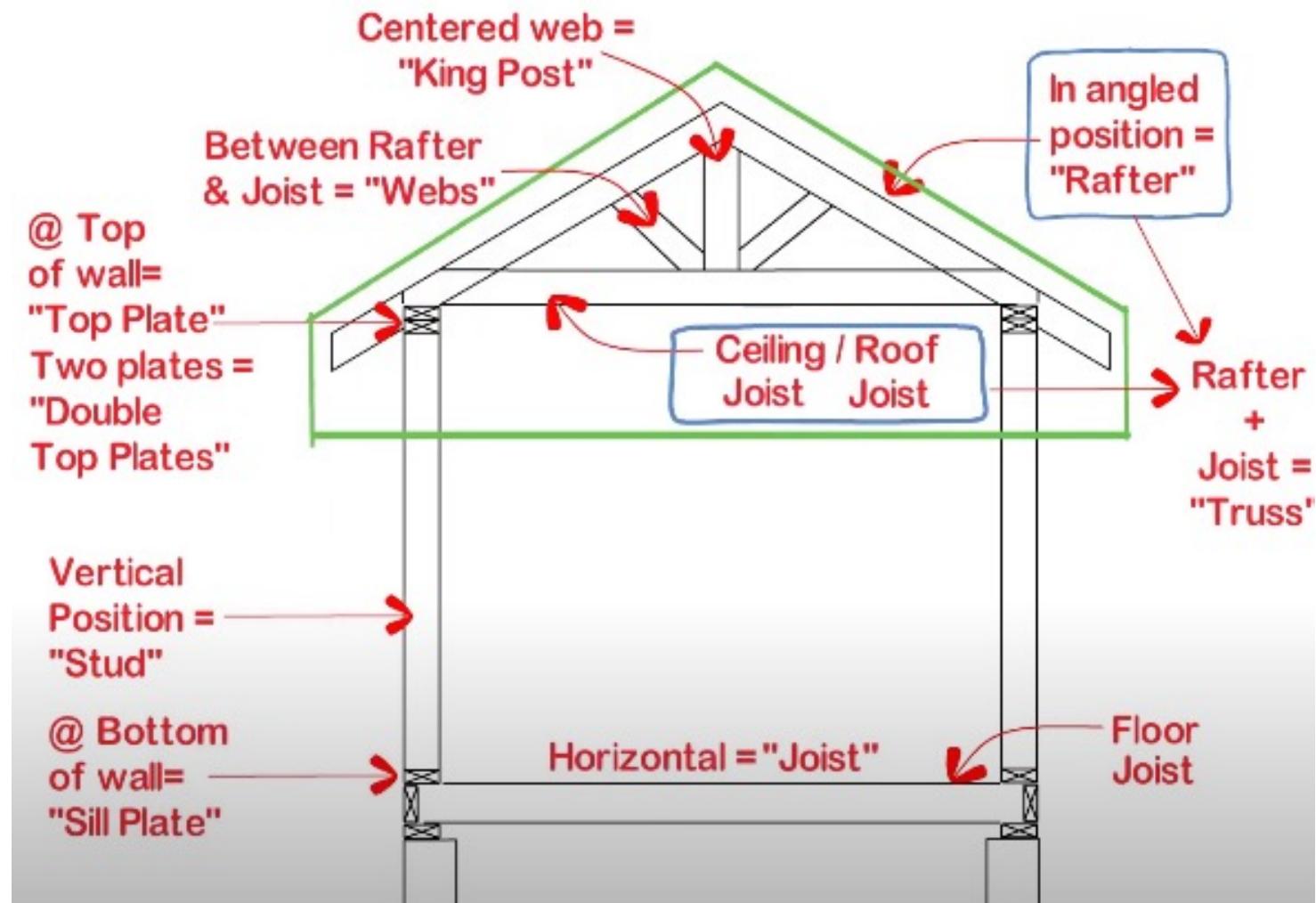
# T601, 202 Primary Structural Frames



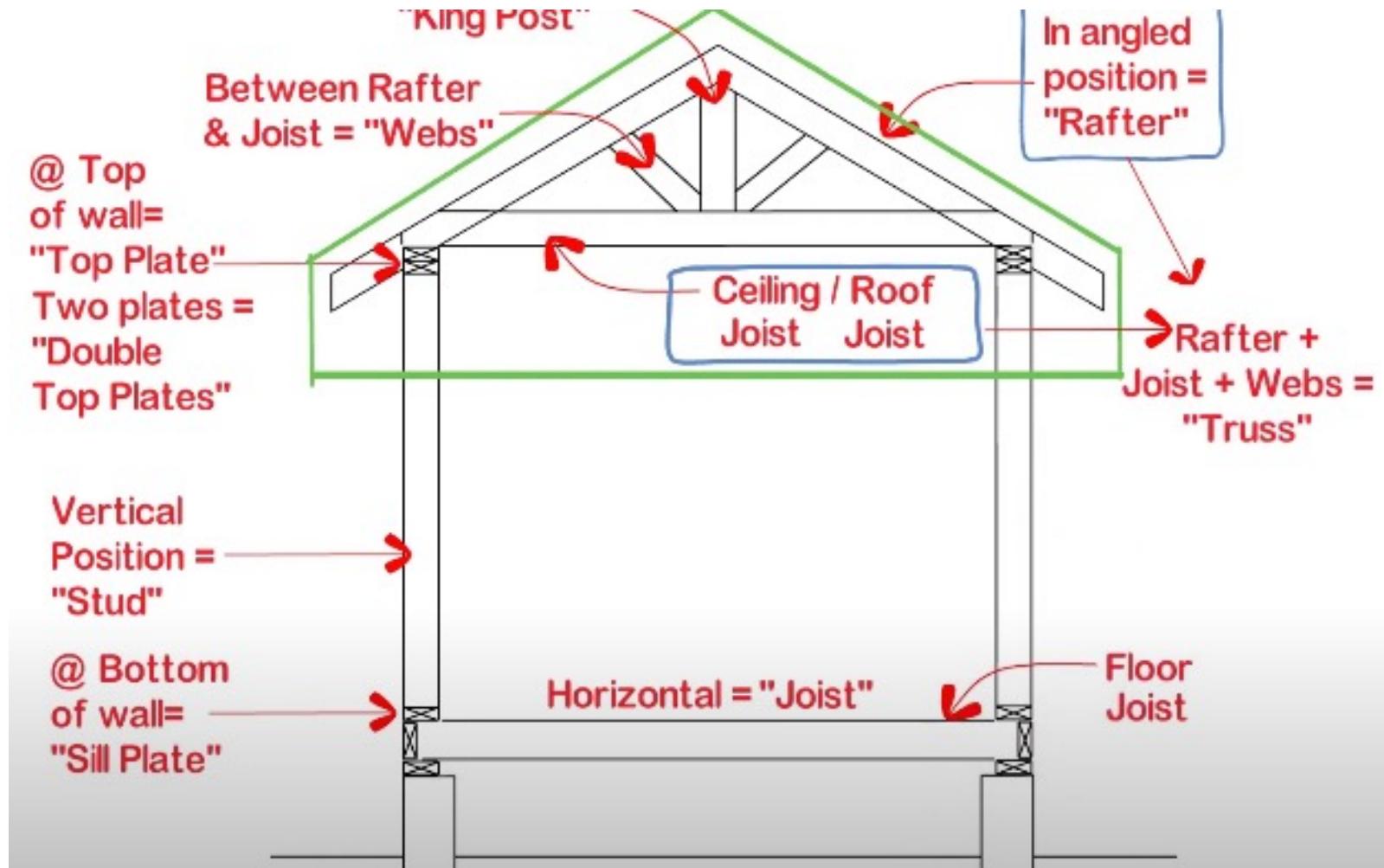
# T601, 202 Primary Structural Frames



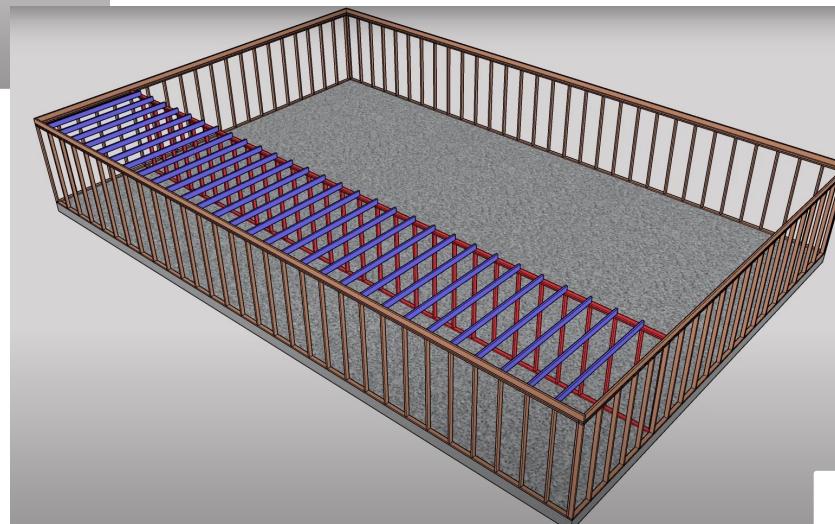
# T601, 202 Primary Structural Frames



# T601, 202 Primary Structural Frames

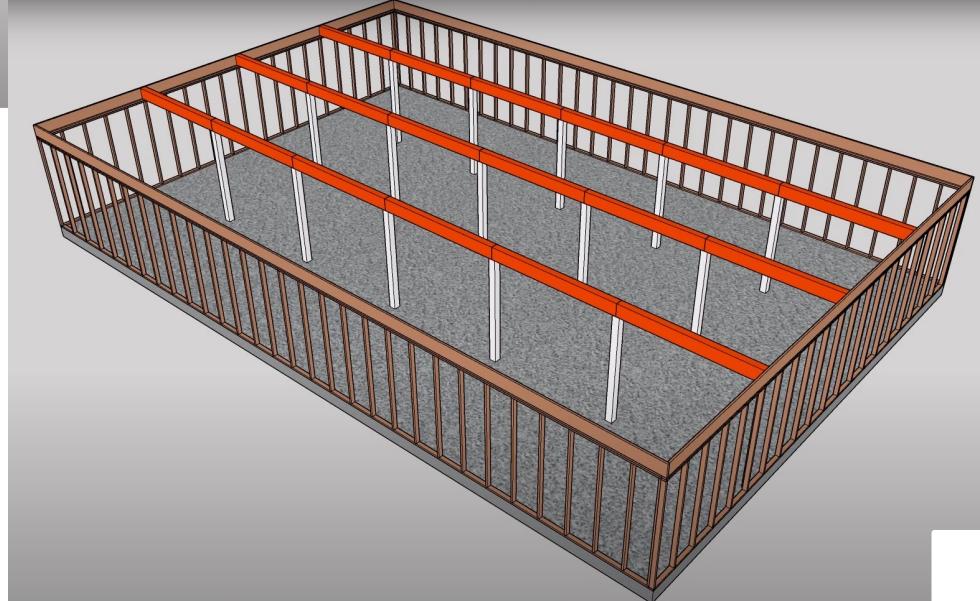


# T601, 202 Primary Structural Frames (joist - wall)



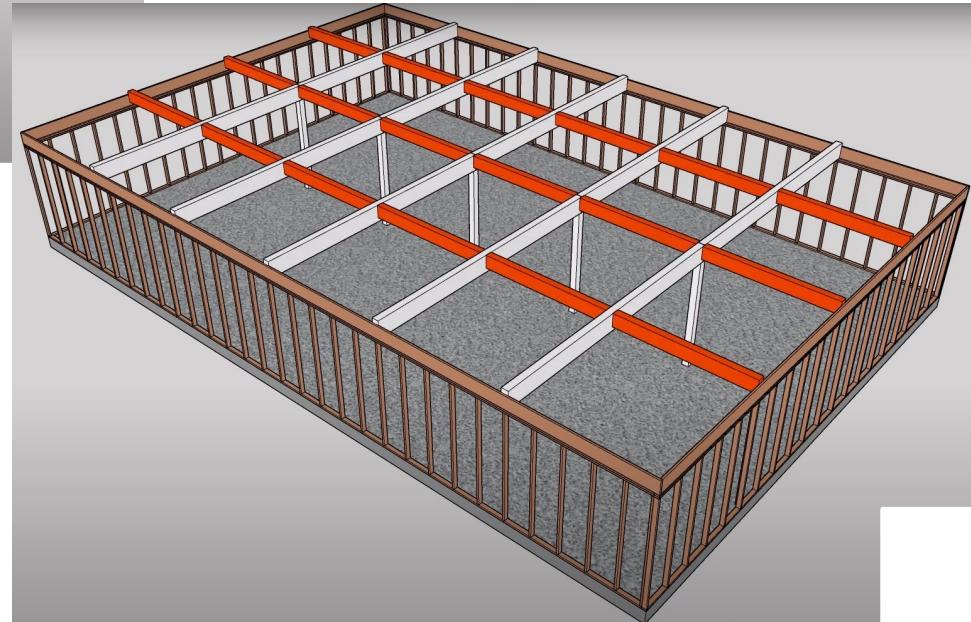
Source: 2021 IBC

# T601, 202 Primary Structural Frames (Walls = Beams –Column)



Source: 2021 IBC

# T601, 202 Primary Structural Frames (Beams –Girders – Column)



# **Class 4: Chapter 5, General Building Heights and Areas**

## 602.1 General Building Heights and Areas

- To gain an understanding of how a building is classified and regulated based on its floor area, height and number of stories.

## 502.1 Address Identification



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As a fundamental requirement, the approved street numbers are to be placed in a location readily visible from the street fronting the property. The fire code official has the authority to require that the address numbers be posted in more than one location to help eliminate any confusion or delay in identifying the location of the emergency.

# 504.3, Table 504.3 Allowable Height Determination

- The maximum height, in feet, of a building shall not exceed the limits specified in Table 504.3. See the exception for towers, spires, steeples and other roof structures.*

TABLE 504.3  
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE\*

OCCUPANCY CLASSIFICATION	See Footnotes	TYPE OF CONSTRUCTION											
		Type I		Type II		Type III		Type IV			Type V		
		A	B	A	B	A	B	C	HT	A	B		
A, B, E, F, M, S, U	NS <sup>b</sup>	UL	160	65	55	65	55	65	65	65	50	40	
	S	UL	180	85	75	85	75	270	180	85	70	60	
H-1, H-2, H-3, H-5	NS <sup>c, d</sup>	UL	160	65	55	65	55	120	90	65	65	50	40
	S	UL	160	65	55	65	55	140	100	85	85	70	60
H-4	NS <sup>c, d</sup>	UL	160	65	55	65	55	65	65	65	50	40	
	S	UL	180	85	75	85	75	180	120	85	85	70	60
I-1 Condition 1, I-3	NS <sup>d, e</sup>	UL	160	65	55	65	55	65	65	65	50	40	
	S	UL	180	85	75	85	75	180	120	85	85	70	60
I-1 Condition 2, I-2	NS <sup>d, e, f</sup>	UL	160	65	55	65	55	65	65	65	50	40	
	S	UL	180	85	75	85	75	180	120	85	85	70	60
I-4	NS <sup>d, g</sup>	UL	160	65	55	65	55	65	65	65	50	40	
	S	UL	180	85	75	85	75	180	120	85	85	70	60
R <sup>h</sup>	NS <sup>d</sup>	UL	160	65	55	65	55	65	65	65	50	40	
	S13D	60	60	60	60	60	60	60	60	60	50	40	
	S13R	60	60	60	60	60	60	60	60	60	60	60	
	S	UL	180	85	75	85	75	270	180	85	70	60	

For SI: 1 foot = 304.8 mm.

UL = Unlimited; NS = Buildings not equipped throughout with an automatic sprinkler system; S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13D = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3.

a. See Chapters 4 and 5 for specific exceptions to the allowable height in this chapter.

b. See Section 903.2 for the minimum thresholds for protection by an automatic sprinkler system for specific occupancies.

c. New Group H occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.5.

d. The NS value is only for use in evaluation of existing building height in accordance with the *International Existing Building Code*.

e. New Group I-1 and I-3 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6. For new Group I-1 occupancies Condition 1, see Exception 1 of Section 903.2.6.

f. New and existing Group I-2 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6 and Section 1103.5 of the *International Fire Code*.

g. For new Group I-4 occupancies, see Exceptions 2 and 3 of Section 903.2.6.

h. New Group R occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.8.

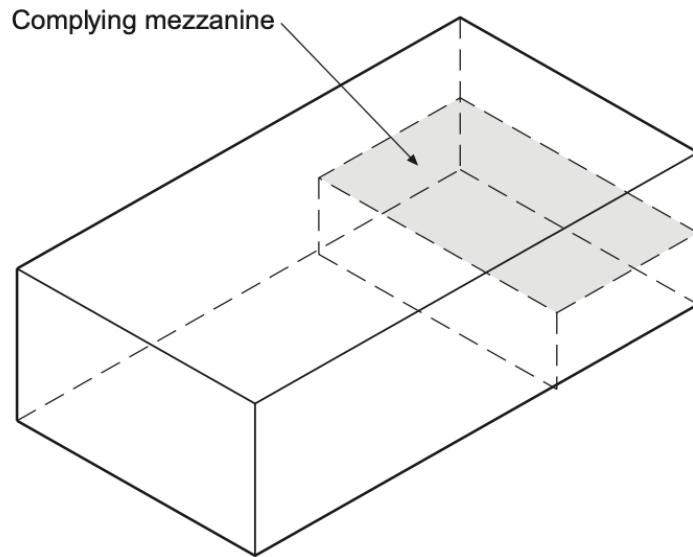
Where an NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low Rise Residential Occupancies*, sprinkler system is installed in a residential building, the table reflects a maximum building height of 60 feet, regardless of the building's type of construction.

Source: 2021 IBC

## 505.2 Mezzanines Scope

- A mezzanine or mezzanines in compliance with Section 505.2 shall be considered a portion of the story below. Such mezzanines shall not contribute to either the building area or number of stories as regulated by Section 503.1. The area of a mezzanine shall be included in determining the fire area.
- There are two distinct benefits derived from the qualification of a floor level as a mezzanine. One, the mezzanine is not considered in the allowable number of stories, and two, for allowable area purposes, the mezzanine floor area does not increase the building area of the story in which it is located. However, in the determination of fire area size for sprinkler requirements, the floor area must be considered. The requirements for sprinkler systems are generally based on the fire load expected in an occupancy; thus, an increased floor area would increase the potential fire loading.

## 505.2 Mezzanines Scope



**Mezzanine:**

- Does not contribute to floor area for maximum allowable area
- Does not contribute as an additional story
- Does contribute to floor area for fire area size determination

**Example:**

For 8,000 sq ft first floor as shown with 2,000 sq ft mezzanine, building area is 8,000 sq ft, building is one story in height, and fire area is 10,000 sq ft

For SI: 1 square foot = 0.093 m<sup>2</sup>

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Although it is quite possible that an individual floor level within a building can meet all of the provisions of the IBC and qualify as a mezzanine, its actual designation is the choice of the designer. It may be more advantageous to treat the floor level simply as an additional story.

## 506.3 Frontage Increase

- Every building shall adjoin or have access to a public way to receive an area factor increase based on frontage. The area factor increase based on frontage shall be determined in accordance with Sections 506.3.1 through 506.3.3. The area factor increase based on frontage shall be determined in accordance with Table 506.3.3.
- The frontage increase is based on the smallest public way or open space that is 20 feet or greater, as well as the percentage of the building perimeter having a minimum 20-foot public way or open space.



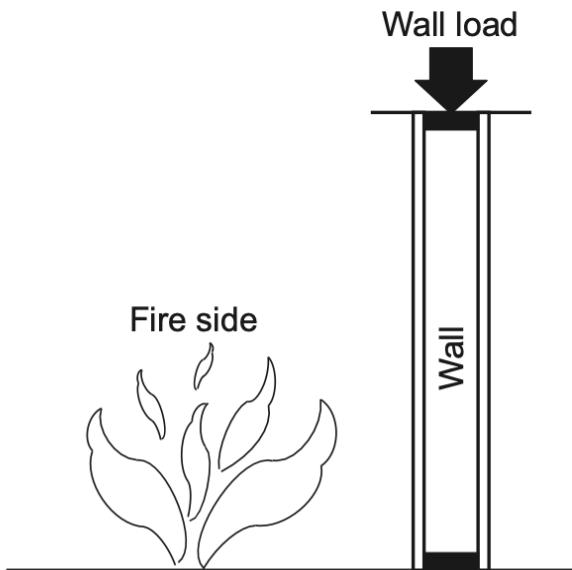
Source: 2021 IBC

# **Class 5: Chapter 7, 701-705 Fire and Smoke Protection Features I**

## 510.7 Objective

- To gain an understanding of
  - the fundamentals of fire-resistance-rated construction,
  - the methods for the determination of fire resistance, and
  - the regulation of exterior walls for fire-resistance rating and opening protection.

## 703.2.1 202 Materials and Systems



Assembly must:

- sustain applied load,
- have no passage of flame or gases hot enough to ignite cotton waste,
- have average temperature rise on unexposed surface not more than 250°F above initial temperature or more than 325°F at any point, and
- have no water pass through during hose-stream test.

### Conditions of acceptance - wall fire test

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For nonsymmetrical wall construction, where interior walls and partitions are provided with differing membranes on opposing sides, the IBC mandates that tests be performed from both sides. The side with the shortest test duration is the basis for the fire-resistance rating.

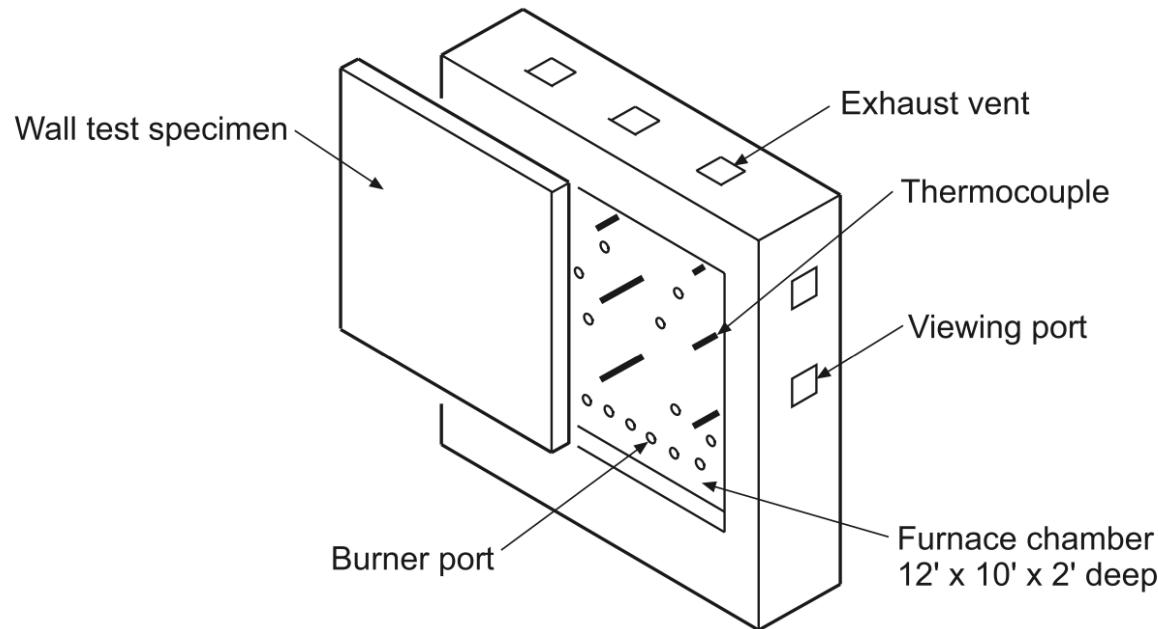
## 703.2.1 202 Materials and Systems

- Fire-resistance rating is the period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both as determined by the tests, or the methods based on tests, prescribed in Section 703. A fire-resistance rating of building elements, components or assemblies shall be determined by the test procedures set forth in ASTM E119 or UL 263 or by analytic methods set forth in Section 703.2.2.
- ASTM E119 is the referenced standard, Standard Test Methods for Fire Tests of Building Construction and Materials. These test methods are used for the great majority of building components or assemblies that are mandated by the code to have a fire resistance rating. Assemblies tested under the criteria of UL 263 are also considered to have the fire-resistance rating as assigned.

## 703.2 Analytical Methods

- The fire resistance of building elements, components or assemblies established by an analytical method shall be of any of the following methods listed in Section 703.2.2, based on the fire exposure and acceptance criteria specified in ASTM E119 or UL 263: (1) fire- resistance designs documented in approved sources; (2) prescriptive designs of fire-resistance-rated building elements as prescribed in Section 721; (3) calculations in accordance with Section 722; (4) engineering analysis based on a comparison of building element, component or assembly designs having fire-resistance ratings as determined by the test procedures set forth in ASTM E119 or UL 263; or (5) fire- resistance designs certified by an approved agency.
- Prescriptive details of fire-resistance-rated building elements are contained in Section 721. Generic listings for structural parts, walls, partitions, floor systems and roof systems are addressed.

## 703.2 Analytical Methods



For SI: 1 foot = 304.8 mm.

**Wall test furnace**

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Section 722 provides methods of calculated fire resistance for concrete, masonry, steel, wood assemblies or members, and mass timber elements. The procedures and calculations are limited to the specific information set forth in this section and are not to be used in any other manner.

## 703.2.1 202 Materials and Systems

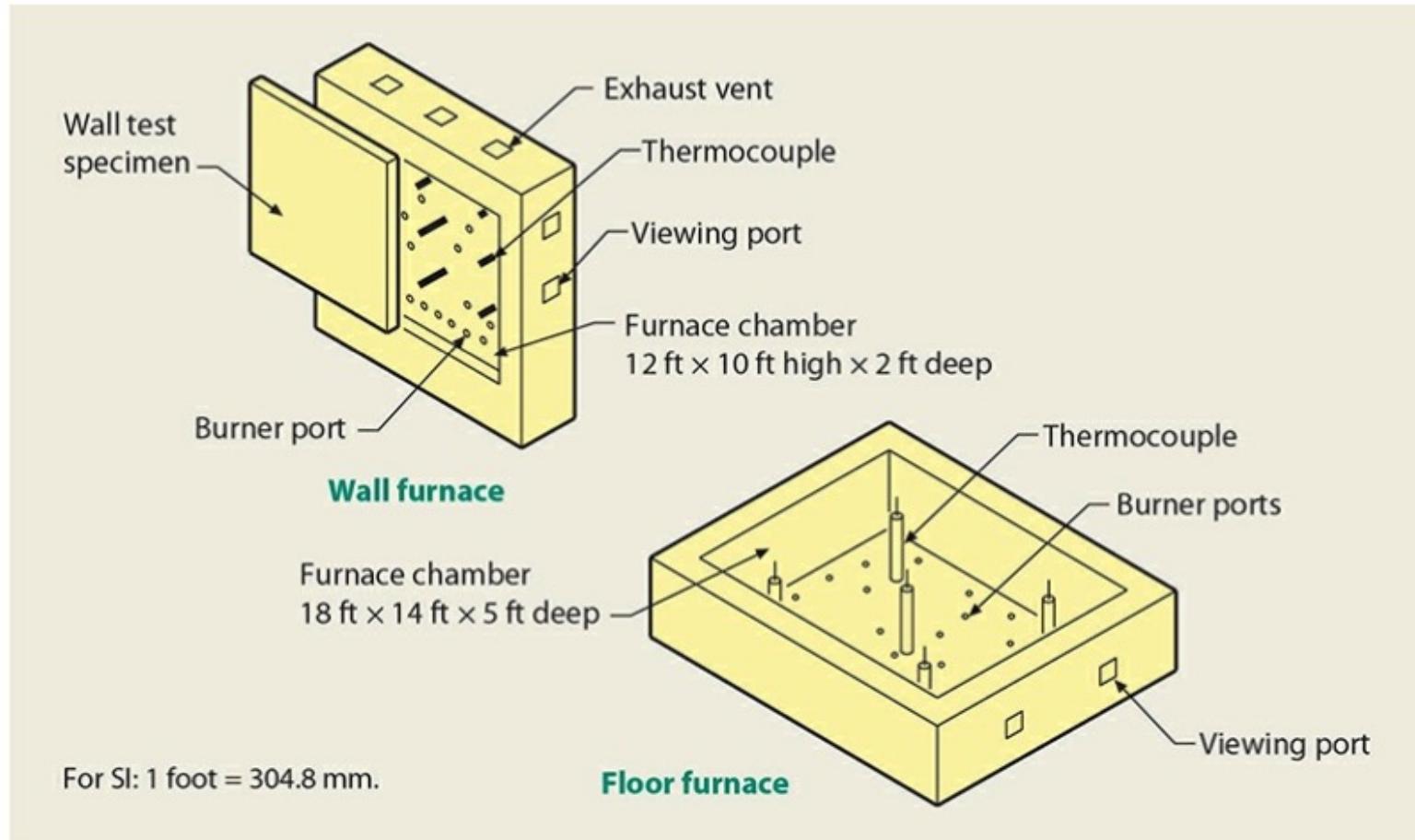


Figure 703-1 **Test furnaces.**

## 703.2.1 202 Materials and Systems

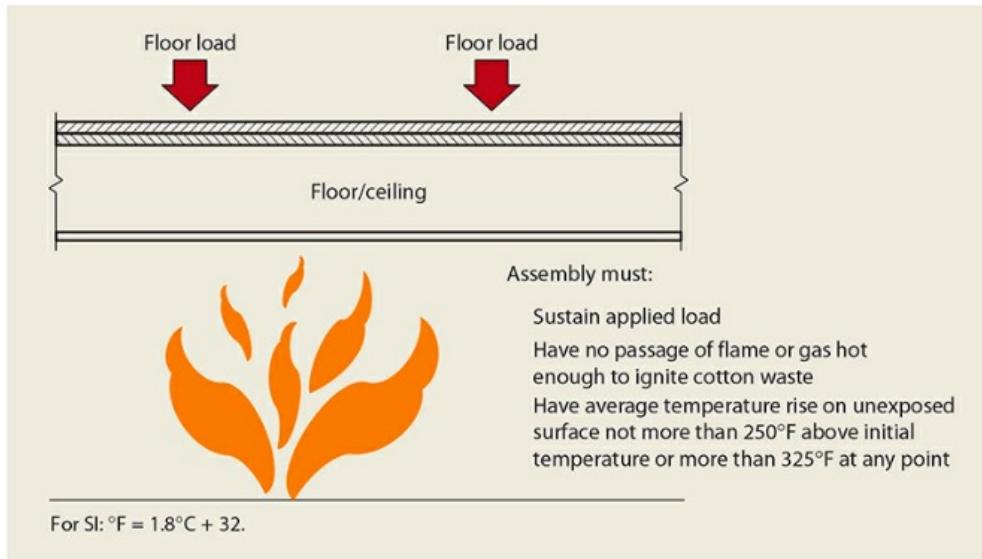


Figure 703-2 **Floor assembly fire test.**

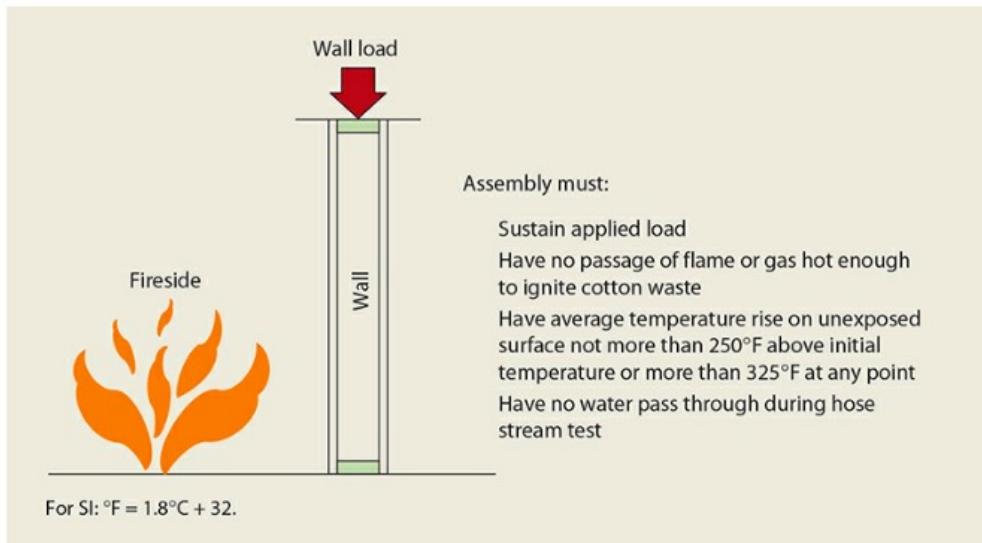


Figure 703-3 **Conditions of acceptance—wall fire test.**

Source: 2021 IBC

## 703.2.1 202 Materials and Systems

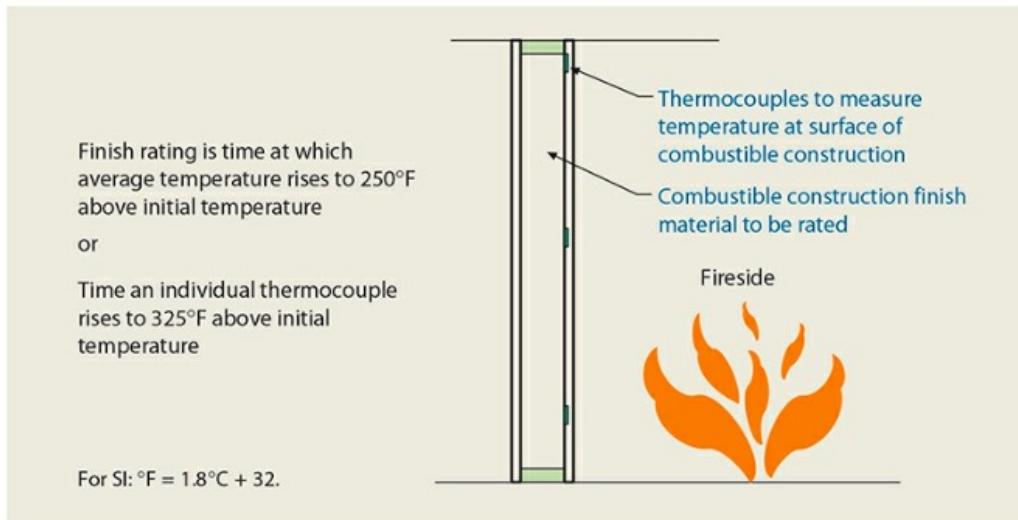


Figure 703-4 Combustible assembly for determining finish rating.

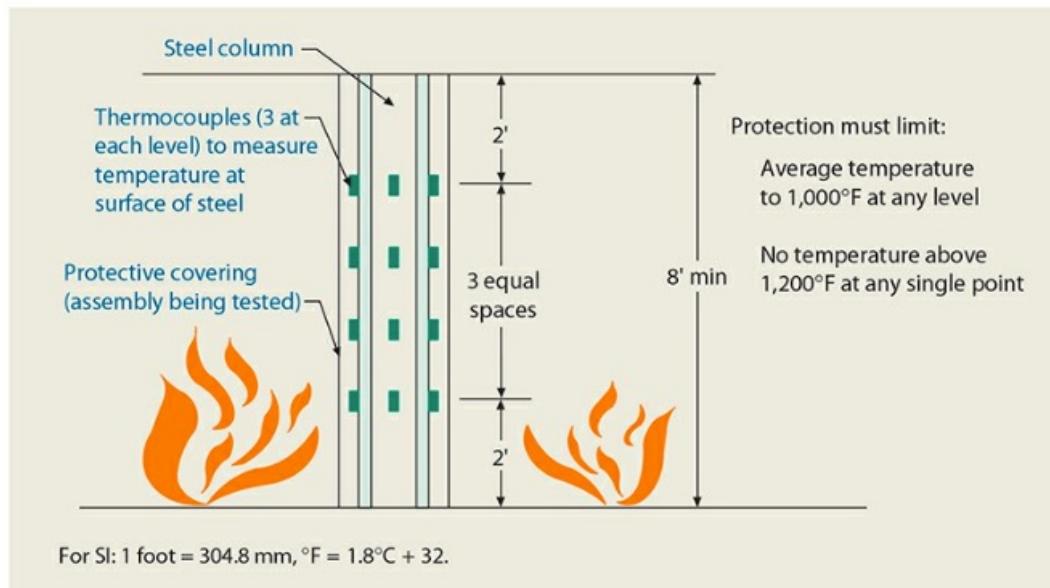


Figure 703-5 Alternative fire test of steel column protection.

Source: 2021 IBC

# **Class 6: Chapter 7, Sections 706 through 712—Fire and Smoke Protection Features II**

# 706-712 Objective

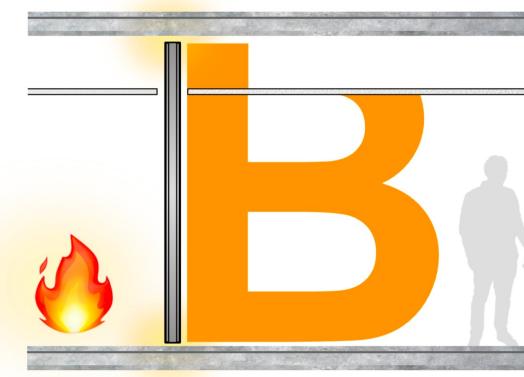
- To gain an understanding of the fire-resistance-rated building components such as fire walls, fire barriers, fire partitions, smoke barriers, smoke partitions, and horizontal assemblies and vertical openings.

# Firewall vs Fire Barrier vs Fire Partition



**FIRE WALL:** This is a type of wall that resists fire from the exterior of the building. It contains the flames in the area of origin to ensure that it does not spread.

- Most Stringent type of Fire Separation
- Separates x2 separate Construction Types
- Allows for an increase in area
- Continuous from foundation to/through roof and exterior wall to/through exterior wall



**FIRE BARRIER:** These are walls inside a building that subdivide specific rooms and floors. The vertical assembly partitions extend from the floor up to the ceiling.

- Must go from Floor Structure to Ceiling's Structure
- Made from Non-Combustible Materials
- Separates occupancies & Storage Rooms



**FIRE PARTITION:** These are walls inside a building that subdivide specific rooms and floors. The vertical assembly partitions extend from the floor up to the ceiling.

- Can be made of wood
- Doesn't need to go to structure
- Can essentially create 'tunnels'
- May terminate at a fire rated floor/ceiling/roof assembly
- Used in Dwelling Unit Separations; Corridors

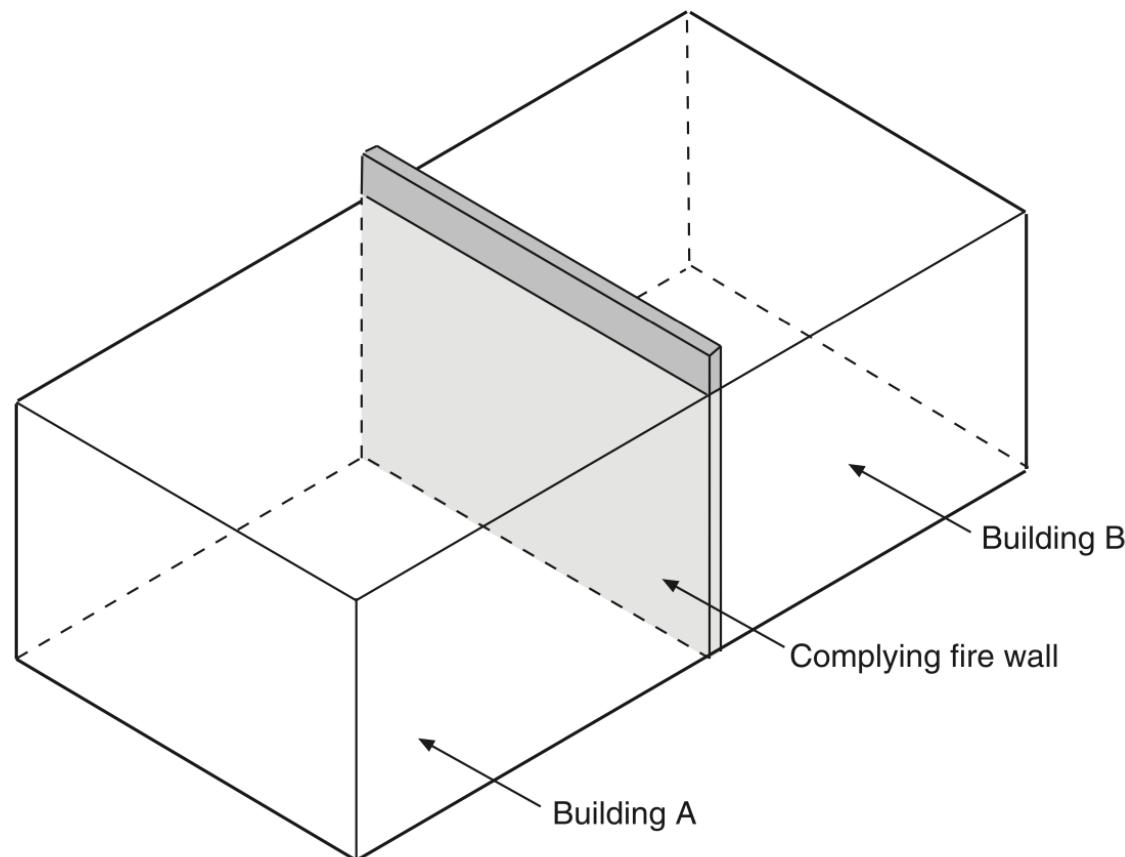
Source: 2021 IBC

## 706.1, 202 Scope: Fire Walls

- A fire wall is a fire-resistance-rated wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.
- By placing one or more fire walls in a large-area building, multiple smaller-area buildings are created. Each of these smaller spaces can then be considered a unique building for the purposes of allowable height, allowable area, construction type and number of control areas. Under various conditions, fire walls are also recognized for use in the creation of horizontal exits, as well as other applications.

## 706.1, 202 Scope: Fire Walls

Fire wall to have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of wall



In a situation where a fire wall separates distinct occupancy groups that are required to be separated by a fire barrier wall, the most restrictive requirements of each separation apply. This includes both the wall's continuity and the required fire-resistance rating.

Source: 2021 IBC

## 706.3, 706.4 Construction: Fire Walls

- Fire walls shall be of any approved noncombustible materials. See the exception for Type V construction. Fire walls shall have a fire-resistance rating of not less than that required by Table 706.4.
- A fire wall is designed to act in a manner similar to an exterior wall, as a barrier to prevent a fire in one building from spreading to the other building. Accordingly, construction of the fire wall must be commensurate with the exterior wall requirements for the construction type. In addition, the fire-resistance rating of the wall must be considerable in order to provide the necessary level of protection based on the anticipated fire loading that is due to the uses of the separate buildings. The required ratings vary based on occupancy and, to some degree, type of construction.

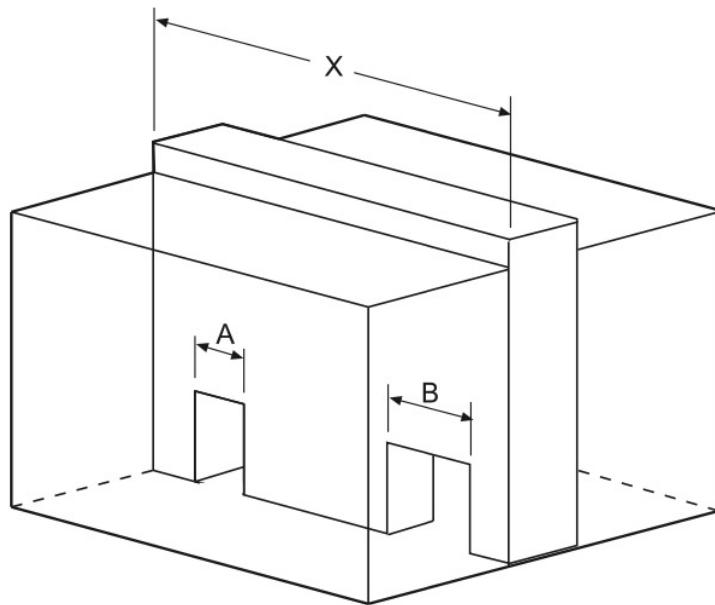
## 706.3, 706.4 Construction: Fire Walls

**TABLE 706.4  
FIRE WALL FIRE-RESISTANCE RATINGS**

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3 <sup>a</sup>
F-1, H-3 <sup>b</sup> , H-5, M, S-1	3
H-1, H-2	4 <sup>b</sup>
F-2, S-2, R-3, R-4	2

- 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 415.4 and 415.5.

## 706.3, 706.4 Construction: Fire Walls



$$A + B \leq 25\% \text{ of } X$$

Each opening limited to 156 square feet unless both buildings are sprinklered

Fire-protection rating based on Tables 706.4 and 715.4

For SI: 1 square foot = 0.093m<sup>2</sup>

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Per Section 706.8, the total width of all openings in a fire wall is limited to 25 percent of the length of the wall in each story. There is no limit on the amount of total wall area containing openings; however, each opening is limited to 156 square feet in nonsprinklered buildings.

## 706.3, 706.4 Construction: Fire Walls

Fire walls must be constructed of noncombustible materials unless separating buildings of Type \_\_\_\_\_ construction.

- a. I
- b. III
- c. IV
- d. V

## 706.3, 706.4 Construction: Fire Walls

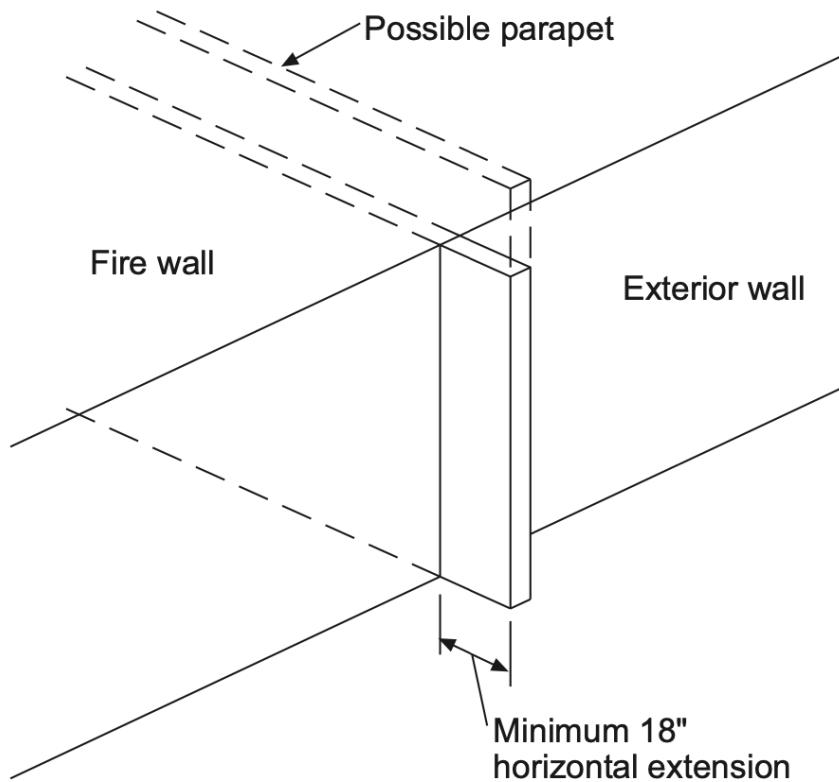
Fire walls must be constructed of noncombustible materials unless separating buildings of Type \_\_\_\_\_ construction.

- a. I
- b. III
- c. IV
- d. V

## 706.5 Horizontal Continuity: Fire Walls

- Fire walls shall be continuous from exterior wall to exterior wall and shall extend not less than 18 inches (457 mm) beyond the exterior surface of exterior walls. See the three exceptions for various methods of terminating the fire wall at the interior surface of the exterior sheathing or finish materials.
- Historically, the code has addressed the hazards of fire exposure at the fire wall from a vertical perspective, at the roof. There is also concern of a similar hazard from the horizontal perspective, at the intersection of the fire wall and the exterior wall. The 18-inch extension is intended to abate the potential for fire to travel from one building to the other around the fire wall. The 18-inch extension must extend the full height of the fire wall.

# 706.5 Horizontal Continuity: Fire Walls



## Horizontal continuity

For SI: 1 inch = 25.4 mm.

The three exceptions acknowledge the effect certain types of exterior wall construction will have on fire breaching the exterior of the building and exposing the adjacent building. These methods of protection are similar to those used at the roof construction where a parapet is not provided.

Source: 2021 IBC

## 706.5 Horizontal Continuity: Fire Walls

As a general provision, what minimum distance must a fire wall extend horizontally beyond the exterior surface of exterior walls?

- a. 18 inches
- b. 20 inches
- c. 30 inches
- d. 4 feet

## 706.5 Horizontal Continuity: Fire Walls

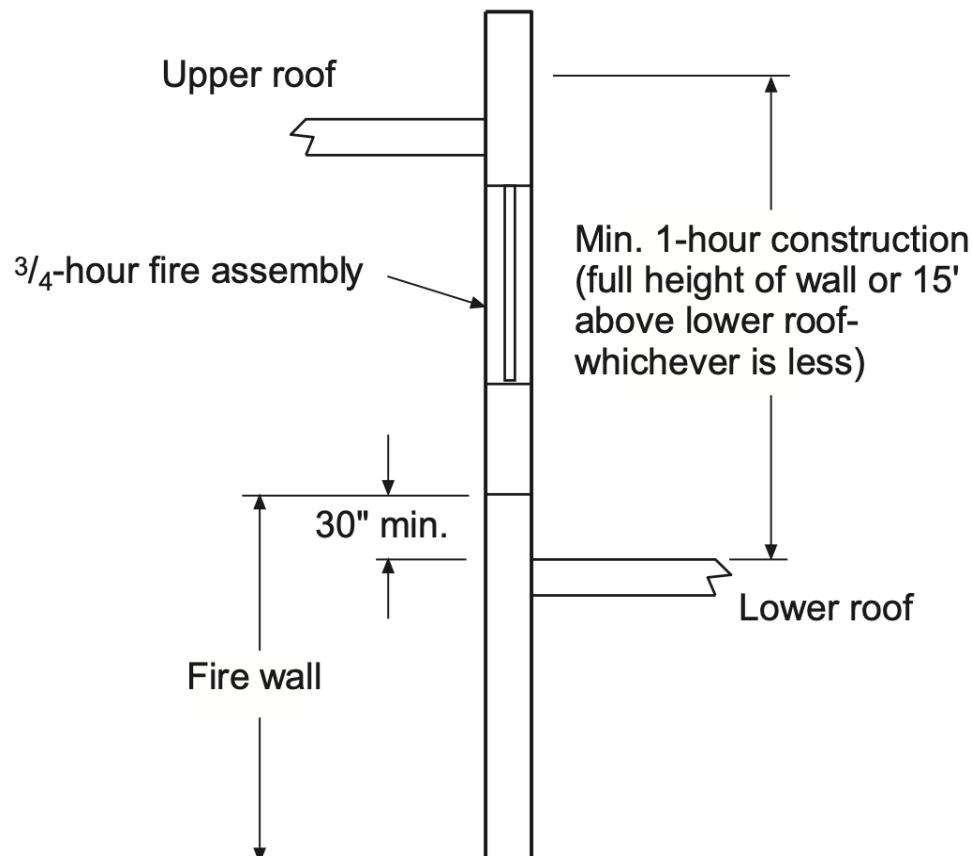
As a general provision, what minimum distance must a fire wall extend horizontally beyond the exterior surface of exterior walls?

- a. 18 inches
- b. 20 inches
- c. 30 inches
- d. 4 feet

## 706.6 Vertical Continuity: Fire Walls

- Fire walls shall extend from the foundation to a termination point not less than 30 inches (762 mm) above both adjacent roofs. See the exceptions for buildings with different roof levels, those with noncombustible roof construction, and those constructed under special provisions.
- To ensure the separate building concept, a fire wall must be continuous vertically with no horizontal offsets from the foundation, through the roof to a point at least 30 inches above. Various exceptions to the parapet requirement allow the fire wall to terminate at the bottom of the roof deck or sheathing. According to many of the exceptions, the roof covering must be minimum Class B, and no openings in the roof are permitted within 4 feet of the fire wall.

## 706.6 Vertical Continuity: Fire Walls



### Stepped buildings

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

A stepped building, where the fire wall separates buildings having different roof levels, may require additional fire resistance to a point 15 feet above the lower roof. An alternative method provides for minimum 1-hour horizontal protection of the lower roof assembly.

Source: 2021 IBC

## 706.6 Vertical Continuity: Fire Walls

In general, what minimum distance above the roof must a fire wall extend?

- a. 18 inches
- b. 30 inches
- c. 3 feet
- d. 4 feet

## 706.6 Vertical Continuity: Fire Walls

In general, what minimum distance above the roof must a fire wall extend?

- a. 18 inches
- b. 30 inches
- c. 3 feet
- d. 4 feet

# 706.6 Vertical Continuity: Fire Walls

**TABLE 706.4  
FIRE WALL FIRE-RESISTANCE RATINGS**

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3 <sup>a</sup>
F-1, H-3b, H-5, M, S-1	3
H-1, H-2	4 <sup>b</sup>
F-2, S-2, R-3, R-4	2

- 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.

A fire wall separating Type VA buildings housing Group M occupancies must have a minimum fire-resistance rating of \_\_\_\_\_ hour(s).

- a. 1
- b. 2
- c. 3
- d. 4

# 706.6 Vertical Continuity: Fire Walls

**TABLE 706.4  
FIRE WALL FIRE-RESISTANCE RATINGS**

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3 <sup>a</sup>
F-1, H-3b, H-5, M, S-1	3
H-1, H-2	4 <sup>b</sup>
F-2, S-2, R-3, R-4	2

- 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.

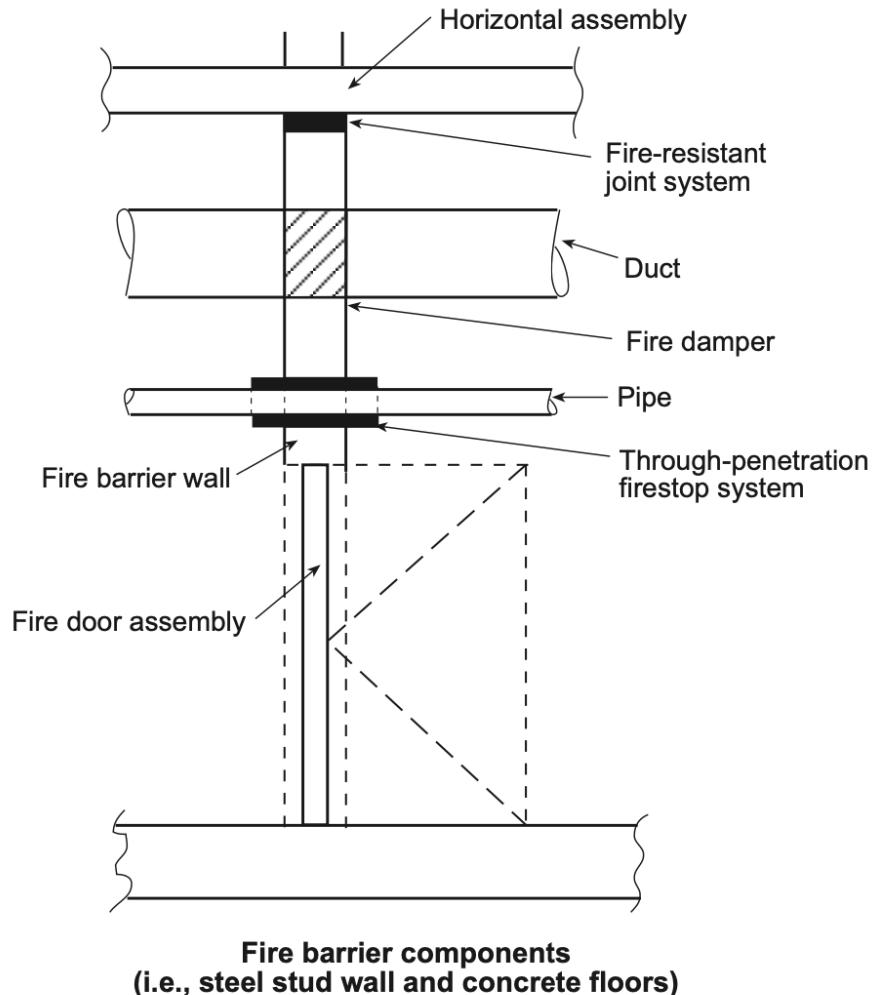
A fire wall separating Type VA buildings housing Group M occupancies must have a minimum fire-resistance rating of \_\_\_\_\_ hour(s).

- a. 1
- b. 2
- c. 3
- d. 4

## 707.1, 202 Fire Barriers: Definition and Scope

- A fire barrier is a fire-resistance-rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained. Fire barriers installed as required elsewhere in the International Building Code or the International Fire Code shall comply with Section 707.
- The term fire barrier is specific in the IBC and is used to describe a unique type of vertical fire separation element. Many of the building elements required to be constructed as fire barriers are listed in Section 707.3, including shaft enclosures, enclosures for interior exit stairways and exit access stairways, exit passageways, horizontal exits, atriums, incidental uses, control areas, separation of mixed occupancies and separation of fire areas.

# 707.1, 202 Fire Barriers: Definition and Scope



Fire barriers may also be mandated for specific conditions not specifically mentioned in Section 707. Throughout the IBC, as well as the other *International Codes*, fire barriers are identified as the element used to provide the necessary fire separation for compartmentation of building spaces.

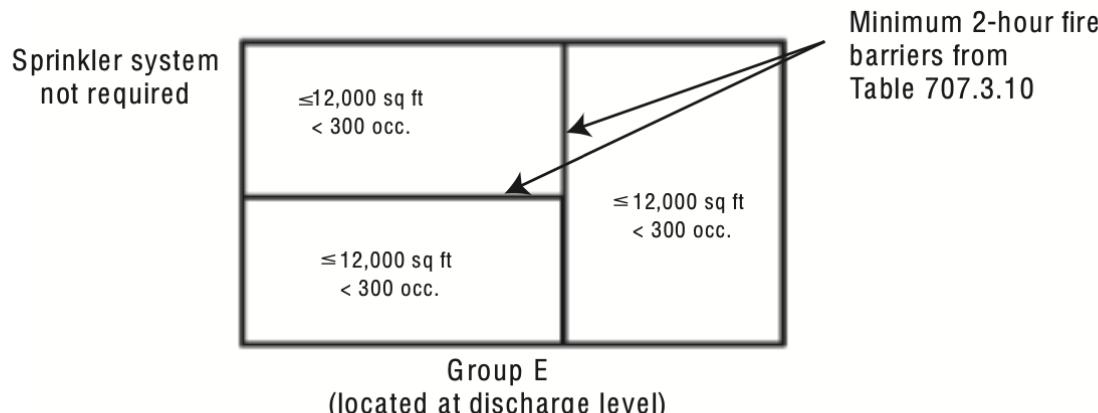
Source: 2021 IBC

## 707.3.10, Table 707.3.10 Fire Areas

- The fire barriers, fire walls or horizontal assemblies, or combination thereof, separating a single occupancy into different fire areas shall have a fire-resistance rating of not less than that indicated in Table 707.3.10. The fire barriers, fire walls or horizontal assemblies, or combination thereof, separating fire areas of mixed occupancies shall have a fire-resistance rating of not less than the highest value indicated in Table 707.3.10 for the occupancies under consideration.
- The code recognizes that in many buildings there are two methods to limit the spread of fire, either: (1) the use of an automatic sprinkler system, or (2) the creation of fire-resistive compartments that contain a fire's movement (fire areas). Section 903.2 identifies those occupancies where compartmentation is an acceptable alternative to a sprinkler system. Table 707.3.10 then mandates the minimum level of fire resistance of the fire barriers utilized to separate the building into two or more compartments (fire areas). As a result, the use of Table 707.3.10 is only applicable in buildings not protected by an automatic sprinkler system.

# 707.3.10, Table 707.3.10 Fire Areas

Example of the use of fire area concept



For SI: 1 square foot = 0.093 m<sup>2</sup>

**TABLE 707.3.10**  
**FIRE-RESISTANCE RATING REQUIREMENTS FOR**  
**FIRE BARRIERS, FIRE WALLS OR HORIZONTAL**  
**ASSEMBLIES BETWEEN FIRE AREAS**

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
H-1, H-2	4
F-1, H-3, S-1	3
A, B, E, F-2, H-4, H-5, I, M, R, S-2	2
U	1

A fire area is considered the aggregate floor area enclosed and bounded by fire walls, fire barriers, exterior walls or horizontal assemblies of a building. The floor area under a canopy or similar horizontal projection is also included in the fire area determination.

ce: 2021 IBC

## 707.3.10, Table 707.3.10 Fire Areas

Fire barriers are required for the separation of all of the following building elements, except \_\_\_\_\_.

- a. shaft enclosures
- b. exit passageways
- c. incidental uses
- d. fire-resistance-rated corridors

## 707.3.10, Table 707.3.10 Fire Areas

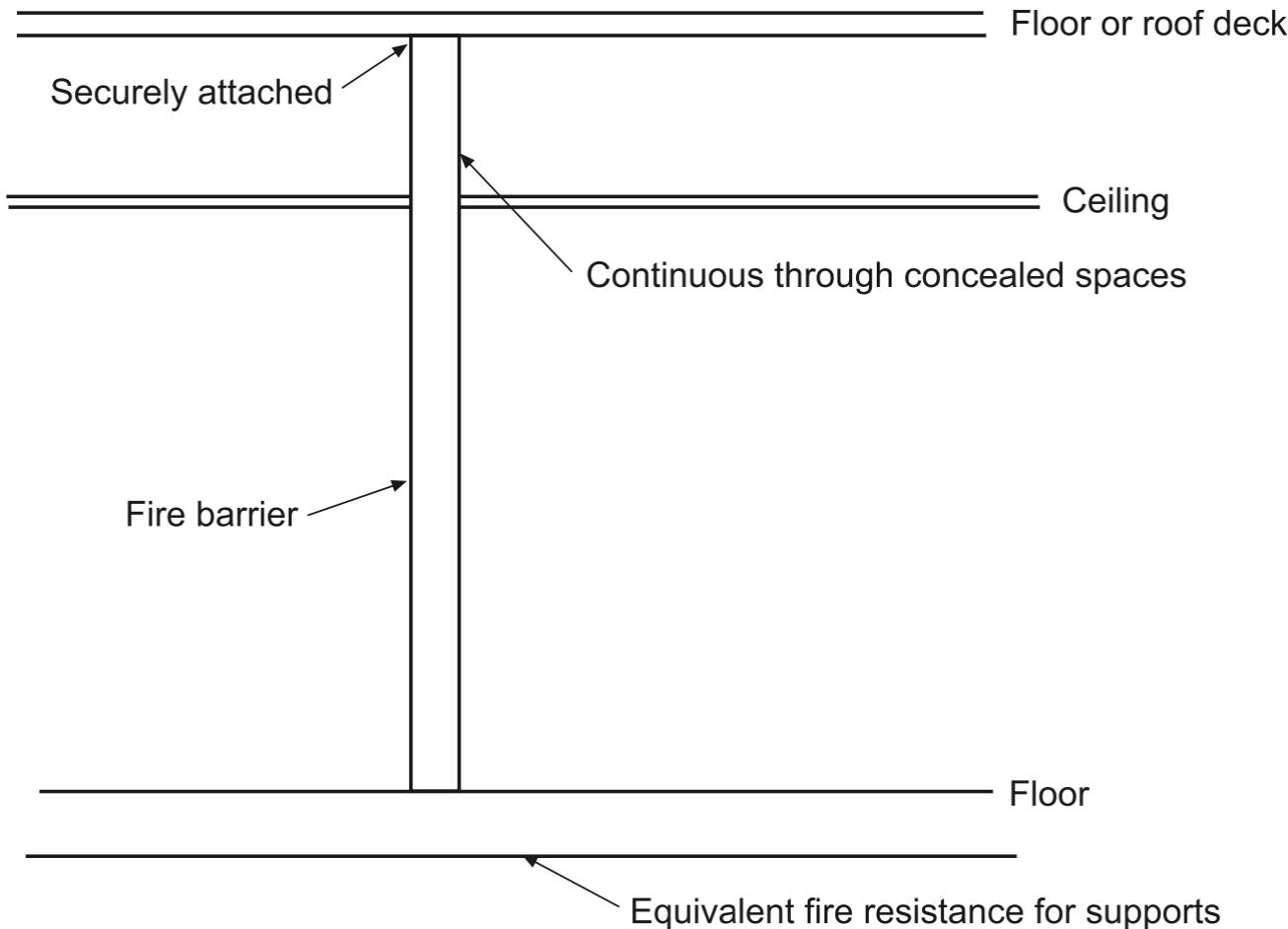
Fire barriers are required for the separation of all of the following building elements, except \_\_\_\_\_.

- a. shaft enclosures
- b. exit passageways
- c. incidental uses
- d. fire-resistance-rated corridors

## 707.5, 707.5.1 Continuity: Fire Barriers

- Fire barrier walls shall extend from the top of the floor/ceiling assembly below to the underside of the floor or roof sheathing, slab or deck above and shall be securely attached thereto. Such fire barriers shall be continuous through concealed spaces, such as the space above a suspended ceiling. See the exceptions for shaft, stairway and ramp, and exit passageway enclosures. The supporting construction for fire barrier walls shall be protected to afford the required fire-resistance rating of the fire barrier supported. See the exceptions for fire barriers: (1) separating tank storage in accordance with Section 415.9.1.2, and (2) enclosing incidental uses.
- Where a wall is required to serve as a fire barrier, it must be tight from floor deck to floor or roof deck in order to provide a full separation. A fire barrier is often used in conjunction with a horizontal assembly in a multistory building to provide a complete separation.

## 707.5, 707.5.1 Continuity: Fire Barriers



Under most conditions, the structural members or assemblies supporting fire barriers must be provided with equivalent or better fire resistance. It is important that the integrity of fire barriers supported by other building elements be maintained for the mandated time period.

Source: 2021 IBC

## 707.5, 707.5.1 Continuity: Fire Barriers

In Type VB buildings, construction supporting fire barriers need not be protected by equivalent fire resistance where the fire barriers are used for \_\_\_\_\_.

- a. 1-hour occupancy separations
- b. 1-hour interior exit stairways
- c. 1-hour incidental use separations
- d. 2-hour horizontal exits

## 707.5, 707.5.1 Continuity: Fire Barriers

In Type VB buildings, construction supporting fire barriers need not be protected by equivalent fire resistance where the fire barriers are used for \_\_\_\_\_.

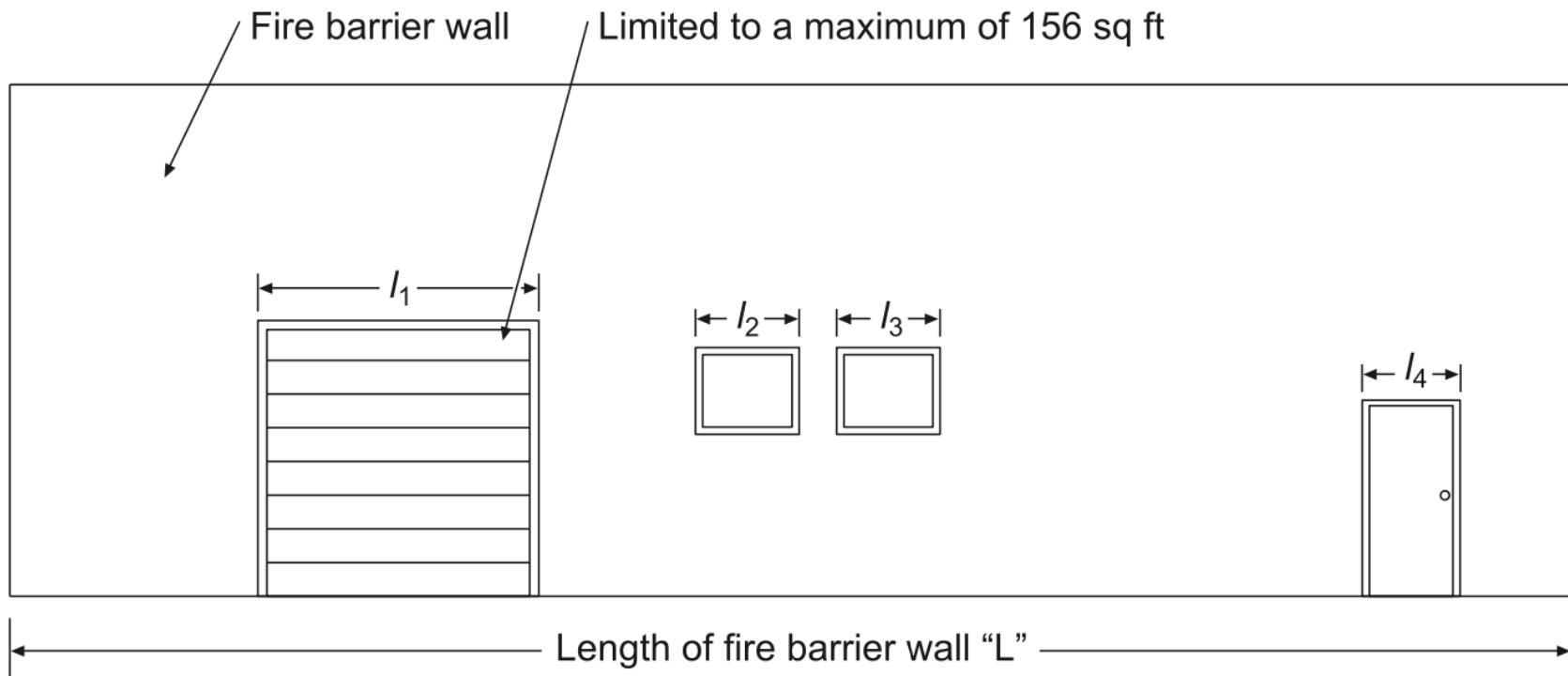
- a. 1-hour occupancy separations
- b. 1-hour interior exit stairways
- c. 1-hour incidental use separations
- d. 2-hour horizontal exits

## 707.6 Openings: Fire Barriers

- Openings in a fire barrier shall be protected in accordance with Section 716. Openings shall be limited to a maximum aggregate width of 25 percent of the length of the wall, and the maximum area of any single opening shall not exceed 156 square feet (15 m<sup>2</sup>). Openings in enclosures for exit access stairways and ramps, interior exit stairways and ramps and exit passageways shall also comply with Sections 1019, 1023.4 and 1024.5, respectively. See the exceptions for (1) sprinklered adjoining floor areas, (2) fire doors serving an interior exit stairway or exit access stairway, (3) openings tested per ASTM E119 or UL 263, (4) fire windows in atrium separation walls and (5) fire doors separating an interior exit stairway/ramp or exit access stairway/ramp from an exit passageway.
- As openings in a fire barrier create a potential breach in the integrity of the fire-resistive separation, a limit is placed on the amount of permitted openings. The limitation allows for design flexibility without compromising the necessary level of fire separation. The aggregate area of such openings is not limited; however, each opening is limited to 156 square feet.

# 707.6 Openings: Fire Barriers

1



For SI: 1 square foot = 0.093 m<sup>2</sup>.

## Opening in Fire-barrier Walls

As is the case with fire walls and fire partitions, penetrations, joints, ducts and air transfer openings are typically protected or prohibited when they occur in fire barriers.

## 707.6 Openings: Fire Barriers

In a nonsprinklered building, any single opening in a fire barrier used for separating control areas is limited to a maximum area of \_\_\_\_\_ square feet.

- a. 20
- b. 100
- c. 120
- d. 156

## 707.6 Openings: Fire Barriers

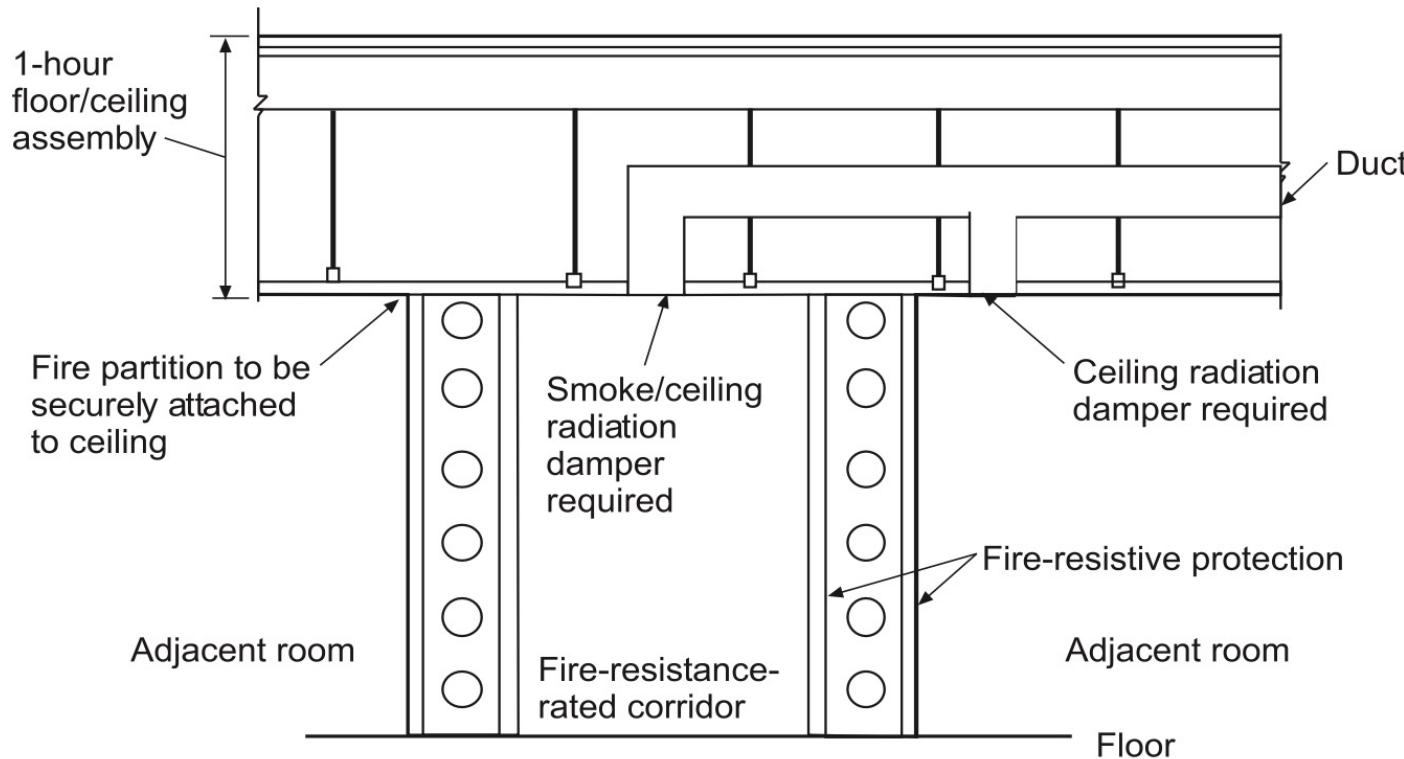
In a nonsprinklered building, any single opening in a fire barrier used for separating control areas is limited to a maximum area of \_\_\_\_\_ square feet.

- a. 20
- b. 100
- c. 120
- d. 156

# 708.1, 202 Fire Partitions: Definition and Scope

- A fire partition is a vertical assembly of materials designed to restrict the spread of fire in which openings are protected. The following wall assemblies shall comply with Section 708: (1) separation walls as required by Section 420.2 for Group I-1 and Group R occupancies; (2) walls separating tenant spaces in covered and open mall buildings as required by Section 402.4.2.1, (3) corridor walls as required by Section 1020.3, (4) enclosed elevator lobby separation as required by Section 3006.3, (5) egress balconies as required by Section 1021.2, (6) walls separating ambulatory care facilities from adjacent spaces, and (7) vestibules per Section 1028.2. Fire partitions shall have a fire-resistance rating of not less than 1 hour. See the exceptions for ratings reductions for corridor walls and dwelling unit/sleeping unit separations.
- Typically required to have a fire-resistance-rating of one-hour, fire partitions provide a moderate level of separation that is necessary under certain conditions. Although fire partitions have limited applications, they are important elements in the specific uses and areas in which they are mandated.

# 708.1, 202 Fire Partitions: Definition and Scope



The suspended ceiling is used to provide fire protection for the structural members above. Dampers are required wherever ducts pierce the rated ceiling.

## Corridor fire partitions

In sprinklered buildings of Types IIB, IIIB and VB construction, the 1-hour fire-resistance rating for dwelling unit and guestroom separations may be reduced to  $\frac{1}{2}$  hour. For a typical wood-stud wall system, this separation could be satisfied with  $\frac{1}{2}$ -inch gypsum board installed on each side.

Source: 2021 IBC

# 708.1, 202 Fire Partitions: Definition and Scope

A fire partition is not the appropriate wall assembly for walls separating

- 
- a. sleeping units in a Group R-1 hotel
  - b. tenant spaces in a covered mall building
  - c. control areas in a manufacturing occupancy
  - d. dwelling units in an apartment building

# 708.1, 202 Fire Partitions: Definition and Scope

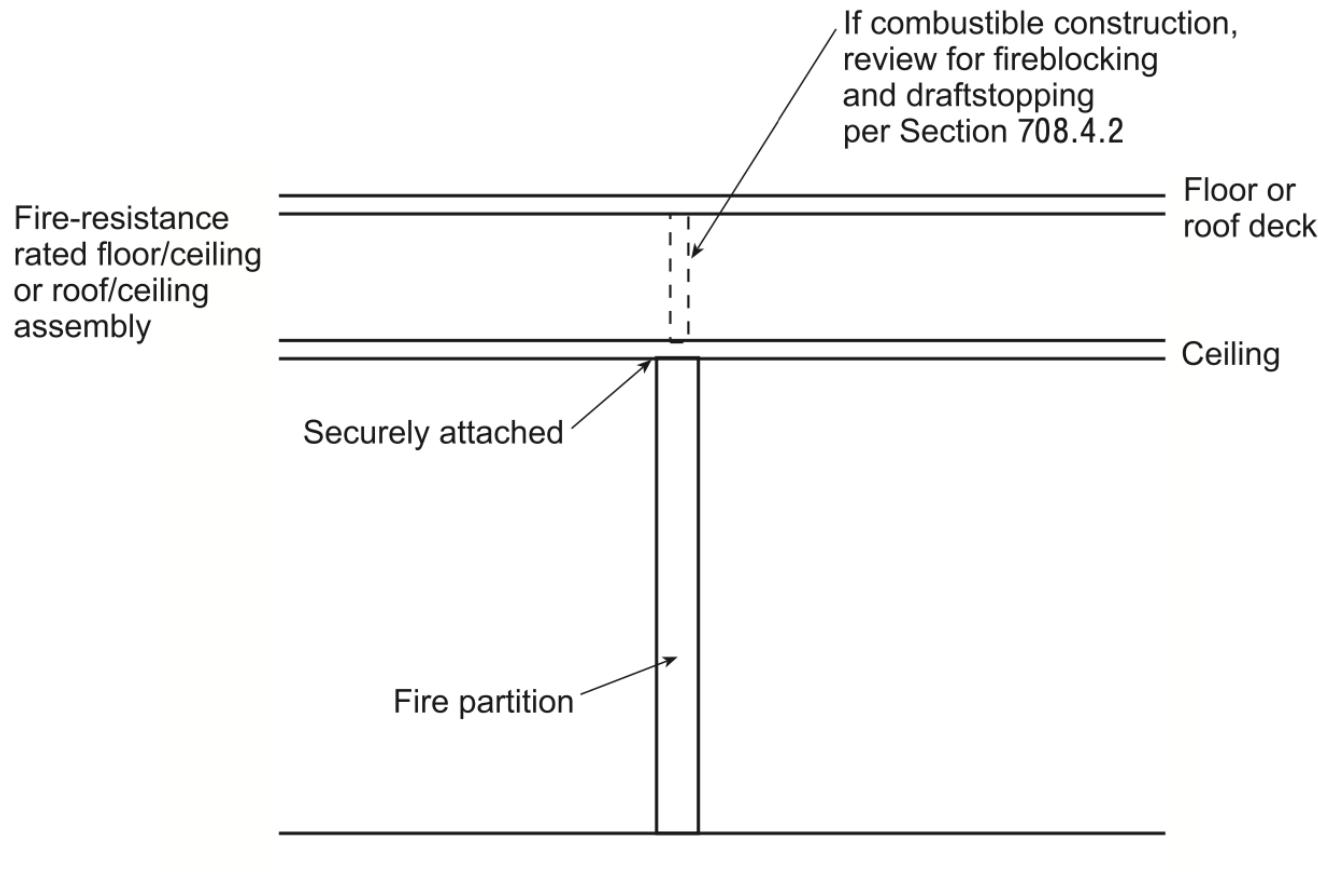
A fire partition is not the appropriate wall assembly for walls separating

- 
- a. sleeping units in a Group R-1 hotel
  - b. tenant spaces in a covered mall building
  - c. control areas in a manufacturing occupancy
  - d. dwelling units in an apartment building

## 708.4 Fire Partitions: Continuity

- Fire partitions shall extend from the top of the foundation or floor/ceiling assembly below and be securely attached to one of the following: (1) the underside of the floor or roof sheathing, deck or slab above; or (2) the underside of a fire-resistance-rated floor/ceiling or roof/ceiling assembly having a fire-resistance rating that is not less than the fire-resistance rating of the fire partition. See four exceptions to these continuity options. The supporting construction for a fire partition shall have a fire-resistance rating that is equal to or greater than the required fire-resistance rating of the supported fire partition. See exception for conditions where rating is not required.
- The method of continuity is a primary difference between fire barriers and fire partitions. Fire partitions need not extend through a concealed space, such as the one above a suspended ceiling, provided that the ceiling is a portion of a fire-resistance-rated floor/ceiling or roof/ceiling assembly.

## 708.4 Fire Partitions: Continuity



A variety of additional methods are described for creating a fire-resistance-rated corridor. A common construction technique is the “tunnel” corridor, where the corridor ceiling is constructed in a manner consistent with that of the corridor walls.

## 708.4 Fire Partitions: Continuity

Where a fire-resistance-rated corridor ceiling is constructed as required for the corridor walls, the walls shall not terminate before reaching \_\_\_\_\_.

- a. the lower membrane of the ceiling assembly
- b. the upper membrane of the ceiling assembly
- c. the underside of the floor or roof deck above
- d. an approved fire-resistant joint system

## 709.4, 202 Smoke Barriers: Definition and Continuity

- A smoke barrier is 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. Smoke barriers shall form an effective membrane continuous from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, deck or slab above, including continuity through concealed spaces, such as those found above suspended ceilings, and including interstitial structural and mechanical spaces. See the exceptions where ceilings or exterior walls provide resistance to fire and smoke equivalent to the resistance provided by smoke barrier walls.
- Where the primary concern of the code is the containment of smoke, the use of a smoke barrier is mandated. The locations for smoke barriers are found in various provisions in the IBC, including Section 407.5 for Group I-2 occupancies and Section 1009.6.4 for areas of refuge.

# 709.4, 202 Smoke Barriers: Definition and Continuity

## Required Use of Smoke Barriers

- Compartmentation of underground buildings (Sec. 405.4.2)
- Compartmentation of Group I-2 (Sec. 407.5)
- Compartmentation of Group I-3 (Sec. 408.6)
- Compartmentation of ambulatory care facilities (Sec. 422.3)
- Compartmentation of Group I-1, Condition 2 (Sec. 420.6)
- Smoke control systems (Sec. 402.7.2, 404.5 and 909.5)
- Areas of refuge (Sec. 1009.6.4)

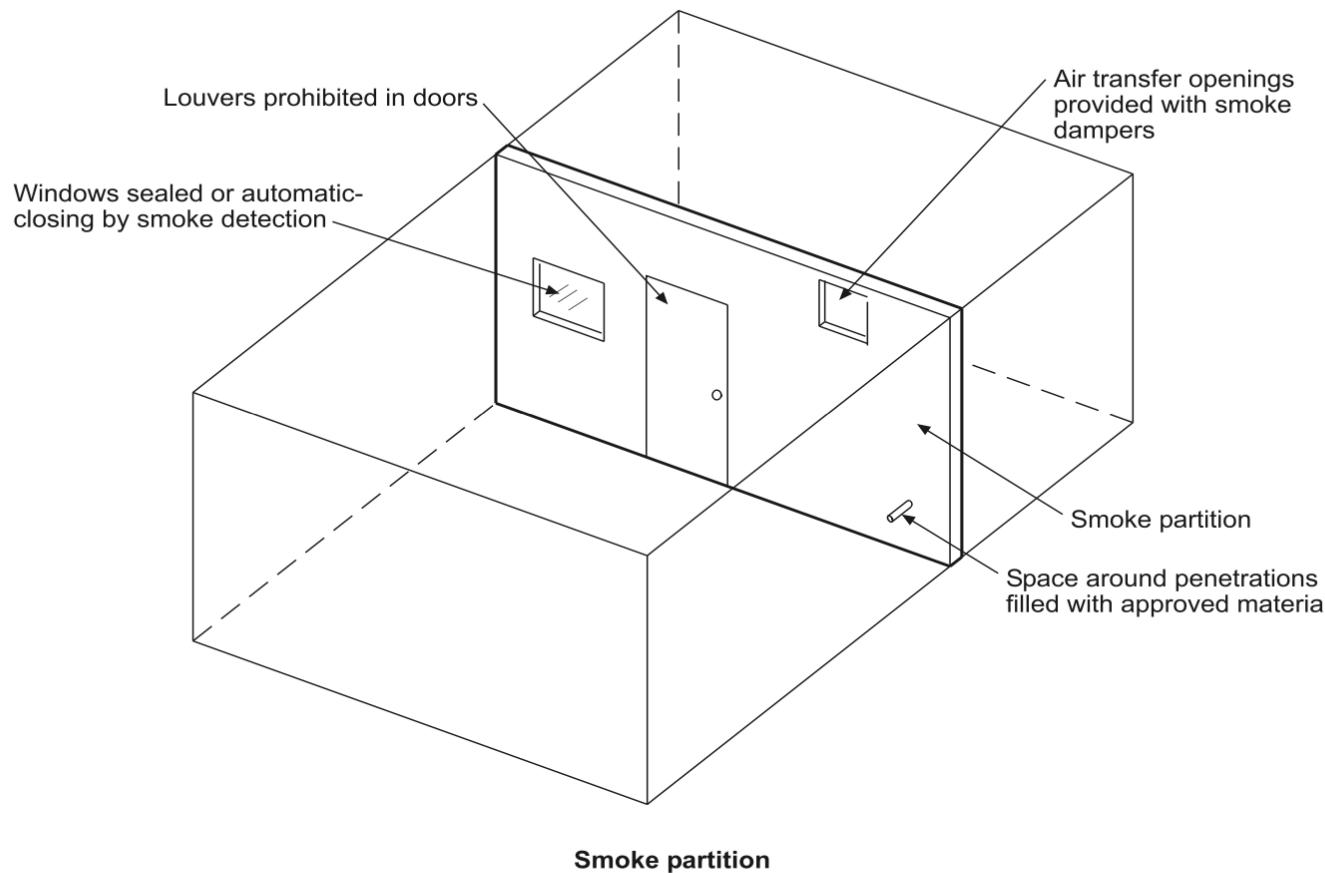
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A smoke barrier must have a minimum 1-hour fire-resistance rating. Openings, penetrations, joints, ducts and transfer openings must also be protected to minimize the passage of smoke through the barrier. Opening protectives must have a minimum 20-minute fire-protection rating.

# 710 Smoke Partition: General Provisions

- Smoke partitions installed as required elsewhere in the IBC shall comply with Section 710. The walls shall be of materials permitted by the building type of construction. Unless required elsewhere in the IBC, smoke partitions are not required to have a fire- resistance rating. Smoke partitions shall extend from the top of the foundation or floor below to the underside of the floor or roof sheathing, deck or slab above or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke.
- A smoke partition is designed for a singular purpose, to limit the movement of smoke from one area to another. Therefore, windows in smoke partitions must be sealed, penetrations and joints must be adequately filled, and smoke dampers used to protect air transfer openings. The most common application of smoke partitions is corridor walls of Group I-2 occupancies.

# 710 Smoke Partition: General Provisions



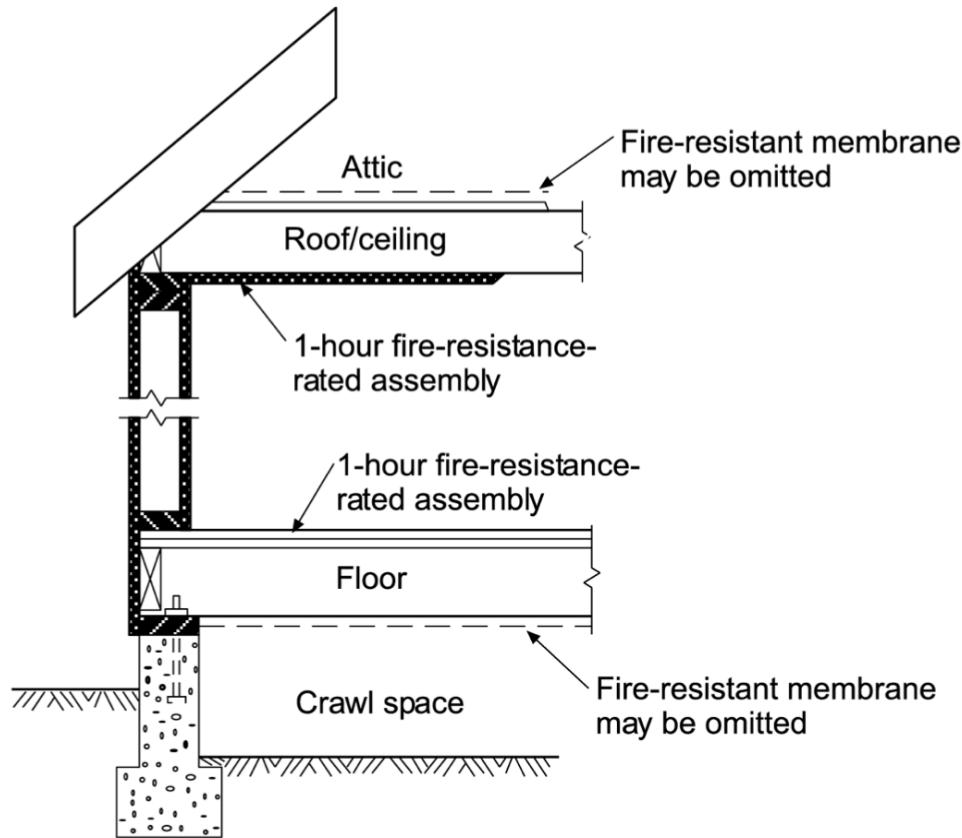
A smoke partition is a specific element with specific requirements, much like smoke barriers, fire barriers, fire partitions and fire walls. Only where the code specifically mandates smoke partitions are the requirements of Section 710 applicable.

Source: 2021 IBC

## 711.2 Fire-Resistance Rating

- Assemblies shall be continuous without vertical openings, except as permitted by Sections 711 and 712. The supporting construction shall be protected to afford the required fire-resistance rating of the horizontal assembly supported. See the exception for incidental uses, dwelling and sleeping unit separations and smoke barriers. The fire-resistance rating of horizontal assemblies shall comply with Sections 711.2.4.1 through 711.2.4.6 but shall be not less than that required by the building type of construction.
- Table 601 regulates the minimum fire-resistance ratings for floor construction based on the building's type of construction. This minimum level of fire-resistance must always be maintained. Other provisions of the code must also be considered where a horizontal separation is needed within a multistory building, such as for control areas or occupancy separations.

## 711.2 Fire-Resistance Rating



**Omission of ceiling and flooring in horizontal assemblies per Section 711.2.6**

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Other than permitted openings, penetrations or joints, horizontal assemblies must be continuous in order to isolate totally one floor from another. An allowance is permitted for fire-resistance-rated roof construction, where skylights and other penetrations may be unprotected.

## 711.2 Fire-Resistance Rating

Under which of the following conditions may the ceiling membrane of a fire-resistance-rated horizontal assembly be omitted?

- a. where usable attic space occurs above
- b. where the assembly has a minimum fire-resistance rating of 2 hours
- c. where the floor construction is limited to combustible construction
- d. where an unusable crawl space occurs below

## 712.1 Applications: Vertical Openings

- Each vertical opening shall comply in accordance with one of the protection methods in Sections 712.1.1 through 712.1.16.
- In multistory buildings, the upward transmission of fire, smoke and toxic gases through openings in the floor/ceiling assemblies continues to be a hazard of the highest degree. For many years, a shaft enclosure was considered the appropriate method to protect openings within a floor/ceiling assembly. Over time, other methods of protection have been identified as acceptable alternatives to the shaft enclosure approach. The IBC now places the emphasis on the presence of vertical openings while identifying the use of shaft enclosures as one of many protective measures that can be utilized to address the concern related to the vertical spread of fire, smoke and toxic gases.

# 712.1 Applications: Vertical Openings

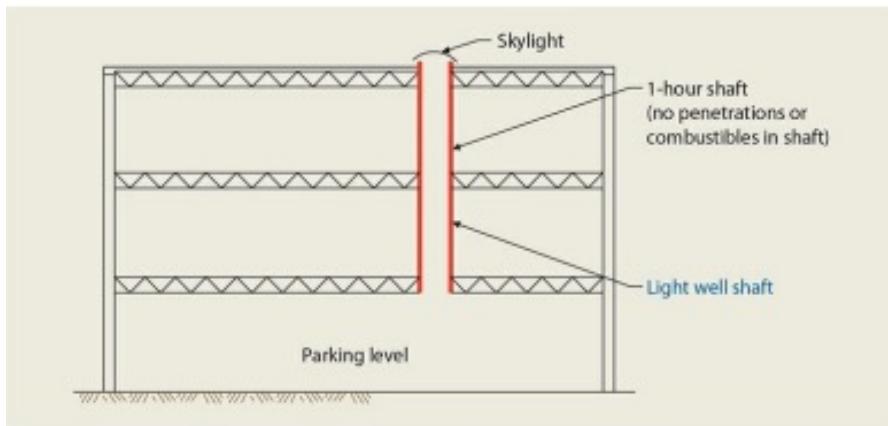


Figure 713-2 Vertical shafts—bottom enclosure.

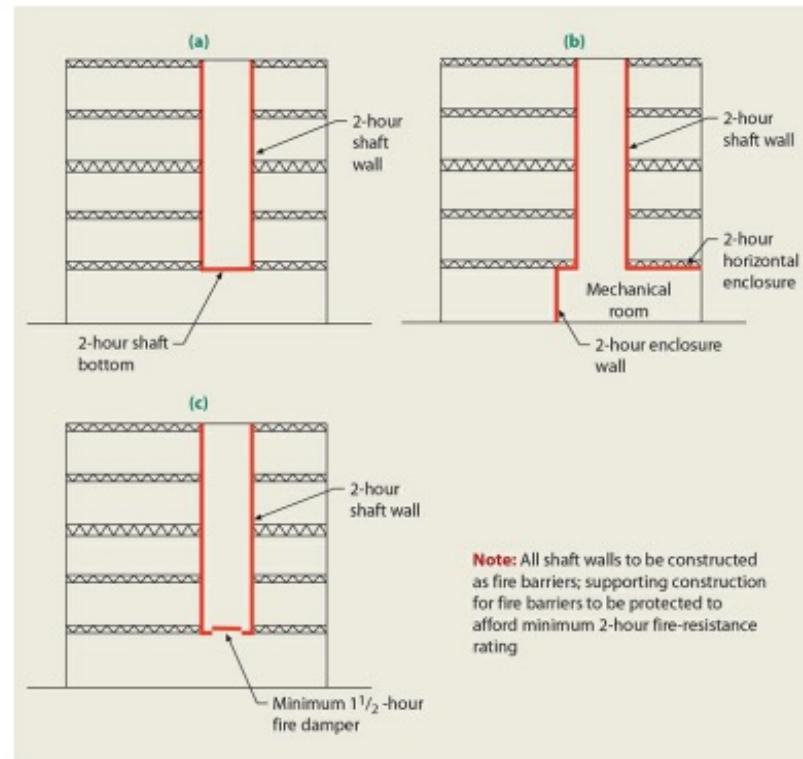


Figure 713-1 Enclosure at shaft bottom.

# **Class 7: Chapter 7, Sections 713 through 720—Fire and Smoke Protection Features III**

## 713-720 Objective

- To gain an understanding of shaft enclosures, fireblocking and draftstopping, as well as the methods of protecting fire-resistance-rated building components where they contain doors, windows, ducts, air transfer openings and penetrations.

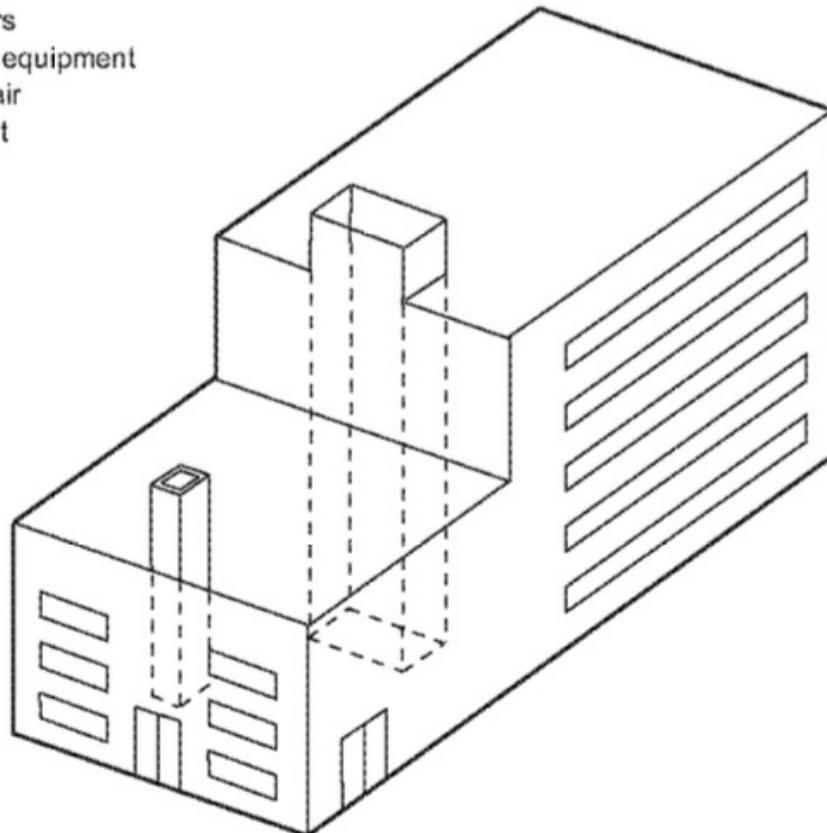
## 713.1, 202 Shaft Enclosures: Scope

- A shaft is an enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and roof. A shaft enclosure is the walls or construction forming the boundaries of a shaft. The provisions of Section 713 shall apply to shafts required to protect openings and penetrations through floor/ceiling and roof/ceiling assemblies.
- It is common in multistory buildings to have openings that are provided to accommodate elevators, mechanical equipment or similar devices, and to transmit light or ventilation air. Because of the potential for the rapid spread of fire, smoke and gases vertically through buildings, such vertical openings must be protected with fire-resistance-rated shaft enclosures or otherwise addressed in accordance with Section 712.

# 713.1, 202 Shaft Enclosures: Scope

Shaft enclosure utilized to enclose interior space extending through floors and may accommodate:

- Elevators
- Dumbwaiters
- Mechanical equipment
- Ventilation air
- Exterior light



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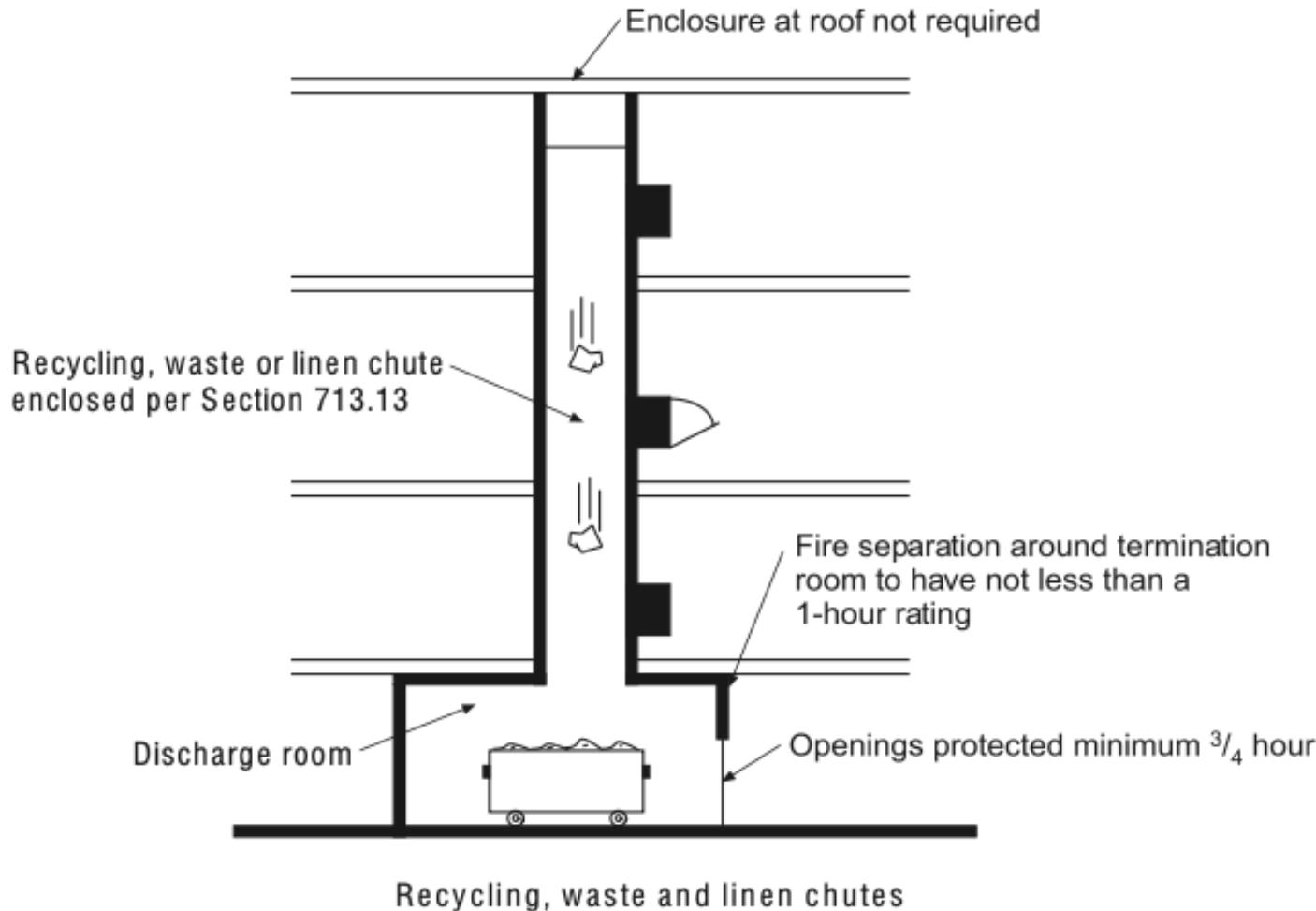
The fire-resistance rating required for a shaft enclosure is based on the building height, with 2 hours being required where four stories or more are connected. Where less than four stories are connected, 1 hour is required. The enclosure rating cannot be less than that of any floor penetrated.

Source: 2021 IBC

## 713.2, 713.7 Shaft Enclosures: Continuity

- Shaft enclosures shall be constructed as fire barriers in accordance with Section 707 or horizontal assemblies constructed in accordance with Section 711, or both. Openings in a shaft enclosure shall be protected in accordance with Section 716 as required for fire barriers. Doors shall be self- or automatic-closing by smoke detection in accordance with Section 716.2.6.6. Openings other than those necessary for the purpose of the shaft shall not be permitted in shaft enclosures.
- The general provisions dictate that a shaft be completely enclosed with fire-resistance-rated construction. However, there are conditions that modify this rule. The protection of exterior shaft walls is often unnecessary. Additionally, for those shafts that do not extend to the bottom of the building, the code provides three methods of maintaining the integrity of the shaft enclosure.

## 713.2, 713.7 Shaft Enclosures: Continuity



Where a shaft enclosure terminates short of the roof, the top enclosure must be constructed to a fire-resistance degree consistent with that of the top floor penetrated. In no case may the enclosure at the top be rated less than that for the remainder of the shaft enclosure.

Source: 2021 IBC

## 713.2, 713.7 Shaft Enclosures: Continuity

- . A shaft enclosure shall have a minimum 2-hour fire-resistance rating where connecting a minimum of \_\_\_\_\_ stories.
- a. two
  - b. three
  - c. four
  - d. six

# 713.13 Chute

**713.13.2 Materials.** A *shaft enclosure* containing a waste, recycling, or linen chute shall be constructed of materials as permitted by the building type of construction.

**713.13.3 Chute access rooms.** Access openings for waste, recycling or linen chutes shall be located in rooms or compartments enclosed by not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. Openings into the access rooms shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour. Doors shall be self- or automatic-closing upon the detection of smoke in accordance with Section 716.2.6.6. The room or compartment shall be configured to allow the access door to the room or compartment to close and latch with the access panel to the chute in any position.

**713.13.4 Chute discharge room.** Table 509.1Waste, recycling or linen chutes shall discharge into an enclosed room separated by *fire barriers* with a *fire-resistance rating* not less than the required fire rating of the *shaft enclosure* and constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with

# 713.13 Chute

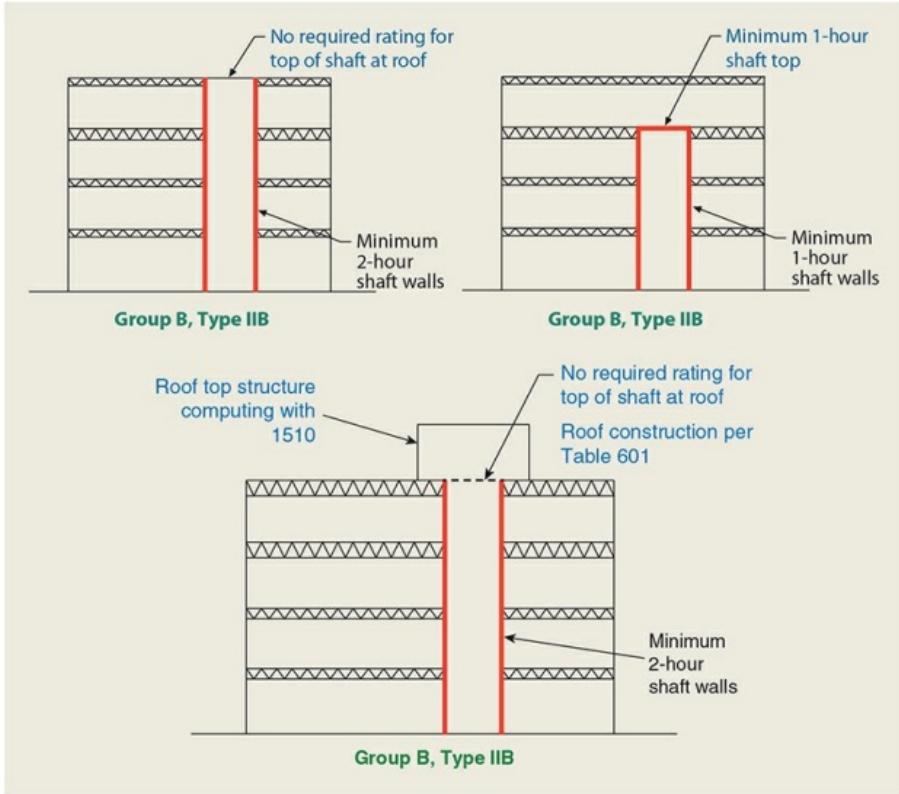


Figure 713-3 **Top enclosure of shaft.**

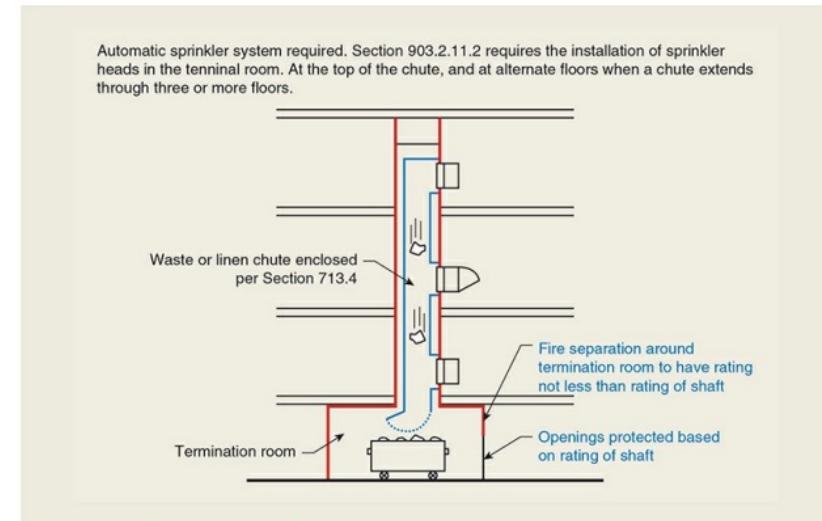


Figure 713-4 **Waste and linen chutes.**

## 713.13 Chute

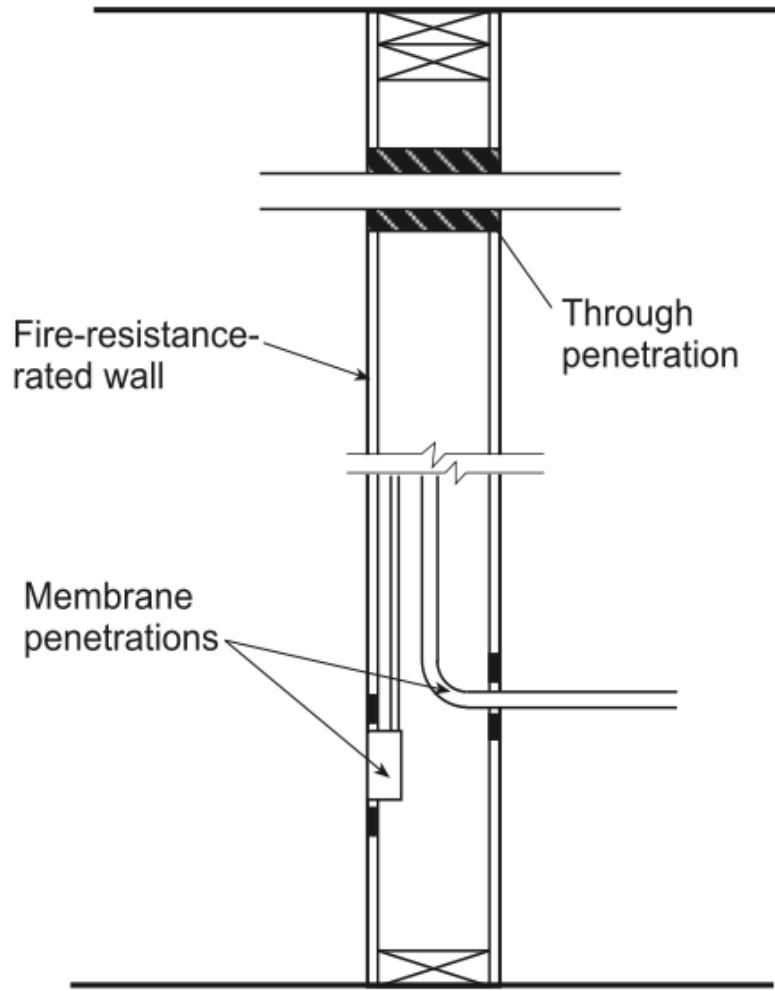
An opening into a linen chute access room shall be protected by an opening protective having a minimum fire protection rating of \_\_\_\_\_.

- a. 20 minutes
- b. 45 minutes
- c. 1 hour
- d.  $1\frac{1}{2}$  hours

# 714.1, 202 Penetrations: Definitions and Scope

- A through penetration is a breach in both sides of a floor, floor-ceiling or wall assembly to accommodate an item passing through the breaches. A membrane penetration is a breach in one side of a floor-ceiling, roof-ceiling or wall assembly to accommodate an item installed into or passing through the breach. The provisions of Section 714 shall govern the materials and methods of construction used to protect through penetrations and membrane penetrations of horizontal assemblies and fire-resistance-rated wall assemblies.
- Fire-resistance-rated walls and horizontal assemblies are usually penetrated, both fully and partially, with piping, conduit, outlet boxes, cable, vents and similar penetrating items. The IBC regulates both the materials and the methods of penetration based on the specific conditions that exist. Where sleeves are used, they must be fastened securely in place, and all open space within and around the sleeve must be appropriately protected.

# 714.1, 202 Penetrations: Definitions and Scope



Penetrations of nonfire-resistance-rated horizontal assemblies are regulated by Section 714.6. Although some horizontal assemblies may not require a fire-resistance rating, the code intends that some degree of separation (compartmentalization) be provided from one story to another.

Source: 2021 IBC

# 714.1, 202 Penetrations: Definitions and Scope

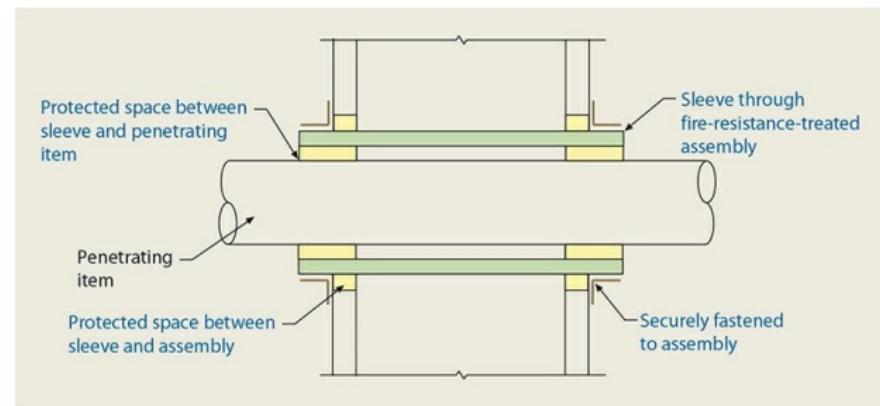
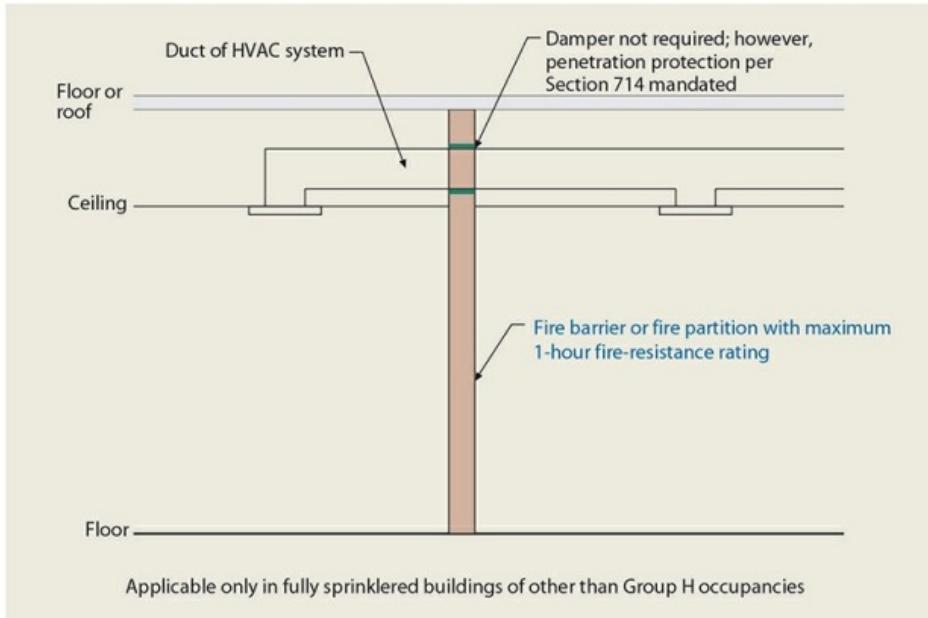
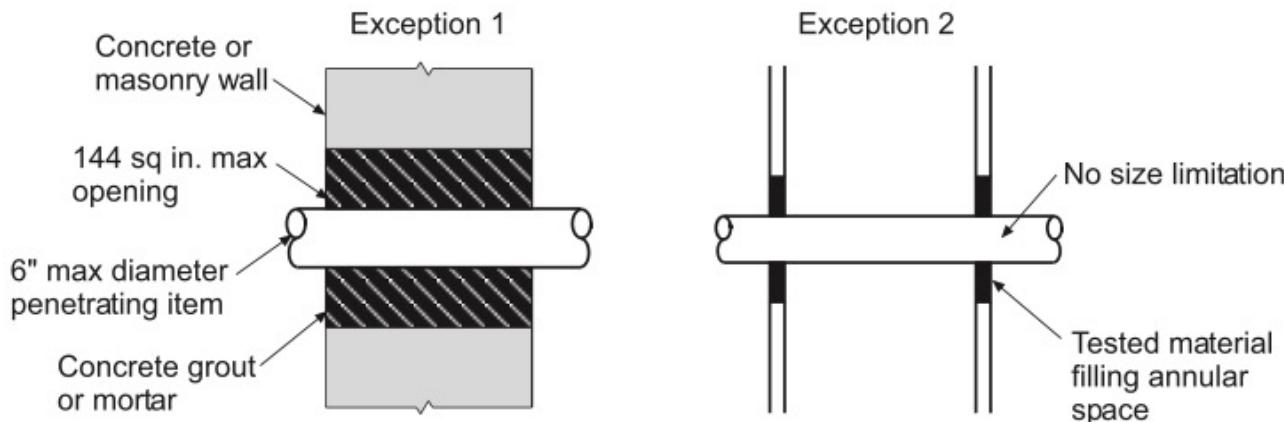
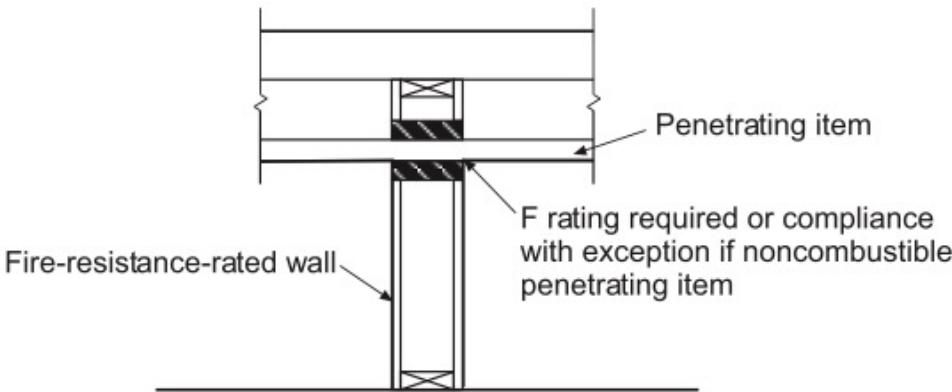


Figure 714-2 Penetration sleeve.

## 714.4 Penetrations: Fire-Resistance-Rated Walls

- Penetrations into or through fire walls, fire barriers, smoke barrier walls, and fire partitions shall comply with Sections 714.4.1 through 714.4.3. Penetrations in smoke barrier walls shall also comply with Section 714.5.4.
- In general, penetrations into or through fire-resistance-rated walls must be either protected with an approved through-penetration firestop system or installed as a tested component of an approved fire-resistance-rated assembly. These methods are considered proprietary, with each penetration being regulated by the specifics of the installation. Two generic methods are identified as exceptions to the general requirements; however, both methods are based on the penetration only of steel, ferrous or copper pipes or steel conduits. Under such conditions, the annular space around the penetrating items shall be filled with an appropriate material.

## 714.4 Penetrations: Fire-Resistance-Rated Walls



**Penetrating items to be steel, ferrous or copper pipes, or steel conduit**

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>.

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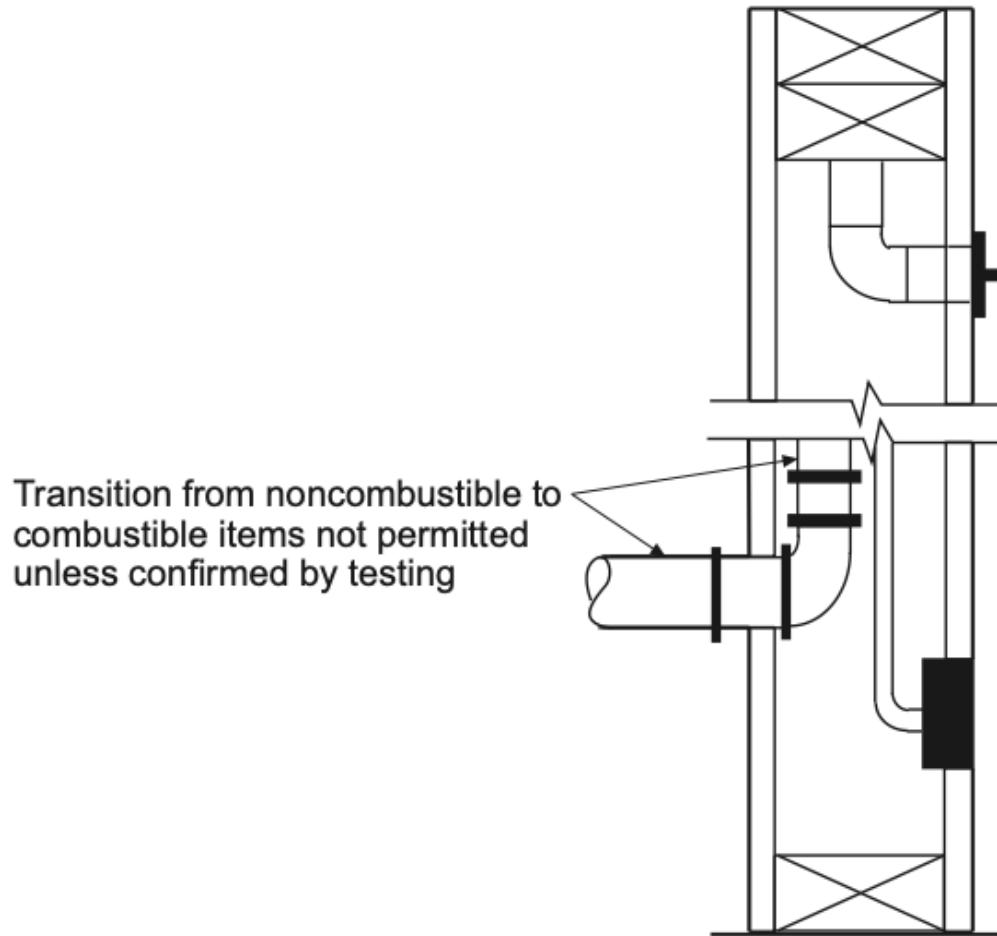
Membrane penetrations are usually addressed in the same manner as through penetrations. Additional exceptions address steel outlet boxes of limited size, listed electrical outlet boxes and fire sprinklers covered by metal escutcheon plates.

Source: 2021 IBC

## 714.4.3, 717.1.2 Penetrations: Fire-Resistance-Rated Walls

- Noncombustible penetrating items shall not connect to combustible items beyond the point of firestopping unless it can be demonstrated that the fire-resistance integrity of the wall is maintained. Ducts that penetrate fire-resistance-rated assemblies and are not required by Section 717 to have fire dampers shall comply with the requirements of Sections 714.3 through 714.4.3.
- Duct penetrations of fire-resistance-rated wall assemblies are typically protected with fire dampers in accordance with Section 717.5. However, in those locations where dampers are not required, it is still necessary to address the structural integrity of the fire resistive-rated wall where it is penetrated. Thus, the space between the duct and the wall must be protected in a manner consistent with that used for pipes, conduits and similar items.

## 714.4.3, 717.1.2 Penetrations: Fire-Resistance-Rated Walls



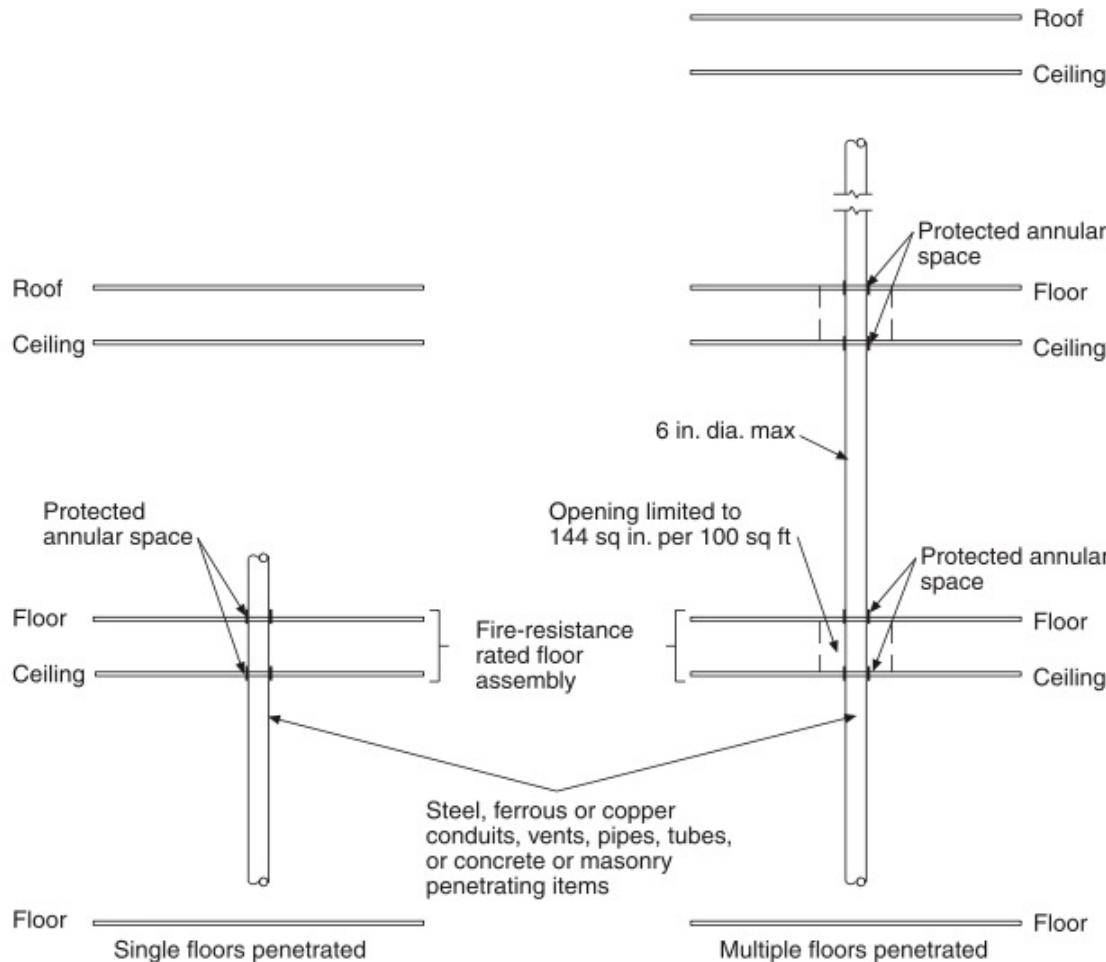
To prevent the creation of an open penetration, the transition from a noncombustible penetrating item to a combustible item is prohibited beyond the point of firestopping. Such a condition is only permitted when its suitability has been demonstrated through testing.

Source: 2021 IBC

## 714.5 Penetrations: Horizontal Assemblies

- Penetrations of a fire-resistance-rated floor, fire-resistance-rated floor/ceiling assembly or the ceiling membrane of a roof/ceiling assembly not required to be enclosed in a shaft by Section 712.1 shall be protected in accordance with Sections 714.5.1 through 714.5.4. Through penetrations of horizontal assemblies shall comply with Section 714.5.1.1 or 714.5.1.2.
- Where horizontal construction is penetrated by a duct, pipe, tube, wire, conduit, cable, vent or similar item, the primary requirements are based on Section 713 for shaft enclosures. However, Section 712.1.4 permits the use of Section 714 for both through penetrations and membrane penetrations. The provisions for horizontal assemblies are very similar to those for walls, with special allowances for steel, copper or ferrous penetrating items. Where the penetrations occur in smoke barriers, any firestop system must also be tested for air leakage and provided with the appropriate L rating.

# 714.5 Penetrations: Horizontal Assemblies



**Penetrations of horizontal assemblies**

For SI: 1 square inch = 645.16 mm<sup>2</sup>, 1 square foot = 0.093 m<sup>2</sup>.

Nonfire-resistance-rated wall assemblies need not be protected where penetrated by conduits, piping and similar penetrating items. However, such protection is mandated for the penetration of nonfire-resistance-rated horizontal assemblies to limit vertical fire spread.

Source: 2021 IBC

# Fire-Resistance-Rated Joint Systems - 2021 IBC

In fire-resistance-rated construction, the joints where differing systems meet require fire protection, to the same degree that the assemblies require fire protection. These rules are found in Chapter 7 of the IBC (2021 edition used for this presentation), Section 715

## CHAPTER 7 FIRE AND SMOKE PROTECTION FEATURES ..... 7-1

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# Fire-Resistance-Rated Joint Systems - 2021 IBC

Fire-Resistance-Rated joints shall be installed at rated assembly intersections that include the following:

- walls/partitions
- floors
- floor/ceiling assemblies
- roofs
- roof/ceiling assemblies.

Ratings need to match, i.e. a 1-hour joint for 1-hour assemblies, etc.

**715.3 Fire-resistance-rated assembly intersections.** *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.

**715.3.1 Fire test criteria.** *Fire-resistant joint systems* shall be tested in accordance with the requirements of either ASTM E1966 or UL 2079. Nonsymmetrical wall *joint* systems shall be tested with both faces exposed to the furnace, and the assigned *fire-resistance rating* shall be the shortest duration obtained from the two tests. Where evidence is furnished to show that the wall was tested with the least fire-resistant side exposed to the furnace, subject to acceptance of the *building official*, the wall need not be subjected to tests from the opposite side.

Let's look at some of these defined terms.

# Fire-Resistance-Rated Joint Systems - 2021 IBC

**[BS] JOINT.** The opening in or between adjacent assemblies that is created due to building tolerances, or is designed to allow independent movement of the building in any plane caused by thermal, seismic, wind or any other loading.

Fire-resistant joint systems must be tested!

**[BF] FIRE-RESISTANT JOINT SYSTEM.** An assemblage of specific materials or products that are designed, tested and fire-resistance rated in accordance with either ASTM E1966 or UL 2079 to resist for a prescribed period of time the passage of fire through *joints* made in or between fire-resistance-rated assemblies.

**[BF] FIRE-RESISTANCE RATING.** The period of time a *building element*, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 703.

What does ASTM E 1966 require?

# ASTM E 1966 – Standard Test Method for Fire-Resistive Joint Systems

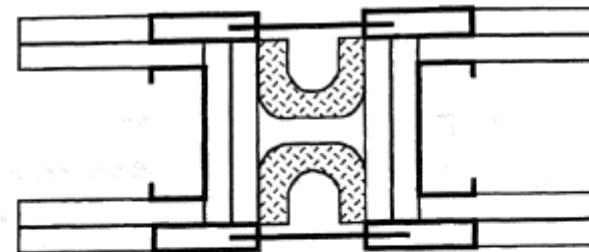
## 1. Scope

1.1 This fire-test-response test method measures the performance of joint systems designed to be used with fire rated floors and walls during a fire endurance test exposure. The fire endurance test end point is the period of time elapsing before the first performance criteria is reached when the joint system is subjected to one of two time-temperature fire exposures.

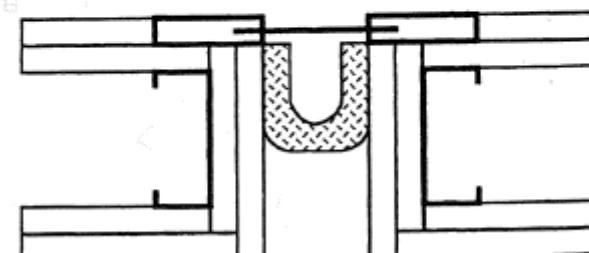
1.2 The fire exposure conditions used are either those specified by Test Method E 119 for testing assemblies to standard time-temperature exposures or Test Method E 1529 for testing assemblies to rapid-temperature rise fires.

1.3 This test method specifies the heating conditions, methods of test, and criteria for the evaluation of the ability of a joint system to maintain the fire resistance where hourly rated fire-separating elements meet.

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



Typical Symmetrical Wall-to-Wall Joint System



Typical Asymmetrical Wall-to-Wall Joint System

FIG. 6 Examples of Wall-to-Wall Joint Systems in Gypsum Wallboard Assemblies

# ASTM E 1966 – Standard Test Method for Fire-Resistive Joint Systems

## 15. Conditions of Compliance

15.1 *Movement Cycling Test*—When movement cycling is conducted, the fire resistive joint system shall have completed at least the minimum number of movement cycles using at least the minimum cyclic rate for the movement type selected.

15.2 *Fire Endurance Test*—Each fire resistive joint system tested shall comply with the following.

15.2.1 The fire endurance rating of the fire resistive joint system shall be determined as the time at whichever of the following conditions occurs first:

15.2.1.1 The temperature rise of any one thermocouple on the unexposed face of the test specimen or adjacent supporting construction is more than 325°F (181°C) above the initial temperature, and

15.2.1.2 For maximum joint widths greater than 4 in. (102 mm), the average temperature rise of the thermocouples on the unexposed face of the test specimen and its supporting construction is more than 250°F (139°C) above the initial temperature.

15.2.2 When the test is continued beyond the rated endurance of the supporting construction, the unexposed thermocouples on the supporting construction in 12.2.4.4 are no longer considered in the conditions of compliance for the test specimen.

15.2.3 When Test Method E 119 is used and the indicated fire endurance rating is 60 min or more, it shall be increased or decreased by the following correction to compensate for significant variation of the measured furnace temperature from the standard time-temperature curve provided that the conditions of 12.6 are met. The correction is expressed by the following formula:

$$C = 2I(A - A_s) / 3(A_s + L) \quad (1)$$

where:

$C$  = correction to the indicated fire endurance in the same units as  $I$ ,

$I$  = indicated fire endurance in min,

$A$  = area under the actual time-temperature curve for the first three fourths of the indicated fire endurance in °F • min (°C • min),

$A_s$  = the area under the standard time-temperature curve for the first three fourths for the same part of the indicated fire endurance in °F • min (°C • min), and

$L$  = lag correction in the same units as  $A$  and  $A_s$ , 3240°F • min (1800°C • min), when furnace thermocouples specified in 6.3.1 are used.

## Movement Cycling Test, and Fire Endurance Test

# ASTM E 1966 – Standard Test Method for Fire-Resistive Joint Systems

**15.3 Integrity Test**— When the cotton pad test is conducted, the fire resistive joint system shall not have allowed the passage of flames or hot gases sufficient to ignite the cotton pad.

**15.4 Load Application**— When a load is applied, the fire resistive joint system shall have sustained the applied load for the full fire resistance period.

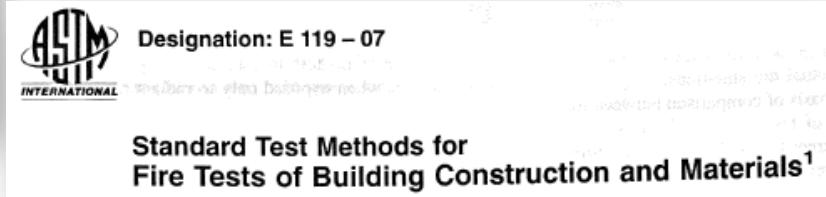
**15.5 Hose Stream Test**— When the hose stream test is conducted, the fire resistive joint system shall have withstood the hose stream test without developing any opening that permits a projection of water from the stream beyond the unexposed surface.

**15.5.1** A projection of water through a supporting construction within  $T/2$ , where  $T$  is equal to the maximum thickness of the adjacent supporting construction, of the longitudinal edge of the test specimen fails only that test specimen.

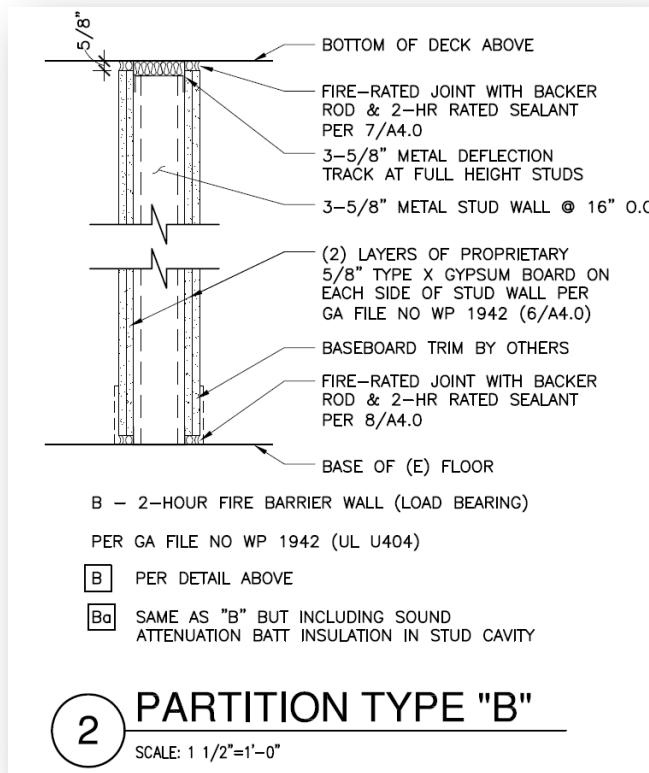
**15.5.2** A projection of water through a supporting construction between two test specimens outside  $T/2$  of the longitudinal edge of either test specimen shall not be deemed a failure of either test specimen.

## Integrity Test, Load Application, and Hose Stream Test.

Note: these are similar to the tests required in the ASTM E 119 test.

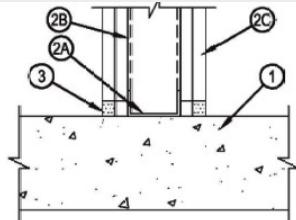


## Example of fire-resistance-rated joint detail



This example is a 2-hour rated fire barrier joining a concrete slab-on-ground floor and a 1-hour rated floor/ceiling assembly above. Note the top and bottom of the system require a fire-rated joint.

# Example of fire-resistance-rated joint detail



1. Floor Assembly — Min 4-1/2 in. (114 mm) thick reinforced lightweight or normal weight (100-150 pcf or 1600-2400 kg/m<sup>3</sup>) structural concrete. Floor may also be constructed of any 8 in. (152 mm) thick UL Classified hollow-core Precast Concrete Units\*. See Precast Concrete Units category in the Fire Resistance Directory for names of manufacturers.
  2. Wall Assembly — The 1 or 2 h fire-rated gypsum board/seal stud wall assembly shall be constructed of the materials and in the manner specified in the individual U400, V400 or W400 Series Wall or Partition Design in the UL Fire Resistance Directory. In addition, the wall may incorporate a head-of-wall joint system as specified in the H/W Series Joint Systems in the UL Fire Resistance Directory. The wall shall include the following construction features:
    - A. Steel Floor Runners — Floor runners of wall assembly shall consist of min No. 25 gauge galv steel channels sized to accommodate steel studs (Item 2B). Floor runners to be provided with 1-1/4 in. (32 mm) flanges. Runners secured with steel fasteners spaced 12 in. (305 mm) OC.
    - B. Studs — Steel studs to be min 3-1/2 in. (89 mm) wide. Studs cut 1/2 to 3/4 in. (13 to 19 mm) less in length than assembly height with bottom nesting in, resting on and fastened to floor runner with sheet metal screws. Stud spacing not to exceed 24 in. (610 mm) OC.
    - C. Gypsum Board\* — Gypsum board installed to a min total thickness of 5/8 or 1-1/4 in. (16 or 32 mm) on each side of wall for a 1 or 2 hr rated wall respectively. Wall to be constructed as specified in the individual U400, V400 or W400 Series Design in the UL Fire Resistance Directory, except that a max 3/4 in. (19 mm) gap shall be maintained between the bottom of gypsum board and top of concrete floor. The hourly fire rating of the joint system is equal to the hourly fire rating of the wall.
  3. Fill, Void or Cavity Material\* Sealant — Max separation between top of floor and bottom of gypsum board wall sheathing is 3/4 in. (19 mm). Min 5/8 in. (16 mm) thickness of fill material installed on each side of the wall between the bottom of the gypsum board and the top of the concrete floor, flush with each surface of the wall.
- HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — CP605 Bottom of Wall Firestop Sealant, CP601S Elastomeric Firestop Sealant, CP500 Flexible Firestop Sealant, GFS-S SIL GG, FS-ONE Sealant or FS-ONE MAX Intumescent Sealant
- \* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

2-HR RATED BOTTOM OF  
WALL JOINT: BW-S-0002

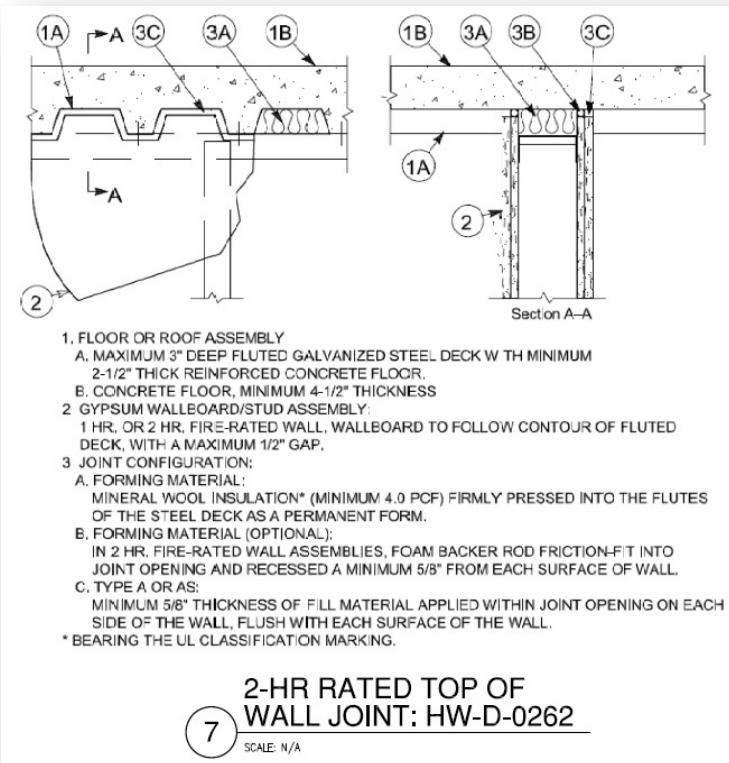
8

SCALE: N/A

Bottom of wall joint test:  
UL BW-S-0002.

Can anyone guess what the  
“BW” stands for in this  
tested assembly?

# Example of fire-resistance-rated joint detail



Top of wall joint test:  
UL HW-D-0262.

Can anyone guess what the  
“HW” stands for in this  
tested assembly?

# Additional UL Information

## From the UL Fire Resistance Directory (2016)

### 18. Fire-resistant Joint Systems

Joint Systems (XHBN) includes designs that have been investigated to protect the joints between fire-resistance-rated walls, floors, floor-ceiling assemblies and roof-ceiling assemblies.

### VI. WALLS AND PARTITIONS

The ratings for walls and partitions apply when either face of the assembly is exposed to the fire unless indicated otherwise in a specific design. Flashing and corner details may vary from those described in a design provided structural equivalency is maintained and similar materials to those specified in the design are used for supports, fasteners and flashings. Where dynamic movement is specified in Joint Systems (XHBN) that utilizes either U400, V400 or W400 Series fire-resistance-rated wall and partition assemblies, the special features of the walls to accommodate dynamic movement are intended to be as specified in the individual designs under XHBN.

This is important, because the wall/partition assemblies may have different head/sill specifications from the joints.

# Additional UL Information

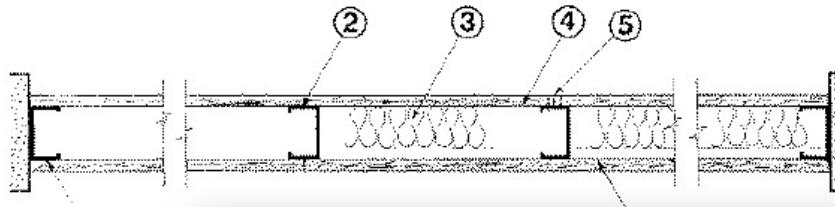
## Example: 1-hour rated partition UL U465

Design No. U465

August 27, 2021

Nonbearing Wall Rating — 1 HR.

\* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.



②

1C. Floor and Ceiling Runners — (Not Shown) — For use with Item 2C — Channel shaped, fabricated from min 20 MSG corrosion-protected or galv steel, min depth to accommodate stud size, with min 1 in. long legs, attached to floor and ceiling with fasteners spaced max 24 in. OC.

Per the partition assembly, fasteners for the floor/ceiling runners are to be spaced at 24" o.c. But what if dynamic movement is required?

# Additional UL Information

## Example Head Joint: HW-D-0262

**XHBN - Joint Systems**

**System No. HW-D-0262**

June 28, 2011

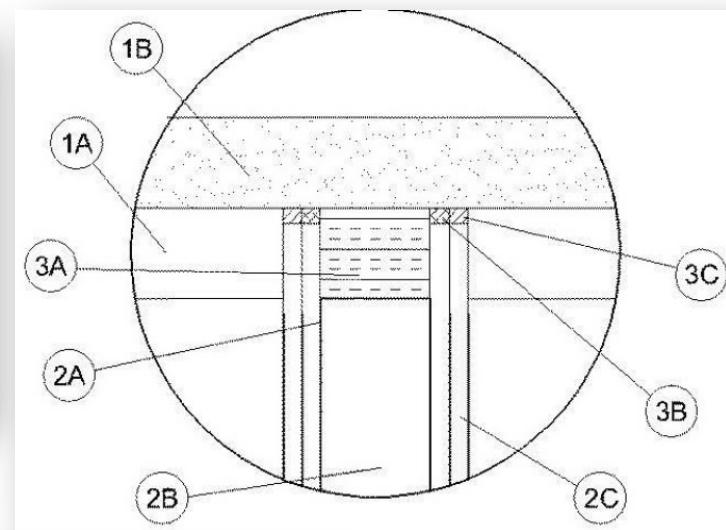
**Assembly Ratings - 1 and 2 Hr (See Item 2)**

**I Rating At Ambient - Less Than 1 CFM/Lin Ft (See Item 3C)**

**I Rating At 400°F - Less Than 1 CFM/Lin Ft (See Item 3C)**

**Joint Width - 5/8 in. Maximum**

**Class II and III Movement Capabilities - 25% Compression or Extension**



**A. Steel Floor And Ceiling Runners** — Floor and ceiling runners of wall assembly shall consist of galv steel channels sized to accommodate steel studs. Ceiling runner to be provided with min 1-1/4 in. (32 mm) flanges. Ceiling runner secured to steel floor deck with steel fasteners or welds spaced max 12 in. (305 mm) OC or to slab with masonry anchors spaced max 12 in. (305 mm) OC.

# The Big Picture

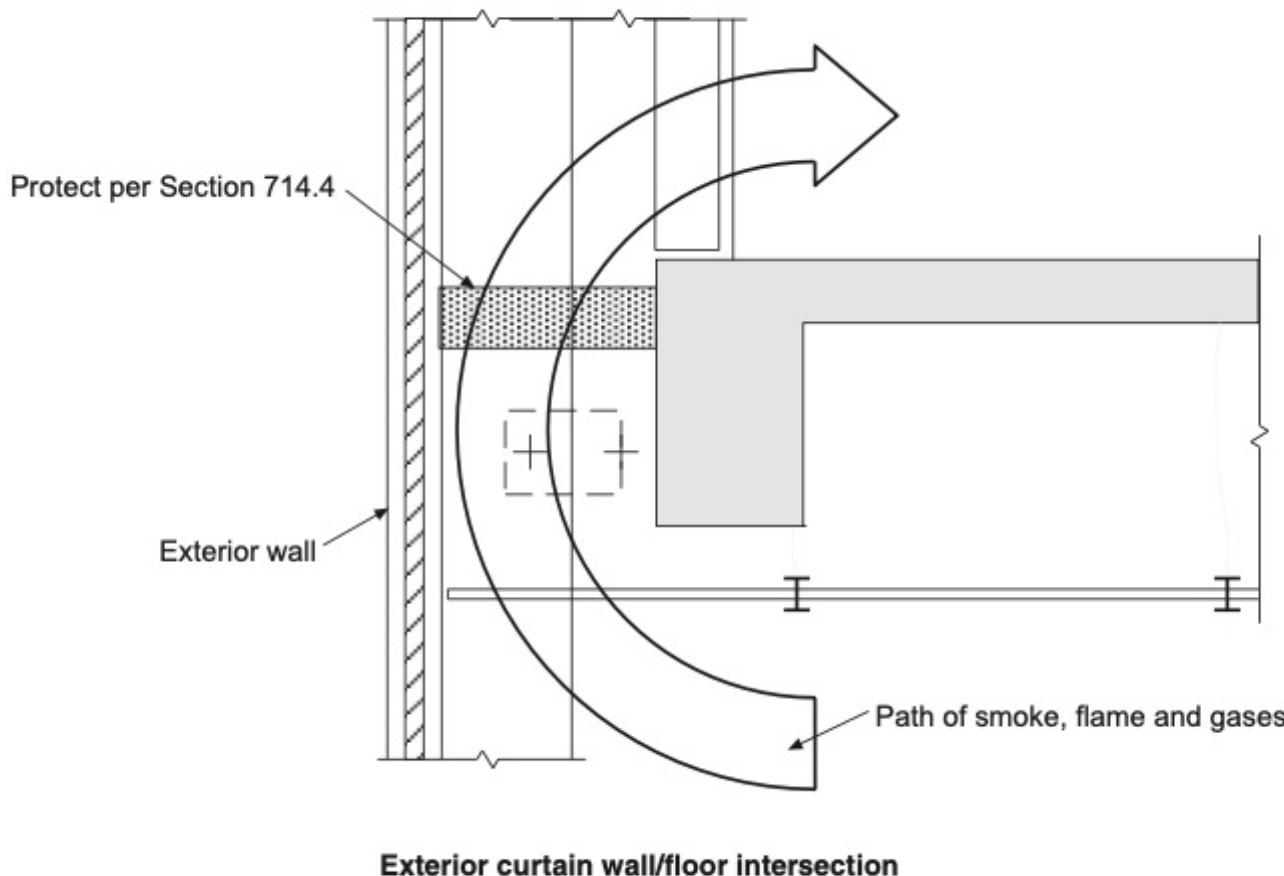
Important take aways:

- Fire rated joints are separate systems, distinct from the rated assemblies they protect.
- A tested joint system is required to be specified.
- If dynamic movement is a relevant factor in the design (ex: walls that require a slip head track), the details of the joint system over-rule the details of the standard wall/partition.

## 715.3, 715.2 Fire-Resistant Joint System

- 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 it is installed. See the exception for 10 locations where joint systems are not required. Systems or materials protecting joints and voids shall be securely installed in accordance with the manufacturer's installation instructions in or on the joint or void for its entire length so as not to dislodge, loosen, or otherwise impair its ability to accommodate expected building movements and to resist the passage of fire and hot gases.
- Joints are created where the structural design of a building necessitates a separation between building components in order to accommodate anticipated structural displacements caused by thermal expansion and contraction, seismic activity, wind or other loads. The integrity of the fire-resistant separation must be maintained where such joints occur.

## 715.3, 715.2 Fire-Resistant Joint System



When not utilizing fire-resistant joint systems, the void created at the intersection of a floor/ceiling assembly and an exterior curtain wall assembly must be protected in a similar manner to prevent the spread of flame and hot gases vertically from floor to floor.

Source: 2021 IBC

## 715.3, 715.2 Fire-Resistant Joint System

In which of the following locations is a fire-resistant joint system required to protect all joints?

- a. floors within malls
- b. horizontal exit walls
- c. mezzanine floors
- d. roofs where openings are permitted

## 715.3, 715.2 Fire-Resistant Joint System: Exception

**Exception:** *Fire-resistant joint systems* shall not be required for *joints* in the following locations:

1. Floors within a single *dwelling unit*.
2. Floors where the *joint* is protected by a shaft enclosure in accordance with Section 713.
3. Floors within *atriums* where the space adjacent to the *atrium* is included in the volume of the *atrium* for smoke control purposes.
4. Floors within *malls*.
5. Floors and ramps within parking garages or structures constructed in accordance with Sections 406.5 and 406.6.
6. *Mezzanine* floors.
7. Walls that are permitted to have unprotected openings.
8. Roofs where openings are permitted.
9. Control *joints* not exceeding a maximum width of 0.625 inch (15.9 mm) and tested in accordance with ASTM E119 or UL 263.
10. The intersection of exterior curtain wall assemblies and the roof slab or roof deck.

## 715.3, 715.2 Fire-Resistant Joint System: Exception

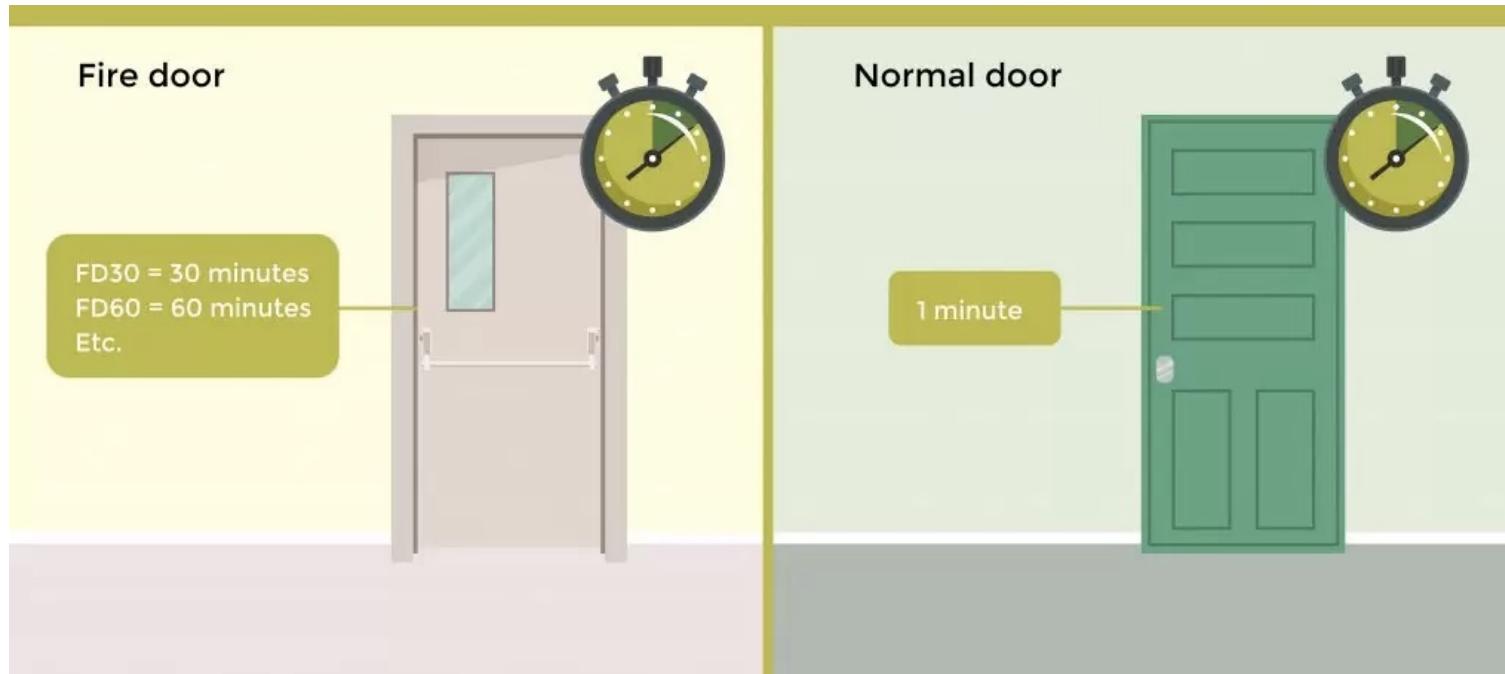
Fire-resistant joint systems are not required for control joints having a maximum width of \_\_\_\_\_ inch when tested in accordance with ASTM E119 or UL 263.

- a. 0.25
- b. 0.375
- c. 0.5
- d. 0.625

## 716.2.1 Fire Door Assemblies: Opening Protectives

- Approved fire door and fire shutter assemblies shall be constructed of any material or assembly of component materials that conforms to the test requirements of Section 716.2.1.1 (side-hinged or pivoted swinging doors), 716.2.1.2 (other types of assemblies) or (glazing in transom lights and sidelights in corridors and smoke barriers), and 716.2.1.4 (smoke and draft control) and the fire-protection rating indicated in Table 716.1(2). See the exceptions for tin-clad fire doors and floor fire doors.
- The level of protection required for a fire door is commensurate with that required for the wall or partition in which it is installed. The minimum fire protection rating varies based on the wall's required rating as well as the type and use of the wall assembly under consideration. In addition to establishing the minimum fire-protection rating required for fire door assemblies. Table 716.1(2) also provides information on door vision panels, side-lights and transoms.

## 716.2.1 Fire Door Assemblies: Opening Protectives



## 716.2.1 Fire Door Assemblies: Opening Protectives

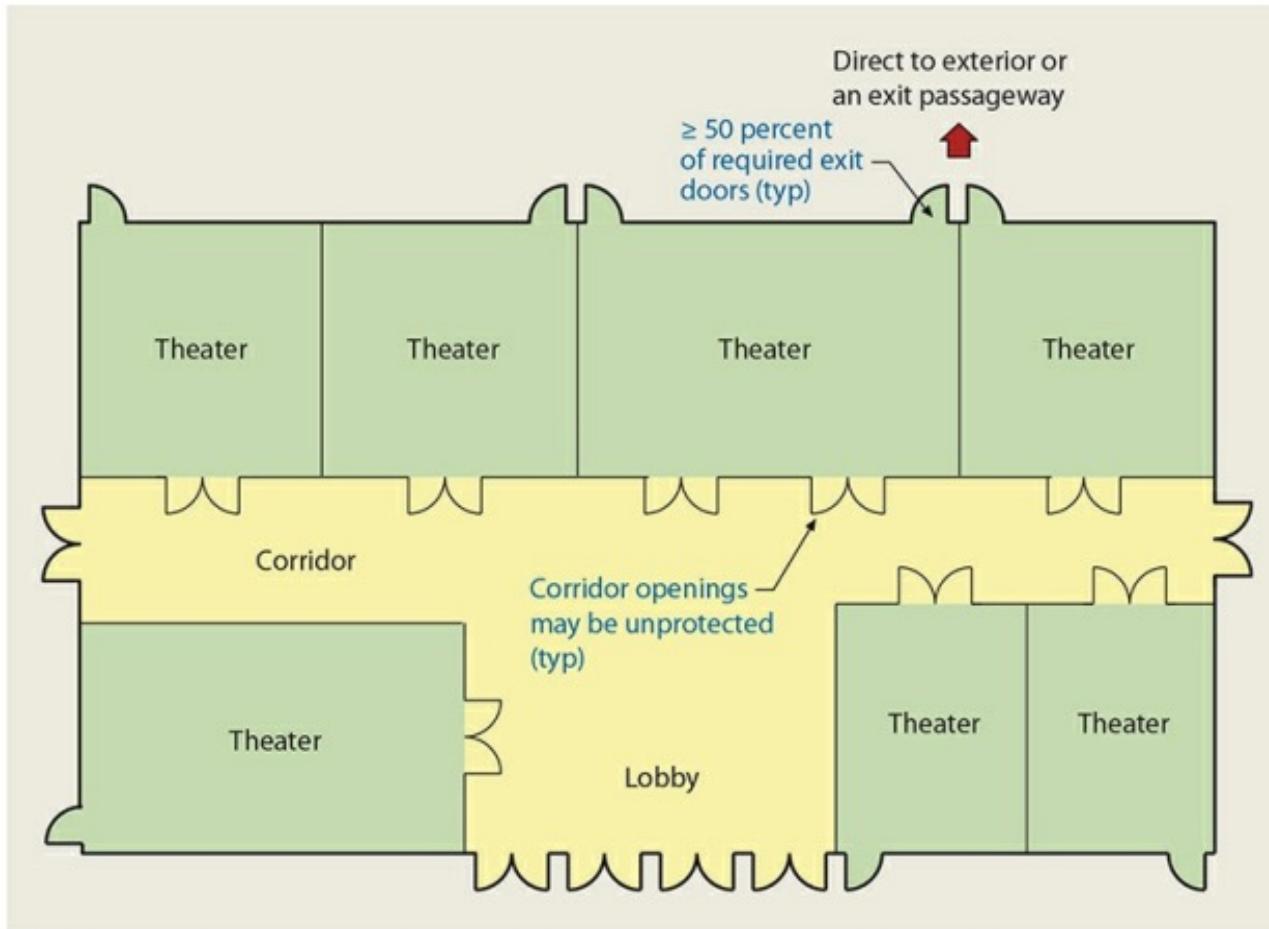


Figure 716-2 Corridor doors in a multitheater complex.

# Table 716.1(2)

**TABLE 716.1(2)**  
**OPENING FIRE PROTECTION ASSEMBLIES, RATINGS AND MARKINGS**

TYPE OF ASSEMBLY	REQUIRED WALL ASSEMBLY RATING (hours)	MINIMUM FIRE DOOR AND FIRE SHUTTER ASSEMBLY RATING (hours)	DOOR VISION PANEL SIZE <sup>a</sup>	FIRE-RATED GLAZING MARKING DOOR VISION PANEL <sup>b,c</sup>	MINIMUM SIDELIGHT/TRANSOM ASSEMBLY RATING (hours)		FIRE-RATED GLAZING MARKING SIDELIGHT/TRANSOM PANEL	
					Fire protection	Fire resistance	Fire protection	Fire resistance
Fire walls and fire barriers having a required fire-resistance rating greater than 1 hour	4	3	See Note a	D-H-W-240	Not Permitted	4	Not Permitted	W-240
	3	3 <sup>d</sup>	See Note a	D-H-W-180	Not Permitted	3	Not Permitted	W-180
	2	1 <sup>1/2</sup>	100 sq. in.	$\leq 100 \text{ sq. in.} = \text{D-H-90}$ $>100 \text{ sq. in.} = \text{D-H-W-90}$	Not Permitted	2	Not Permitted	W-120
	1 <sup>1/2</sup>	1 <sup>1/2</sup>	100 sq. in.	$\leq 100 \text{ sq. in.} = \text{D-H-90}$ $>100 \text{ sq. in.} = \text{D-H-W-90}$	Not Permitted	1 <sup>1/2</sup>	Not Permitted	W-90
Fire barriers having a required fire-resistance rating of 1 hour: Enclosures for shafts, exit access stairways, exit access ramps, interior exit stairways and interior exit ramps; and exit passageway walls	1	1	100 sq. in.	$\leq 100 \text{ sq. in.} = \text{D-H-60}$ $>100 \text{ sq. in.} = \text{D-H-T-W-60}$	Not Permitted	1	Not Permitted	W-60

## Table 716.1(2)

A fire door assembly in a 1-hour fire barrier used in an interior exit stairway enclosure shall have a minimum fire protection rating of \_\_\_\_\_ hour.

- a.  $\frac{1}{3}$
- b.  $\frac{1}{2}$
- c.  $\frac{3}{4}$
- d. 1

## Table 716.1(2)

Fire door assemblies required in a 2-hour exterior wall shall have a minimum fire protection rating of \_\_\_\_\_.

- a. 20 minutes
- b. 45 minutes
- c. 1 hour
- d. 90 minutes

**TABLE 716.1(2)—continued**  
**OPENING FIRE PROTECTION ASSEMBLIES, RATINGS AND MARKINGS**

**Table 7**

TYPE OF ASSEMBLY	REQUIRED WALL ASSEMBLY RATING (hours)	MINIMUM FIRE DOOR AND FIRE SHUTTER ASSEMBLY RATING (hours)	DOOR VISION PANEL SIZE <sup>a</sup>	FIRE-RATED GLAZING MARKING DOOR VISION PANEL <sup>b,c</sup>	MINIMUM SIDELIGHT/TRANSOM ASSEMBLY RATING (hours)		FIRE-RATED GLAZING MARKING SIDE-LIGHT/TRANSOM PANEL	
					Fire protection	Fire resistance	Fire protection	Fire resistance
Horizontal exits in fire walls <sup>d</sup>	4	3	100 sq. in.	≤100 sq. in. = D-H-180 > 100 sq. in.=D-H-W-240	Not Permitted	4	Not Permitted	W-240
	3	3 <sup>d</sup>	100 sq. in.	≤100 sq. in. = D-H-180 > 100 sq. in.=D-H-W-180	Not Permitted	3	Not Permitted	W-180
Fire barriers having a required fire-resistance rating of 1 hour: Enclosures for shafts, exit access stairways, exit access ramps, interior exit stairways and interior exit ramps; and exit passageway walls	1	1	100 sq. in.	≤100 sq. in. = D-H-60 >100 sq. in.=D-H-T-W-60	Not Permitted	1	Not Permitted	W-60
Fire protection								
Other fire barriers	1	3/4	Maximum size tested	D-H	3/4 <sup>b</sup>		D-H <sup>b</sup>	
Fire partitions: Corridor walls	1	1/3 <sup>a</sup>	Maximum size tested	D-20	3/4 <sup>b</sup>		D-H-OH-45	
	0.5	1/3 <sup>a</sup>	Maximum size tested	D-20	1/3		D-H-OH-20	
Other fire partitions	1	3/4 <sup>i</sup>	Maximum size tested	D-H-45	3/4		D-H-45	
	0.5	1/3	Maximum size tested	D-H-20	1/3		D-H-20	
Exterior walls	3	1 1/2	100 sq. in. <sup>s</sup>	≤100 sq. in. = D-H-90 > 100 sq. in = D-H-W-90	Not Permitted	3	Not Permitted	W-180
	2	1 1/2	Maximum size tested	D-H 90 or D-H-W-90	1 1/2 <sup>b</sup>	2	D-H-OH-90 <sup>b</sup>	W-120
					Fire protection			
	1	3/4	Maximum size tested	D-H-45	3/4 <sup>b</sup>		D-H-45 <sup>b</sup>	

## Table 716.1(2)

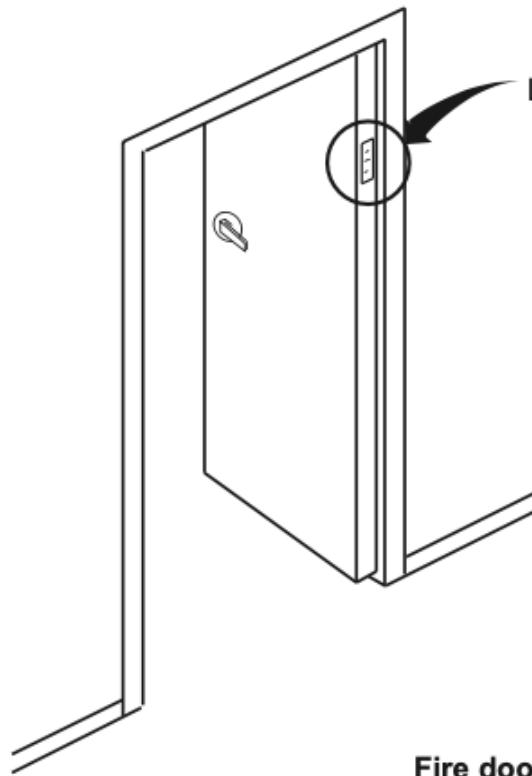
Fire door assemblies required in a 2-hour exterior wall shall have a minimum fire protection rating of \_\_\_\_\_.

- a. 20 minutes
- b. 45 minutes
- c. 1 hour
- d. 90 minutes

## 716.2.1 Labeling Requirements: Fire Door Assemblies

- Fire doors shall be labeled showing the name of the manufacturer or other identification readily traceable back to the manufacturer, the name or trademark of the third-party inspection agency, the fire-protection rating, and where required for fire doors in interior exit stairways and ramps and exit passageways by Section 716.2.2.3, the maximum transmitted temperature end point. Smoke and draft control doors complying with UL 1784 shall be labeled as such and shall also comply with Section 716.2.9.3. Labels shall be approved and permanently affixed. The label shall be applied at the factory or location where fabrication and assembly are performed.
- To be certain that the proper protective assembly is installed in the proper location, it is critical that the assembly be listed and labeled. Field alteration of a fire door assembly is not permitted, because the assembly is usually only listed for use in the condition it was in when it left the factory.

## 716.2.1 Labeling Requirements: Fire Door Assemblies



Label to be permanently affixed and include:

- Name of manufacturer
- Name of third-party inspection agency
- Fire protection rating
- Maximum transmitted temperature end point (where required)
- Designation as smoke and draft control door with "S" label (where required)

**Fire door assembly**

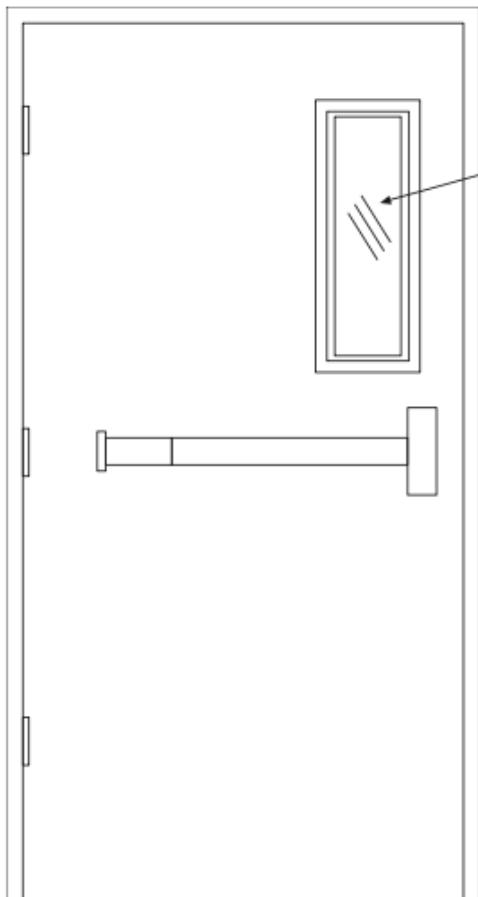
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Some fire door assemblies are too large to be tested in available furnaces. Therefore, the code recognizes a certificate of inspection as proof that the oversized doors comply with the requirements for materials, design and construction for a comparable fire door.

## 716.1.2.2 Fire Door Glazing Identification: Opening Protectives

- Fire-rated glazing assemblies shall be marked in accordance with Tables 716.1(1), 716.1(2) and 716.1(3). For fire-rated glazing, the label shall bear the identification required in Tables 716.1(1) and 716.1(2). “D” indicates that the glazing is permitted to be used in fire door assemblies and meets the fire protection requirements of NFPA 252, UL 10B or UL 10C. “H” indicates that the glazing meets the hose stream requirements of NFPA 252, UL 10B or UL 10C. “T” indicates that the glazing meets the temperature requirements of Section 716.2.2.3.1. The placeholder “XXX” represents the fire rating period, in minutes
- Glazing utilized in fire door assemblies can be easily identified for verification of its appropriate application. Such glazing must also be provided with the proper identification indicating its compliance as safety glazing in conformance with Section 2406.4.

## 716.1.2.2 Fire Door Glazing Identification: Opening Protectives



Glazing to be labeled with 4-part identifier:

- “D”: applicable for fire-door assemblies and meets applicable fire-resistance requirements
- “H”: meets hose stream requirements
- “T”: meets temperature requirements
- “XXX”: fire-protection rating in minutes

---

The identification methods for glazing found in Table 716.1(1) are also applicable to fire-resistance-rated glazing utilized as wall assemblies as well as fire-protection-rated glazing used in fire window assemblies as established in Table 716.1(3).

Source: 2021 IBC

## 716.1.2.2 716.2.6.1, 716.2.6.2: Door Closing: Fire Door Assemblies

- Fire doors shall be latching and self- or automatic-closing in accordance with Section 716. See the exceptions for fire doors in common walls between Group R-1 guestrooms, and elevator car and associated hoistway doors. Unless otherwise specifically permitted, single side-hinged swinging fire doors and both leaves of pairs of side-hinged swinging fire doors shall be provided with an active latch bolt that will secure the door when it is closed.
- Fire doors must close and latch to be effective during a fire. The expectation is that the doors will normally be in a closed position and that the self-closing device will cause the door to close after use. Where specifically mandated by the code, automatic-closing devices must be installed. Such devices are intended for doors normally held in an open position.

# 716.1.2.2 716.2.6.1, 716.2.6.2: Door Closing: Fire Door Assemblies

**Per Section 716.2.6.6, automatic-closing doors shall be actuated by smoke detection at:**

- Doors in walls of incidental uses required to resist the passage of smoke (Sec. 509.4);
- Doors installed in smoke barriers (Sec. 709.5);
- Doors installed in fire partitions (Sec. 708.6);
- Doors installed in fire walls (Sec. 706.8);
- Doors installed in shaft enclosures (Sec. 713.7);
- Doors installed in waste and linen chutes and access and discharge rooms (Sec. 713.13);
- Doors installed in smoke partitions (Sec. 710.5.2.3);
- Doors installed in fire barriers (Sec. 707.6).

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Automatic-closing fire door assemblies are required only where specifically addressed, such as in Section 709.5.1 for cross-corridor doors in Group I-2 occupancies and ambulatory care facilities. Where automatic-closing fire doors are provided, including nonrequired locations, they must typically be smoke activated.

Source: 2021 IBC

## 716.2.2.2 Door Assemblies

### **716.2.2.2 Door assemblies in other fire partitions.**

*Fire door* assemblies required to have a minimum *fire protection rating* of 20 minutes where located in other *fire partitions* having a *fire-resistance rating* of 0.5 hour in accordance with Table 716.1(2) shall be tested in accordance with NFPA 252, UL 10B or UL 10C with the hose stream test.

### **716.2.2.3 Doors in interior exit stairways and ramps and exit passageways.**

*Fire door* assemblies in *interior exit stairways* and *ramps* and *exit passageways* shall have a maximum transmitted temperature rise of not more than 450°F (250°C) above ambient at the end of 30 minutes of standard fire test exposure.

**Exception:** The maximum transmitted temperature rise is not required in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

## 716.2.2.2 Door Assemblies

In a nonsprinklered building, a fire door assembly in an exit passageway shall have a maximum transmitted temperature end point of \_\_\_\_\_ above ambient at the end of 30 minutes of standard fire test exposure.

- a. 250°F
- b. 450°F
- c. 600°F
- d. 650°F

# 717, 202: Fire and Smoke Dampers: Definitions

- A fire damper is a listed device, installed in ducts and air transfer openings designed to close automatically upon detection of heat and resist the passage of flame. A smoke damper is a listed device installed in ducts and air transfer openings that is designed to resist the passage of smoke. A ceiling radiation damper is a listed device installed in a ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly to limit automatically the radiative heat transfer through an air inlet/outlet opening.
- The IBC identifies several types of dampers, each of which performs a specific function. The required type of damper is based on the function of the building element that is being penetrated by the duct or air transfer opening.

# 717, 202: Fire and Smoke Dampers: Definitions

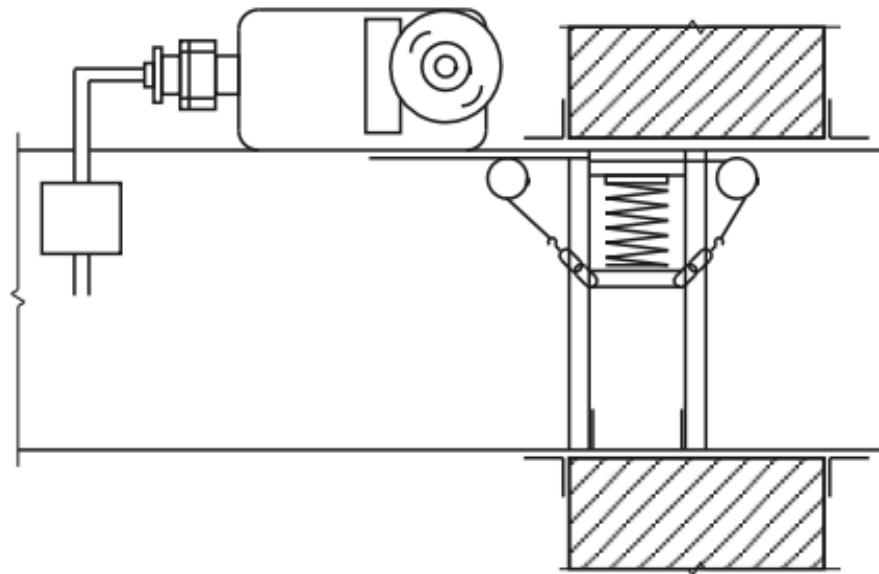


Figure courtesy  
Sheet Metal and Air Conditioning Contractors National Association

Note: This illustration is not intended to exclusively endorse or indicate preference for a combination fire and smoke damper. Two separate dampers that satisfy the requirements for the respective functions may also be used for fire and smoke control.

## Combination fire and smoke dampers

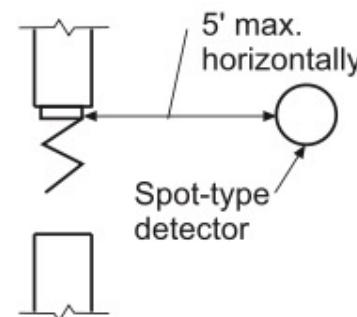
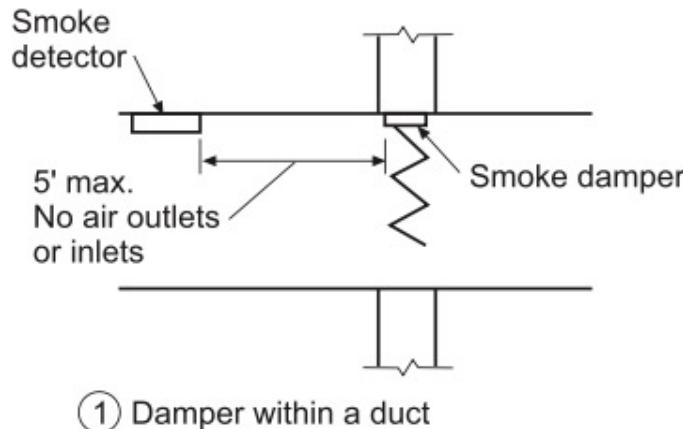
Where both a fire and a smoke damper are mandated, the use of a combination damper is permitted. This type of listed device is designed to close automatically upon detecting heat and to resist the passage of air and smoke.

Source: 2021 IBC

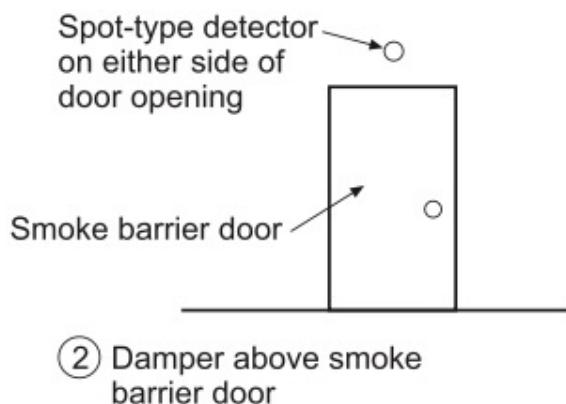
## 717.3.1: Ducts and Air Transfer Openings.

- Dampers shall be listed and labeled in accordance with the standards in Section 717.3. Fire dampers shall comply with the requirements of UL 555. Smoke dampers shall comply with the requirements of UL 555S. Combination fire/smoke dampers shall comply with the requirements of both UL 555 and UL 555S. Ceiling radiation dampers shall comply with the requirements of UL 555C (or tested as a part of a horizontal assembly). Corridor dampers shall comply with requirements of both UL 555 and UL 555S. Fire dampers shall have the minimum fire-protection rating specified in Table 717.3.2.1. Smoke damper leakage ratings shall be Class I or II. Elevated temperature ratings shall not be less than 250°F (121°C).
- Consistent with other openings that penetrate a fire-resistance-rated assembly, fire and smoke dampers must be provided where it is necessary to maintain the integrity of the assembly. The minimum damper rating is based on the rating of the assembly penetrated. Where corridor dampers are required, they shall have a minimum one-hour fire-resistance rating and a Class I or II leakage rating.

## 717.3.1: Ducts and Air Transfer Openings.



③ Damper within an unducted air opening



- ④ In corridor wall or ceiling, damper controlled by smoke-detection system installed in corridor
- ⑤ When total-coverage smoke-detection system provided within all areas served by HVAC system, dampers controlled by smoke detection system

1 foot = 304.8 mm

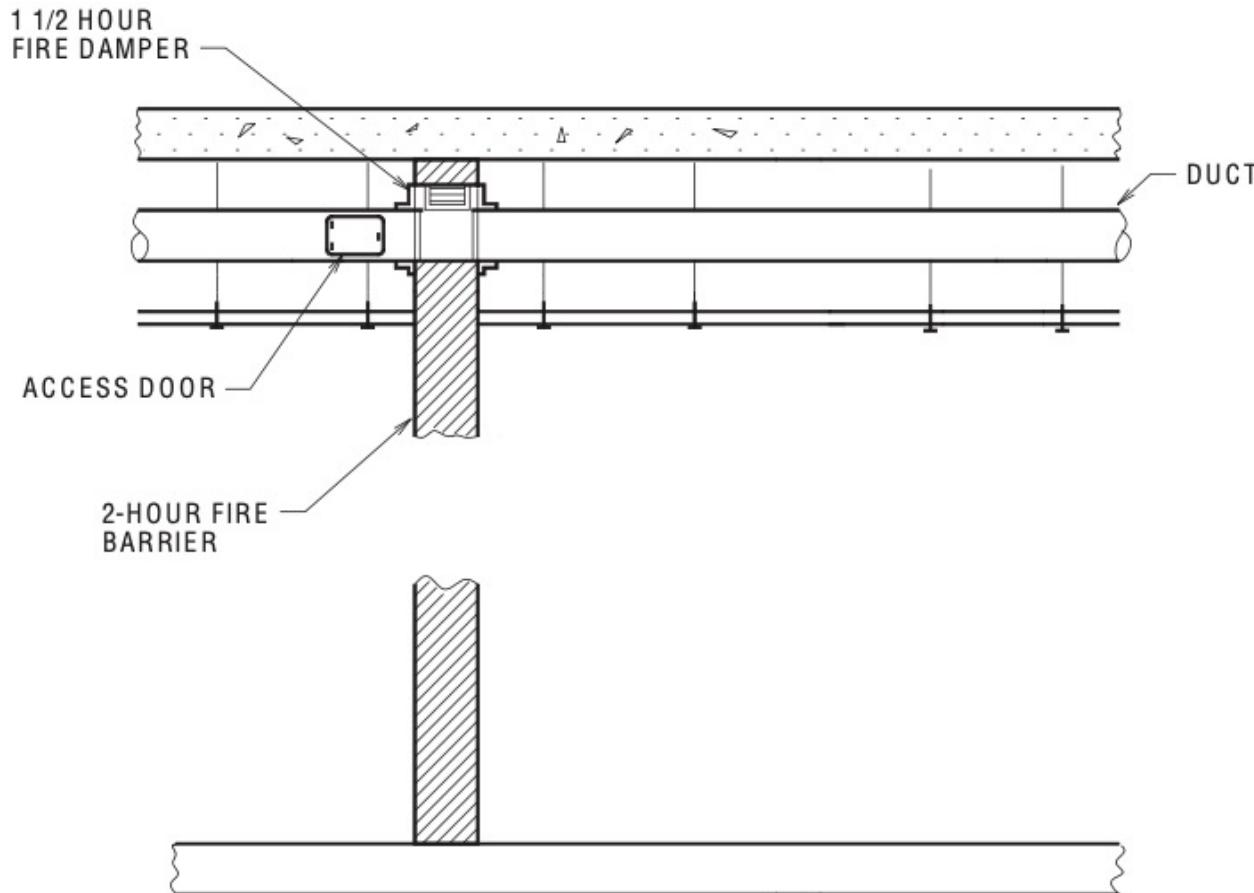
A smoke damper must close upon actuation of a listed smoke detector or smoke detection system. The IBC identifies five methods, one or more of which may be applicable, for the detector location and/or actuation.

Source: 2021 IBC

## 717.5: Fire and Smoke Dampers

- Fire dampers, smoke dampers, combination fire/smoke dampers, ceiling radiation dampers and corridor dampers shall be provided at the locations prescribed in Sections 717.5.1 through 717.5.7 and 717.6. Where an assembly is required to have both fire dampers and smoke dampers, combination fire/smoke dampers or a fire damper and a smoke damper shall be provided.
- Only those specific building elements identified in the code need to be protected by fire and/or smoke dampers where penetrated by ducts or air transfer openings. As a general rule, fire dampers protect such openings in fire walls, fire barriers, shaft enclosures and fire partitions. Fire dampers may also be installed in some of those locations where a shaft enclosure is otherwise required. Smoke dampers are generally required for openings in shaft enclosures, smoke- and draft-control corridor enclosures, and smoke barriers.

## 717.5: Fire and Smoke Dampers



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There will be times when a fire-resistance-rated assembly is penetrated by a duct or transfer opening that is not required to be protected by a fire or smoke damper. In such situations, the condition will be regulated and protected as a penetration in accordance with Section 714.

## 717.5: Fire and Smoke Dampers

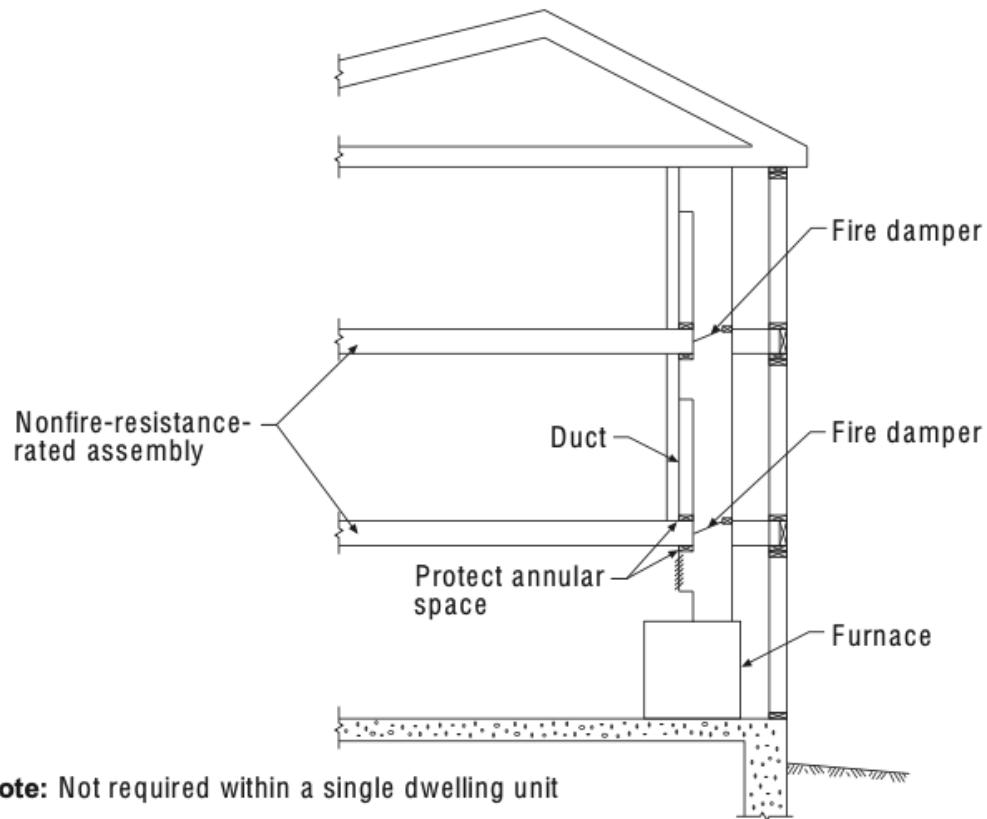
Where a duct passes through a fire wall used as a horizontal exit, which of the following dampers is/are required?

- a. fire damper only
- b. smoke damper only
- c. both a fire damper and a smoke damper
- d. neither a fire damper nor a smoke damper

## 717.6.3: Nonrated Floor Assemblies: Ducts and Air Transfer Openings

- Duct systems constructed of approved materials in accordance with the International Mechanical Code that penetrate nonfire-resistance-rated floor assemblies shall be protected by any of the following methods. See three methods addressing (1) shaft enclosures, (2) ducts connecting only two stories, and (3) ducts connecting a maximum of three stories where floor assemblies are noncombustible construction.
- It is important when addressing the vertical spread of fire, smoke and gases—even in buildings where the floor assemblies are not required to have a fire-resistance rating—that some level of compartmentation is provided between stories.

## 717.6.3: Nonrated Floor Assemblies: Ducts and Air Transfer Openings

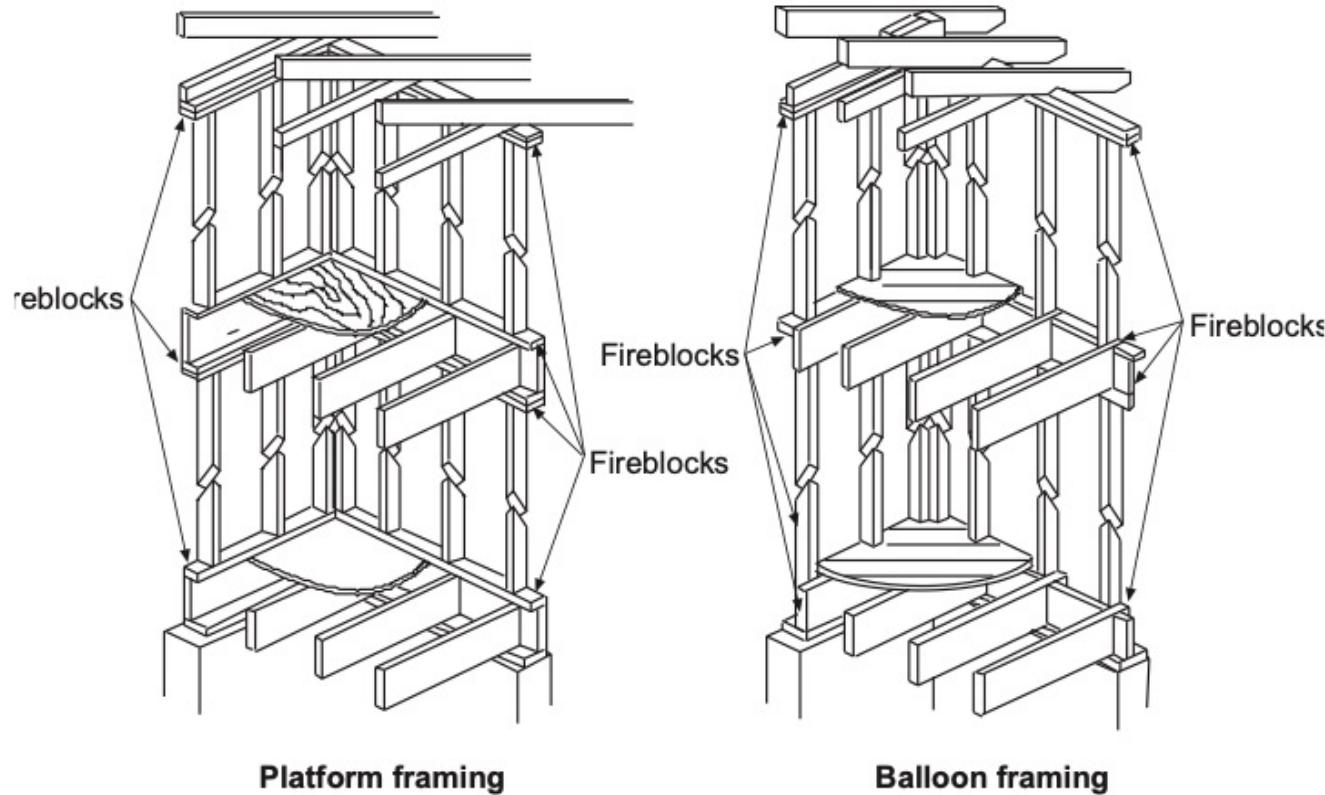


Where Item 3 is utilized for a duct that connects three stories, a minimum  $1\frac{1}{2}$ -hour fire damper is required at each floor line even though the floor or floor/ceiling assembly is not required to have a fire-resistance rating, because the damper is an alternative to a 1-hour shaft enclosure.

## 718.2 202: Fireblocking: Concealed Spaces

- Fireblocking consists of materials installed to resist the free passage of flame to other areas of the building through concealed spaces. In combustible construction, fireblocking shall be installed to cut off concealed draft openings (both vertical and horizontal) and shall form an effective barrier between floors, between a top story and a roof or attic space. Fireblocking shall be installed in the locations specified in Sections 718.2.2 through 718.2.7.
- Experience has shown that the greatest fire damage to conventional light-framed wood buildings occurs when the fire travels unimpeded through concealed draft openings. Virtually any concealed air space within a building will provide an open channel through which high-temperature air and gases can spread. Fireblocking is invaluable to the control of fire prior to active fire suppression activities.

## 718.2 202: Fireblocking: Concealed Spaces

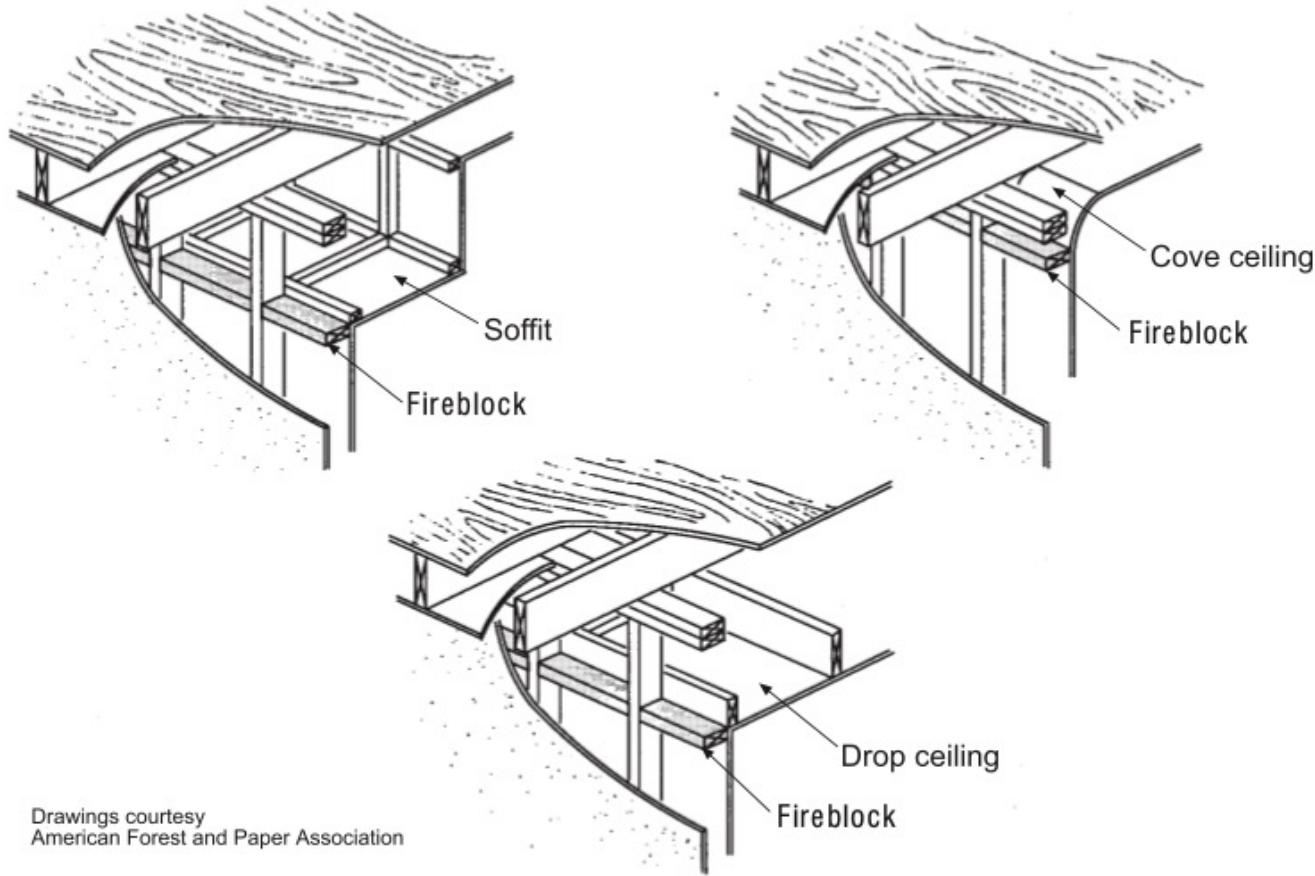


In noncombustible construction, building materials located in concealed areas of the building construction do not contribute to the spread of fire. Therefore, fireblocking and draftstopping are required only in buildings of combustible construction.

## 718.2 202: Fireblocking: Concealed Spaces

- Fireblocking shall be provided in concealed spaces of stud walls and partitions, including furred spaces, and parallel rows of studs or staggered studs, as follows: (1) vertically at the ceiling and floor levels, and (2) horizontally at intervals not exceeding 10 feet (3048 mm). Fireblocking shall be provided at interconnections between concealed vertical . . . and horizontal spaces . . . such as occur at soffits, drop ceilings, cove ceilings and similar locations. See additional provisions for fireblocking at stairways; openings around vents, ducts and chimneys; concealed spaces of exterior architectural trim; and concealed sleeper spaces in floors.
- The platform framing techniques that are typically used in light-frame wood construction provide adequate fireblocking between stories in the stud walls. However, furred spaces and openings for penetrating elements such as vents should be addressed carefully as avenues for fire transmission between stories or along a wall.

## 718.2 202: Fireblocking: Concealed Spaces



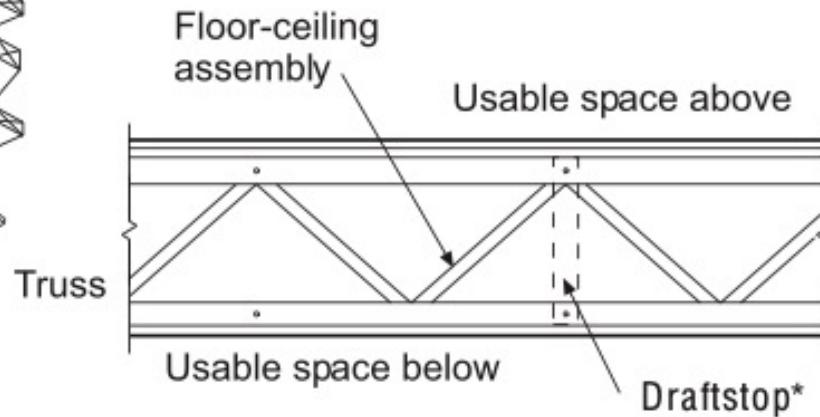
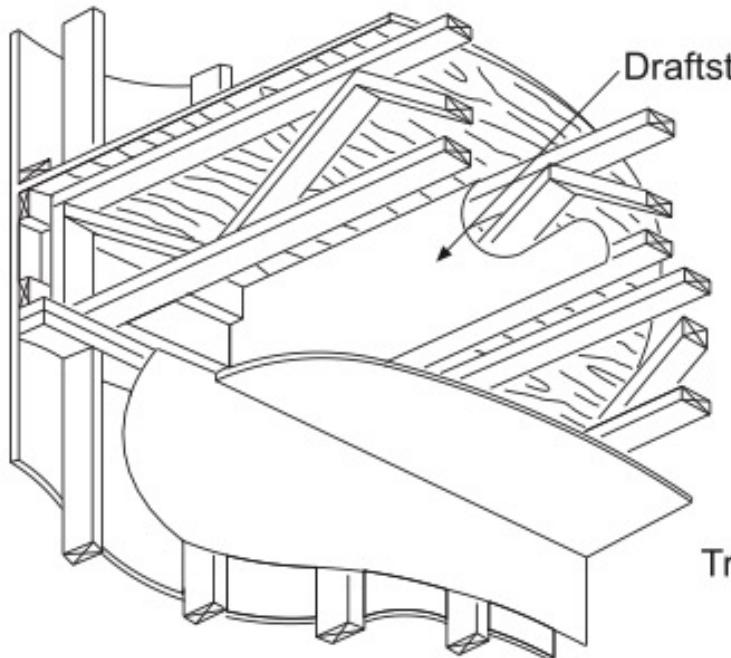
Drawings courtesy  
American Forest and Paper Association

In general, fireblocking materials must consist of lumber or wood structural panels of the thicknesses specified, gypsum board, cement fiber board, batts or blankets of mineral wool or glass fiber, or any other approved materials securely fastened in place.

## 718.3.1 202: Draftstopping: Definition and Materials

- A draftstop is a material, device or construction installed to restrict the movement of air within open spaces of concealed areas of building components such as crawl spaces, floor/ceiling assemblies, roof/ceiling assemblies and attics. Draftstopping materials shall not be less than 1/2-inch (12.7 mm) gypsum board, 3/8-inch (9.5 mm) wood structural panel, 3/8-inch (9.5 mm) particleboard, 1-inch (25 mm) nominal lumber, cement fiber- board, batts or blankets of mineral wool or glass fiber, or other approved materials adequately supported. The integrity of draftstops shall be maintained.
- Draftstopping, like fireblocking, is required only in combustible construction. Although the role of draftstopping is important, it is less critical than that of fireblocking. Therefore, the protective materials used in draftstopping construction are permitted to be less substantial.

## 718.3.1 202: Draftstopping: Definition and Materials



\*Required to divide space into areas no greater than 1,000 sq ft

Drawings courtesy  
American Forest and Paper Association

For SI: 1 square foot = 0.093 m<sup>2</sup>.

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The provisions for draftstops are categorized for two general occupancy categories: residential and all uses other than residential. Both floor/ceiling assemblies and attics are addressed for each category. Many of the requirements are eliminated in fully sprinklered buildings.

Source: 2021 IBC

## 718.3.1 202: Draftstopping: Definition and Materials

Draftstopping shall be installed in combustible floor/ceiling spaces of a nonsprinklered Group E occupancy such that the horizontal floor areas are a maximum of \_\_\_\_\_ square feet.

- 
- a. 100
  - b. 400
  - c. 1,000
  - d. 3,000