

CONST-181

Building Code Interpretation:

Non-Structural

Commercial Building Inspector

Certification: Commercial Building Inspector

Exam ID: B2

Scope:

A Commercial Building Inspector will be responsible for performing inspections of structures to determine compliance with the various Building Codes and Standards adopted by his / her jurisdiction. At this level of certification, the Inspector shall be able to inspect commercial structures of any size or occupancy.



- 80 multiple-choice questions
- 3-1/2-hour limit
- Open book

01 General Administration 6%

0101 Project Administration 1%
Verify that project information is provided and is adequate. Verify that the project is designed by approved persons when required, and has required approvals. Verify that products not detailed in the building code are approved by the building official and installed according to their listing. Verify that the required approved plans and specifications are available when required and retained by the building official for the period required.

0102 Public Information and Legal 1%
For new and existing structures, answer questions about the need for permits and inspections, including special inspections and structural observations, general code compliance of designs, procedures, and materials. Communicate, issue, and maintain inspection reports, correction notices, stop work orders, and data for the issuance of the certificate of occupancy.

0103 Plan Reading 4%
Read plans to verify the project conforms with the code, approved plans, and construction documents.

02 Building Planning 20%

0201 Fire Resistance-Rated Construction 5%
Inspect fire resistance-rated construction for compliance with the code and tested assembly requirements.

0202 Building Location 2%
Inspect the construction site to see that the building or structure location is in compliance with the requirements of the local ordinances, fire separation regulations, fire access, and the approved site plan. Verify that final grade will provide the required slope away from the footing or foundation wall. Verify finish floor elevation in flood-hazard areas for compliance with local and federal requirements.

0203 Interior Environment 1%
Verify that the actual and allowable floor area calculations are correct. Inspect for compliance of minimum room dimensions and openings. Verify compliance of lighting and ventilation systems.

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Performance Task			Weight
0204	<u>Occupancy Classification and Type of Construction</u> Verify or determine the occupancy classification, provisions for special uses, and type of construction requirements, including individual elements or components.	5%	8%
0205	<u>Safeguards During Construction</u> Assure that the precautions are taken for the safety and sanitation at the construction site.	1%	5%
0206	<u>Accessibility</u> Inspect buildings to assure elements are accessible and usable by individuals with physical disabilities as specified by the code, approved plans, and construction documents.	2%	3%
0207	<u>Material Quality</u> Inspect that materials are in compliance with the markings, standards, and the materials' characteristics.	2%	21%
0208	<u>Interior Coverings</u> Verify that floor, wall, and ceiling coverings are correct types and thicknesses and are correctly supported and fastened.	2%	5%
03	Footings and Foundations	8%	
0301	<u>Footings</u> Verify that the building site's soil load-bearing capacity and stability complies with approved plans or reports. Verify that footings are laid out with correct depth, size, and setbacks, and that footings extend below the frost line. Inspect below-grade work for compliance with the code.	3%	3%
0302	<u>Stepped Footings and Special Foundations</u> Verify that stepped footings and specialized foundations are constructed per the approved plans or code.	1%	3%
0303	<u>Piles and Piers</u> Verify that piles and piers are correctly supported and anchored, and that wood members are protected against insects and decay.	1%	5%
0304	<u>Foundation Walls</u> Verify that foundation stem walls are correctly sized and have sufficient height above grade. Verify that foundation wall reinforcement, anchor bolts, and fasteners are correct type, size, and grade and are placed per approved plans. Verify that foundation dampproofing and waterproofing is installed where required. Verify maximum unbalanced fill height. Verify that foundation walls are properly braced prior to back fill.	3%	2%
04	Floor Construction		
0401	<u>Floor Systems</u> Inspect floor system spans, bearing, and connections for compliance with approved plans. Verify that the cutting, notching, and borings are within the limitations permitted by code, and that materials are protected against insects and decay where required. Verify that subflooring and decking has required thickness, span, and grade and meets installation specifications. Verify compliance of floor design and fasteners. Verify that crawlspaces have required clearance, ventilation, insulation, screening, and access openings.	5%	3%
0402	<u>Concrete Slabs</u> Inspect concrete slabs placement for compliance with standards and material characteristics, and that proper precautions are used in adverse weather conditions.		
05	Wall Construction and Coverings		
0501	<u>Wood Wall Systems</u> Inspect wall systems for proper spans, spacing, bearing, and connections. Verify that pre-engineered wall systems are in accordance with the approved drawings and manufacturer's specifications. Verify that the cutting, notching, and borings are within the limitations permitted by code, and that wood members are protected against insects and decay where required.	5%	5%
0502	<u>Steel Framing Systems</u> Inspect wall systems for proper spans, spacing, bearing, and connections. Verify that pre-engineered wall systems are in accordance with the approved drawings and manufacturer's specifications. Inspect steel framing for compliance with markings, standards, and the material		
0503	<u>Masonry Wall Systems</u> Inspect grouting, bonding, mortar type, mortar joint thickness, height, size, lintels, and distance between lateral supports for masonry walls. Verify that weather conditions are suitable for masonry construction and that proper precautions are used for adverse weather conditions.	5%	3%
0504	<u>Concrete Wall Systems</u> Inspect height, size, attachments, bracing, and distance between lateral supports. Verify that weather conditions are suitable for construction and that proper precautions are used for adverse weather conditions.		
0505	<u>Wall Reinforcement</u> Inspect reinforcement for size, length of lap splices, clearances, alignment, cleanouts, and presence of loose rust, oil, or millscale.	3%	
0506	<u>Exterior Sheathing and Weather-Resistant Coverings</u> Verify that exterior sheathing and weather-resistant siding materials are correctly sized, identified, and installed; protected against insects and decay; and have appropriate clearances to finish grade. Verify that exterior veneers and weather-resistant siding have correct anchorage, support, and backing. Verify that a weather-resistant barrier is correctly installed for all walls and around all wall openings. Verify that plaster, stucco, and metal lath have correct thickness and fasteners, and are correctly installed.	3%	

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06	Roof/Ceiling Construction	6%		
0601	<u>Roof/Ceiling Assemblies</u> Inspects roof/ceiling construction for compliance with span, grade, type, connections, bearing, and quality requirements. Verifies that trusses are in accordance with the drawings and properly spaced, braced, and supported. Verify roof access and rooftop structures where required. Verify that insulation is of permitted materials, is provided where required, and is correctly installed. Verify that vapor and moisture barriers are correctly installed. Verify that attic and ceiling area construction has proper ventilation, screens, and access.	5%		1%
0602	<u>Roof Sheathing and Coverings</u> Verify correct classification of roof coverings, roof slope, installation, flashings, and details, and method of roof drainage. Inspects roof sheathing for proper thickness, grade, support, and fastening. Verify re-roofing complies with code, design, and installation standards.	1%		
07	Public Safety and Special Construction	31%		
0701	<u>Means of Egress</u> Verify general means of egress requirements, exit access, exits, and exit discharge. Verify any miscellaneous means of egress and special occupancy requirements. Verify emergency escape and rescue requirements.	10%		
0702	<u>Fire Protection Systems</u> Inspects both manual and automatic fire protection, fire alarms, and detection and standpipe systems for proper installation, power supply, and locations.	4%		
0703	<u>Smoke and Fire Venting Control</u> Inspect for smoke control and fire venting as required by the code, approved plans, and construction documents.	4%		
0704	<u>Interior Finishes and Insulation</u> Verify that interior floor, wall and ceiling finishes, insulation, and foam plastics comply with flame spread and smoke-developed index density requirements. Verify floor finishes comply with the critical flux rating required by the code, approved plans, and construction documents.	4%		
0705	<u>Safety Glazing and Glass</u> Verify that safety glazing is correctly installed and labeled where required.	4%		
0706	<u>Opening Protectives, Penetrations, and Joint Systems</u> Inspects opening protectives, penetrations, and joint systems in fire-rated assemblies to assure compliance with the code, approved plans, and construction documents. Verify that fire blocking and draft stopping are provided where required.	2%		
0707	<u>Miscellaneous Construction</u> Verify that exterior stairs, ramps, porches, decks, and balconies which are open to the weather are constructed to support designed loads; are of suitable materials; and have required slope and width, tread, riser, headroom, guardrails, and handrail dimensions.	1%		

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.

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

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

Noncombustible	Exterior and interior (bearing or nonbearing) walls, floors, roofs and structural elements are to be of noncombustible materials	I	A	B
		II	A	B
Noncombustible or combustible	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

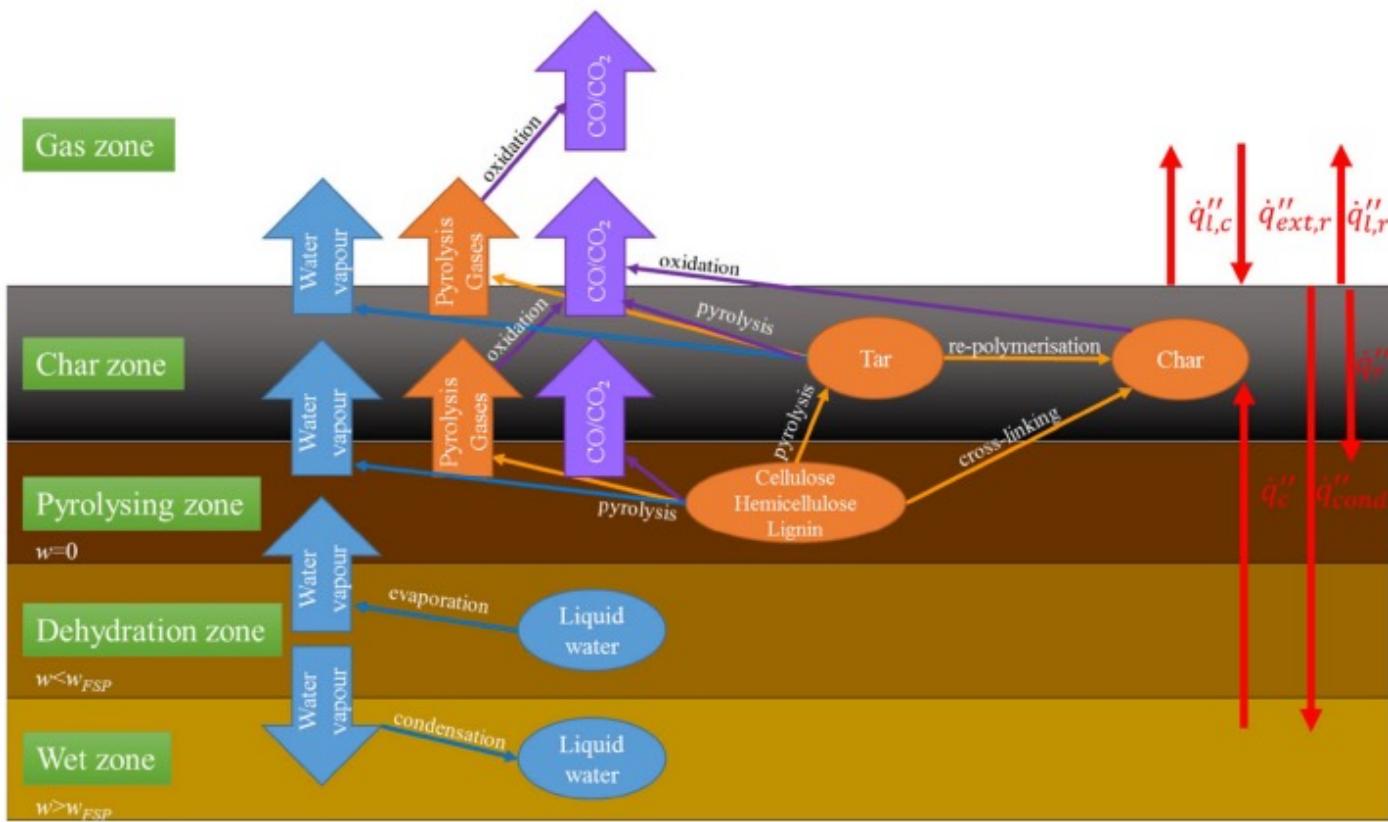


Figure 1. Chemical and physical processes within a burning timber sample; $\dot{q}_{l,c}''$ is the surface heat losses by convection, $\dot{q}_{l,r}''$ is the surface heat losses by radiation, $\dot{q}_{ext,r}''$ is the external heat flux, \dot{q}_r'' is in-depth radiation, \dot{q}_{cond}'' is conduction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

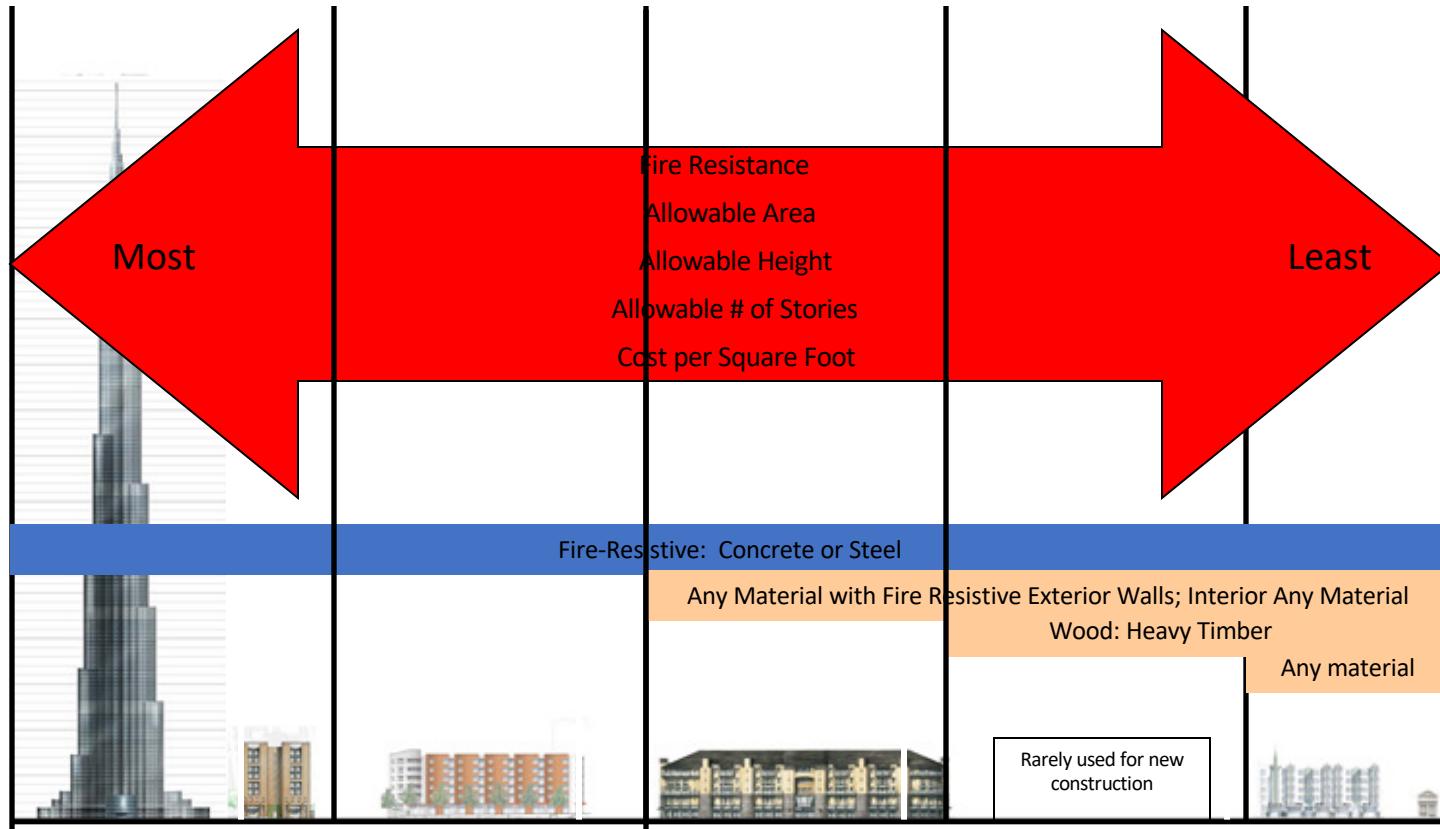
Wood and hours



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

Source: 2021 IBC

1. The Five Basic Construction Types

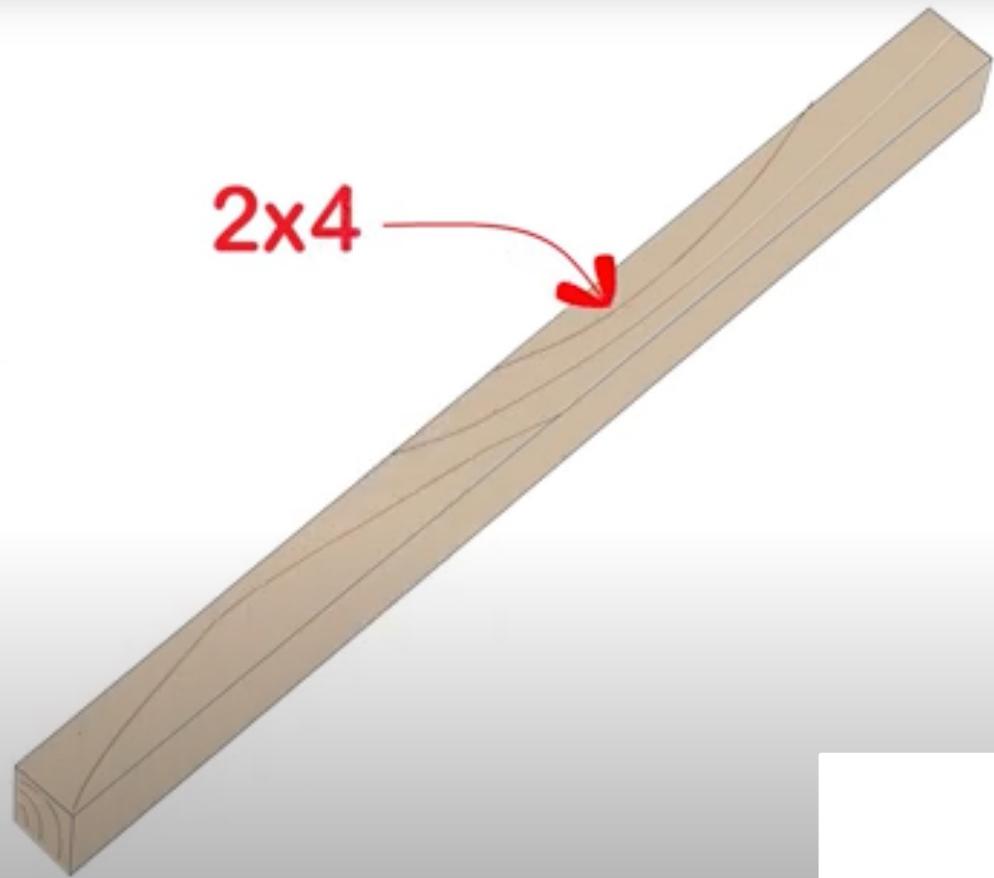


T601, 202 Primary Structural Frames

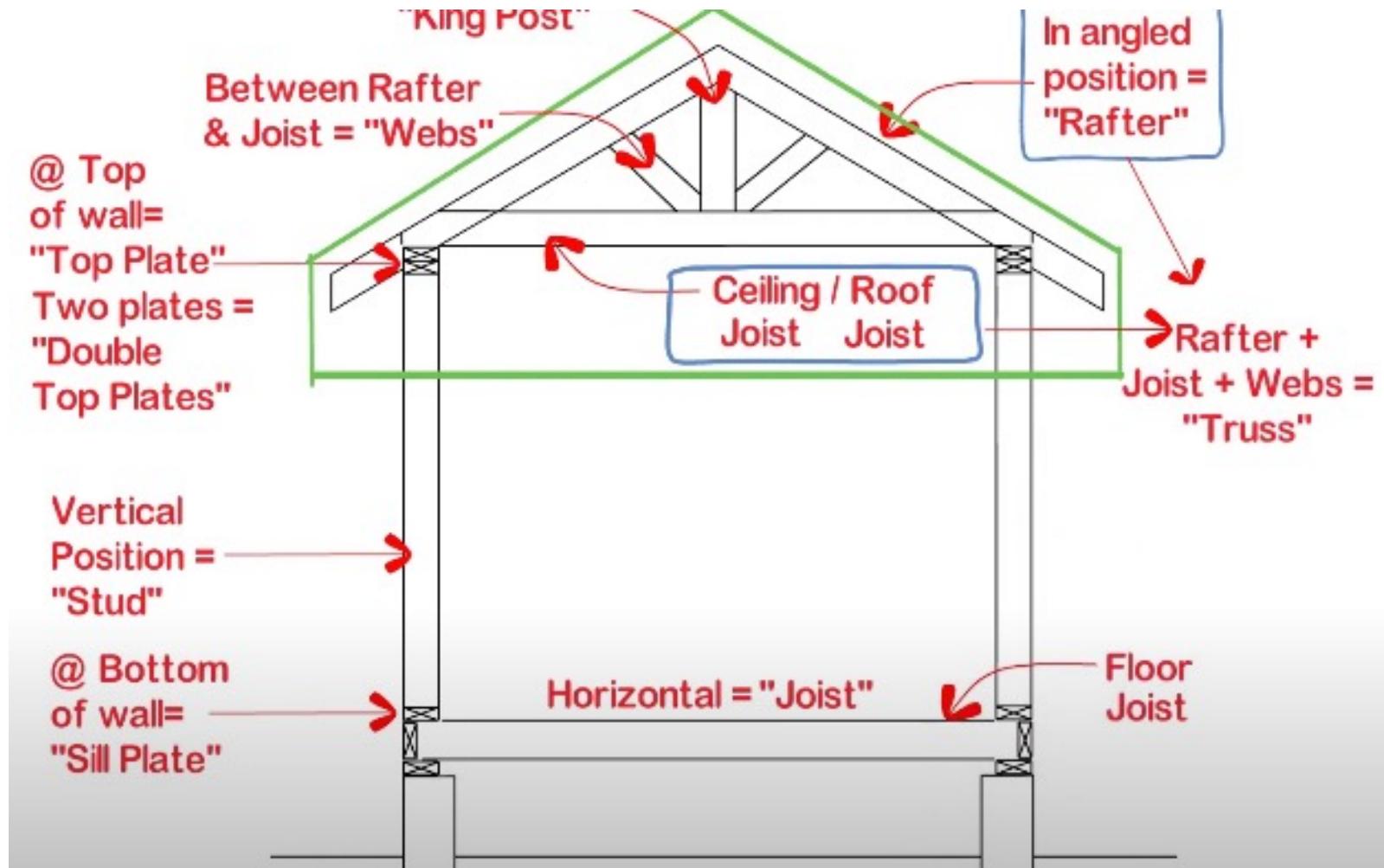
Joist?

Rafter?

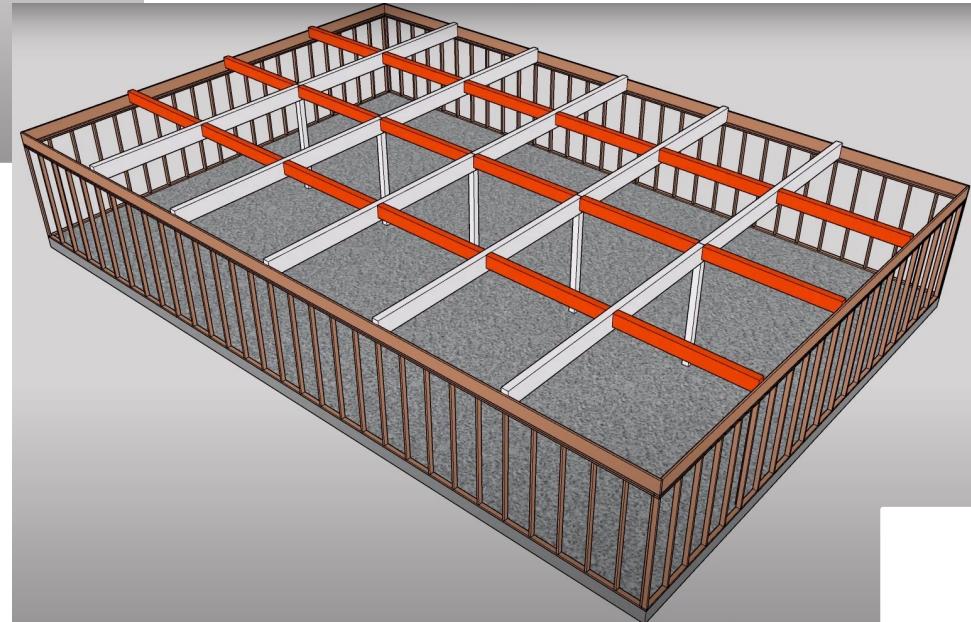
2x4



T601, 202 Primary Structural Frames



T601, 202 Primary Structural Frames (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



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 ^b	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 ^{c, d}	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 ^{c, d}	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 ^{d, e}	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 ^{d, e, f}	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 ^{d, g}	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 ^h	NS ^d	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*.

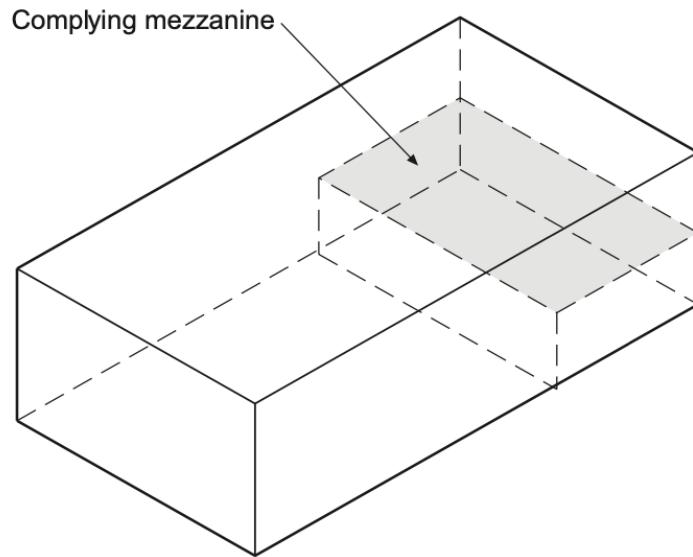
g. For new Group I-4 occupancies, see Exceptions 2 and 3 of Section 903.2.6.

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



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 m²

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.



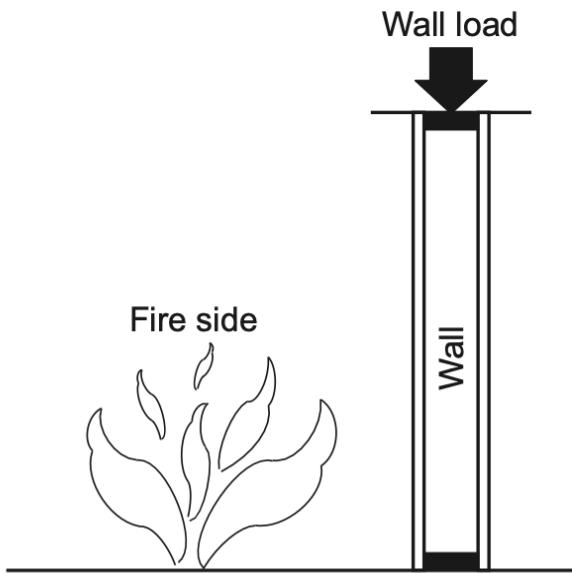
Source: 2021 IBC

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

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.

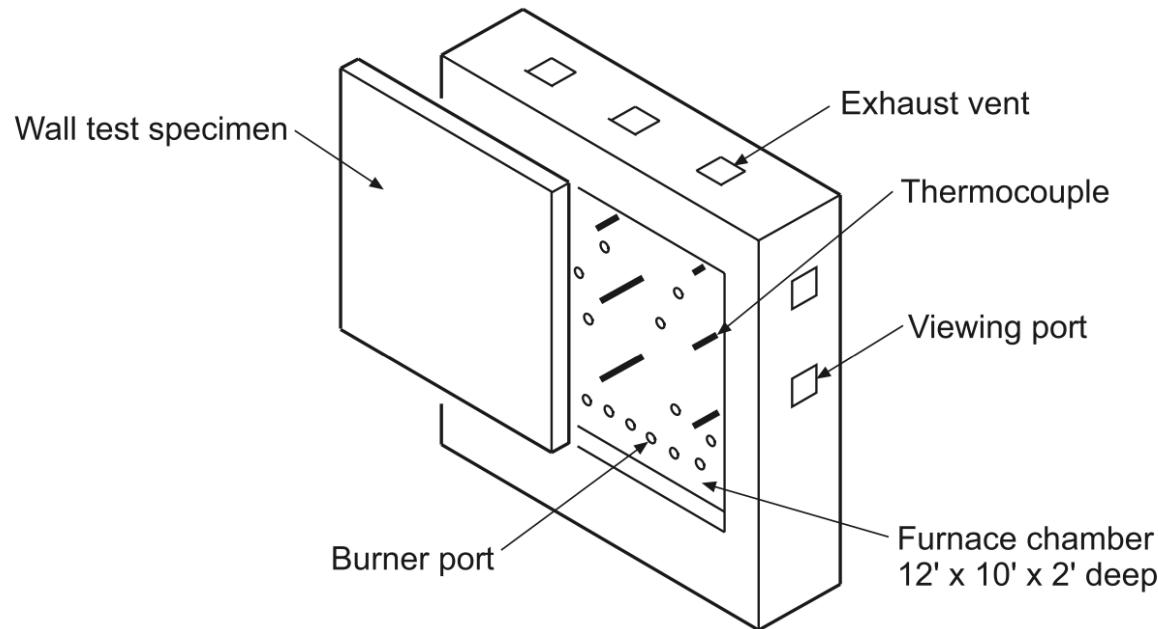
703.2.1 202 Materials and Systems

- 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

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

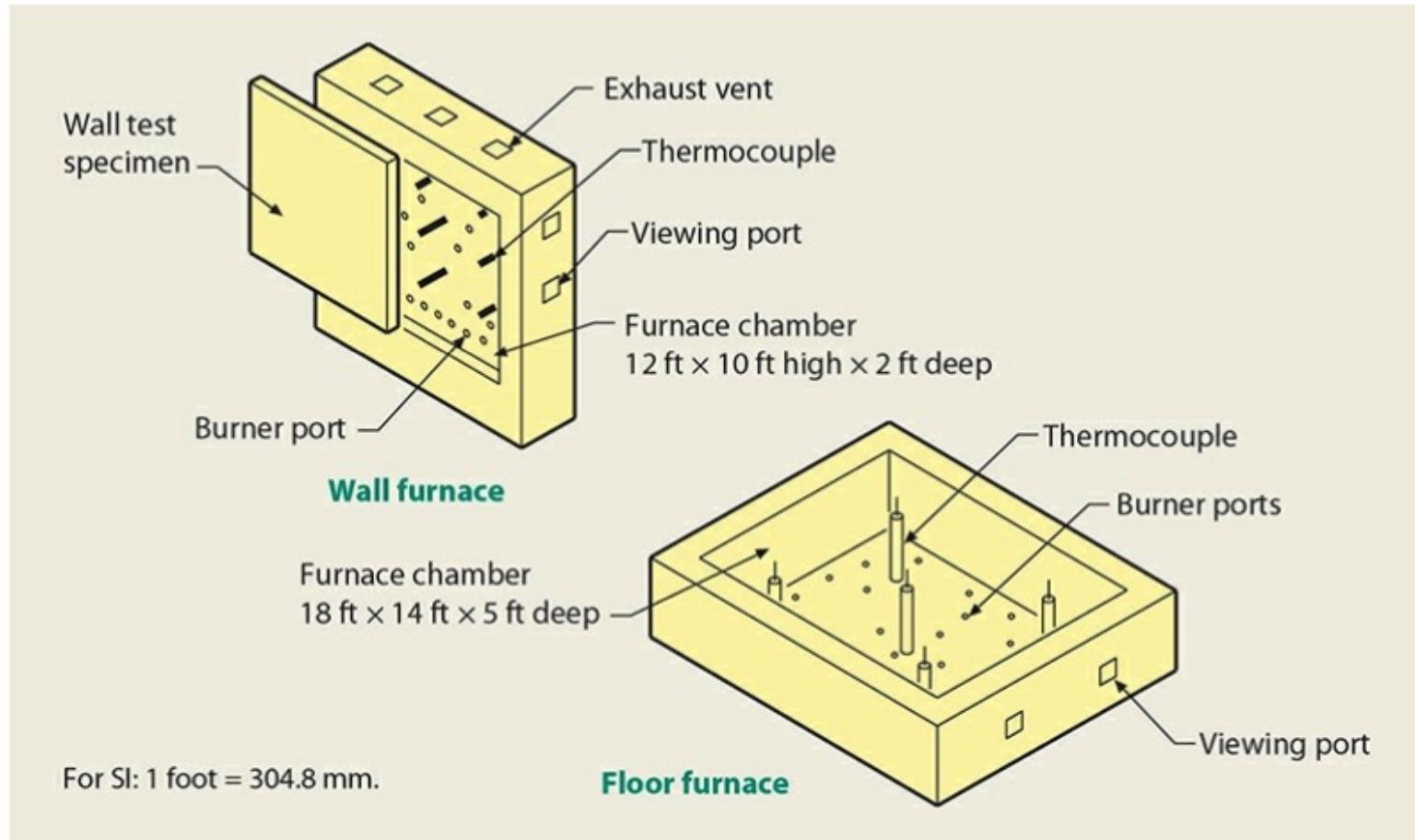


Figure 703-1 **Test furnaces.**

703.2.1 202 Materials and Systems

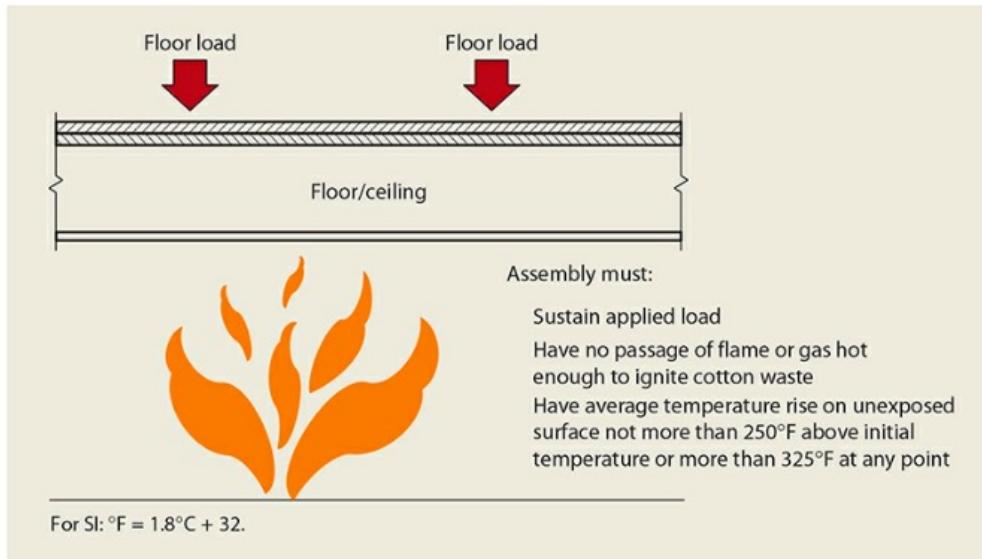


Figure 703-2 **Floor assembly fire test.**

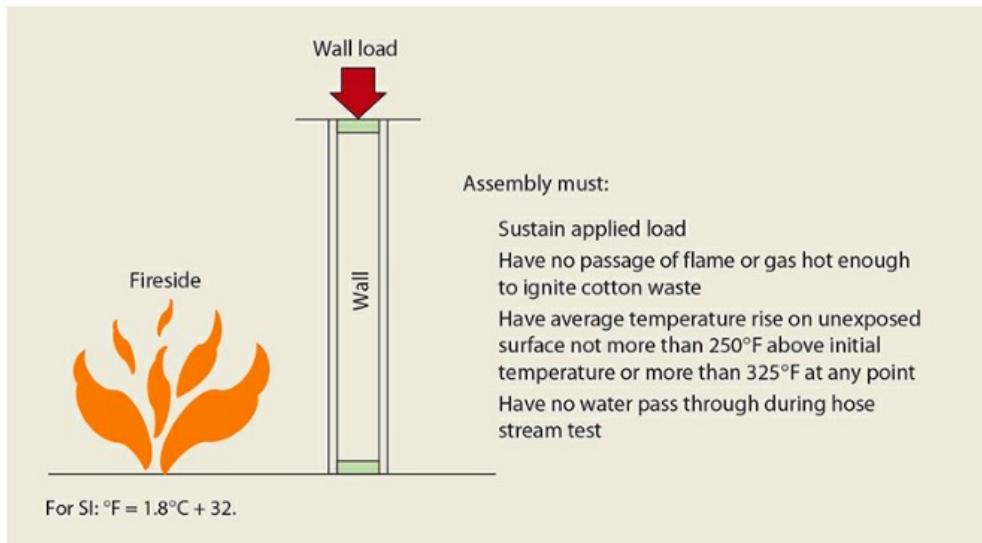


Figure 703-3 **Conditions of acceptance—wall fire test.**

Source: 2021 IBC

703.2.1 202 Materials and Systems

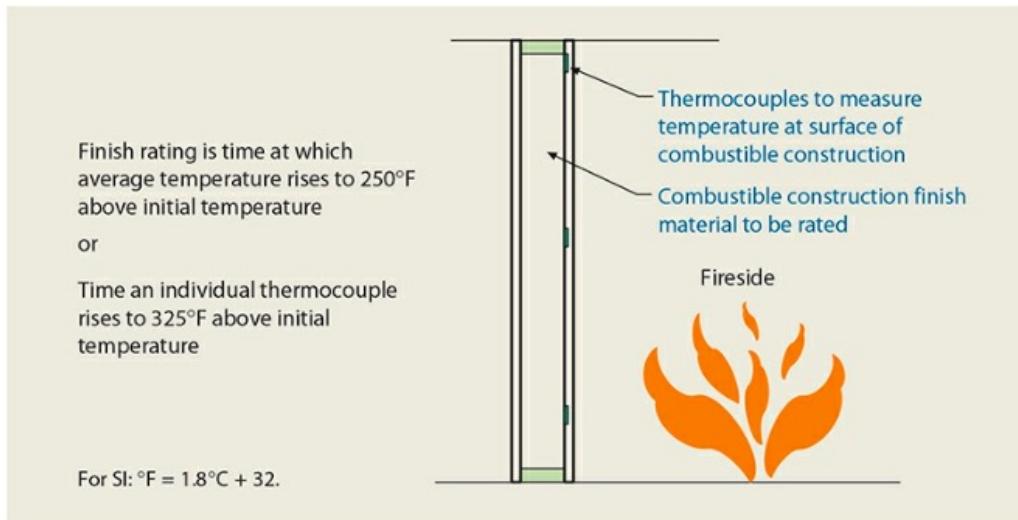


Figure 703-4 Combustible assembly for determining finish rating.

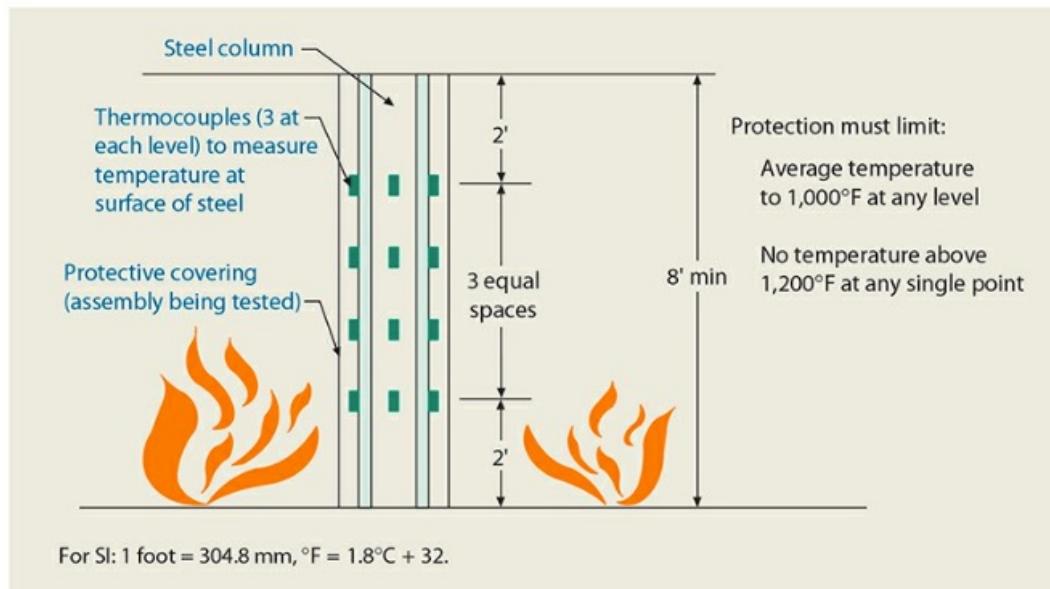


Figure 703-5 Alternative fire test of steel column protection.

Source: 2021 IBC

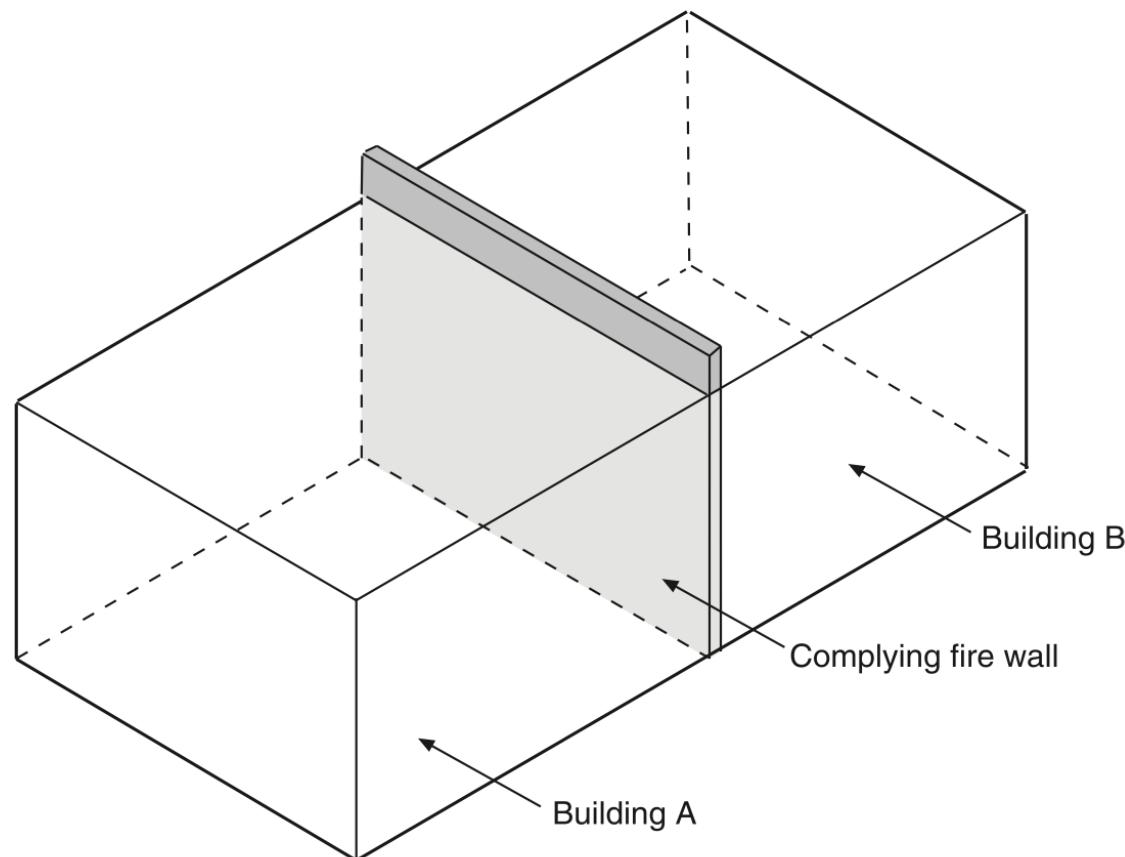
Class 6: Chapter 7, Sections 706 through 712—Fire and Smoke Protection Features II

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.

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

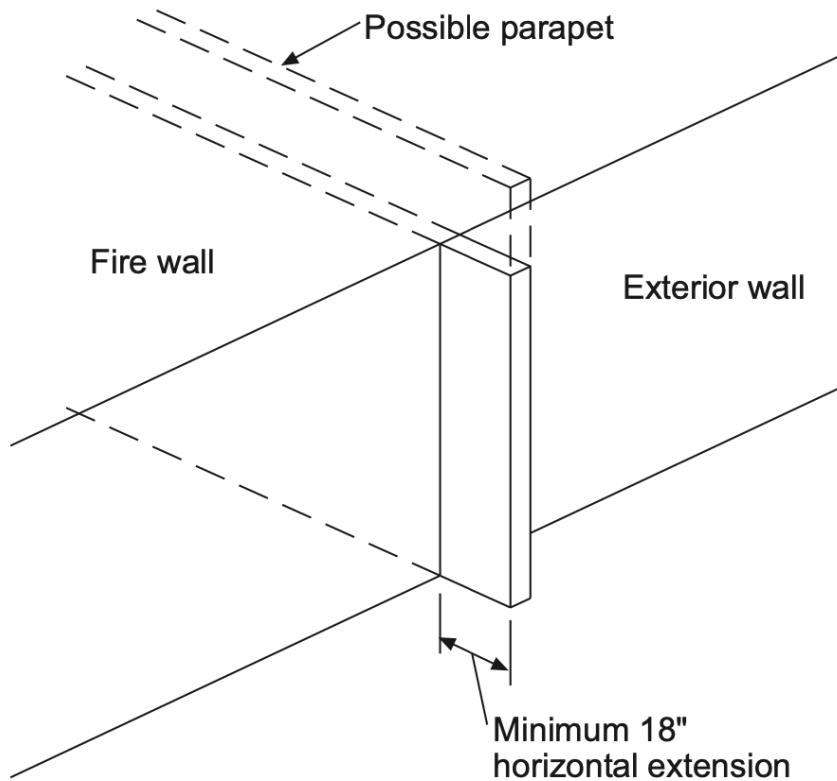
706.3, 706.4 Construction: Fire Walls

**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 ^a
F-1, H-3 ^b , H-5, M, S-1	3
H-1, H-2	4 ^b
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.

706.5 Horizontal Continuity: Fire Walls



Horizontal continuity

For SI: 1 inch = 25.4 mm.

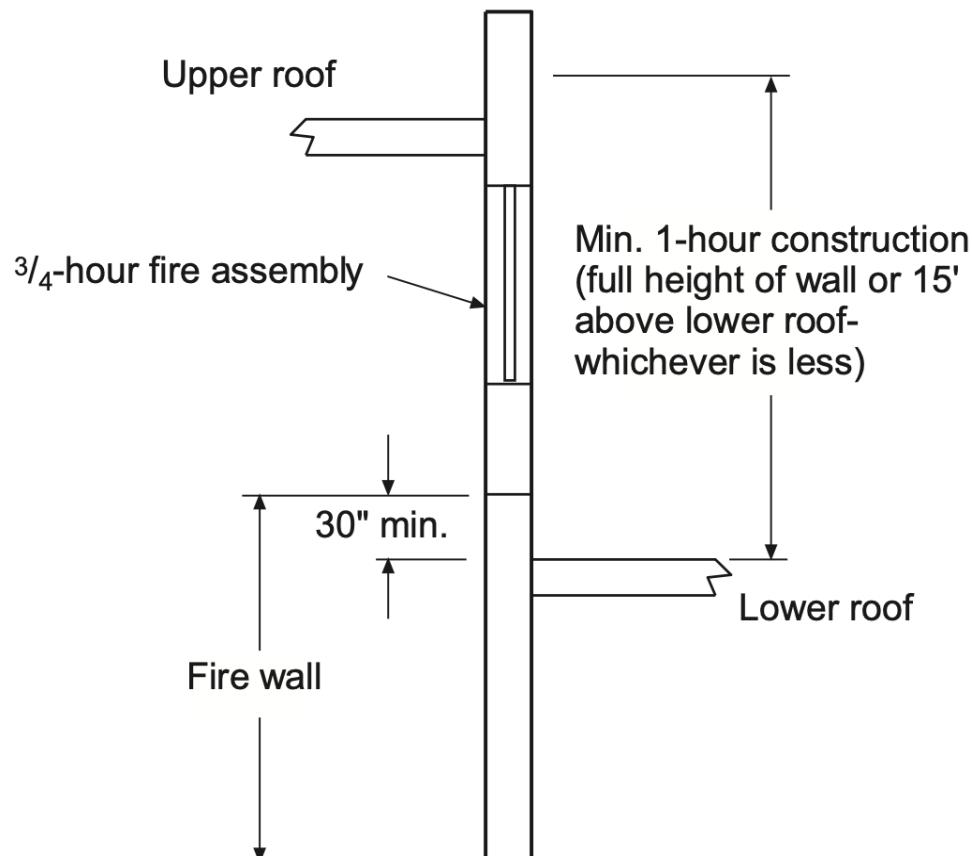
The three exceptions acknowledge the effect certain types of exterior wall construction will have on fire breaching the exterior of the building and exposing the adjacent building. These methods of protection are similar to those used at the roof construction where a parapet is not provided.

Source: 2021 IBC

706.6 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



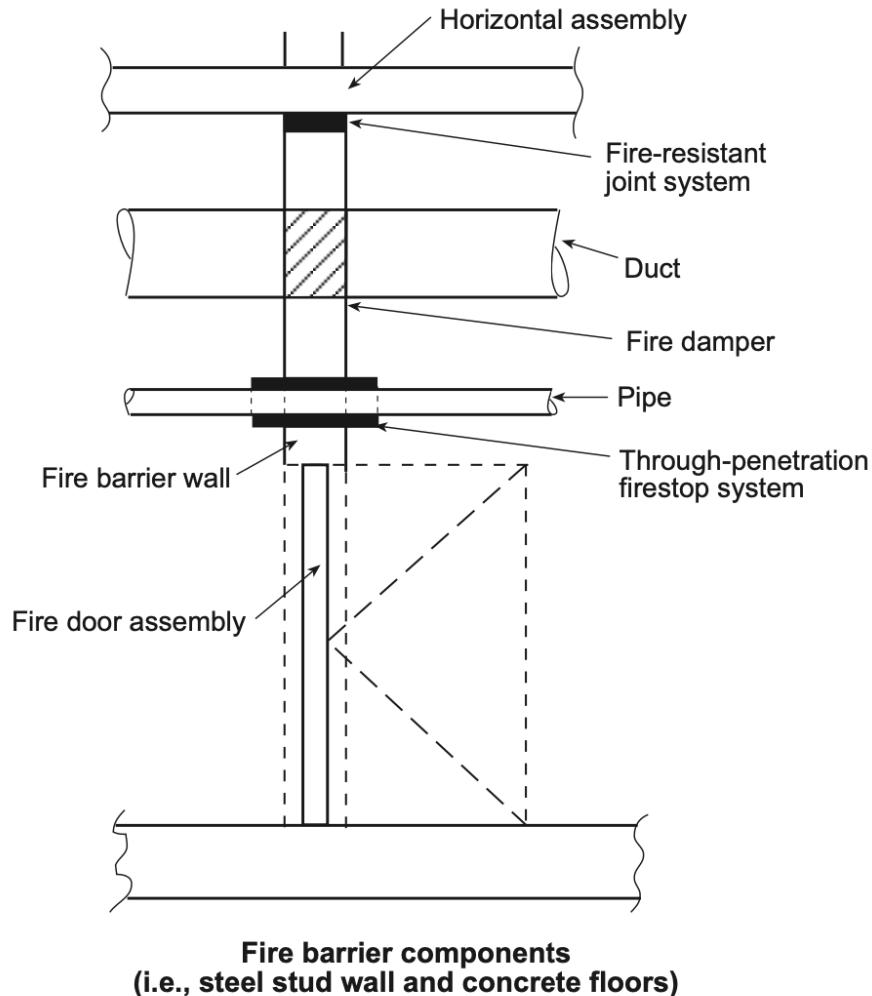
Stepped buildings

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

707.1, 202 Fire Barriers: Definition and Scope

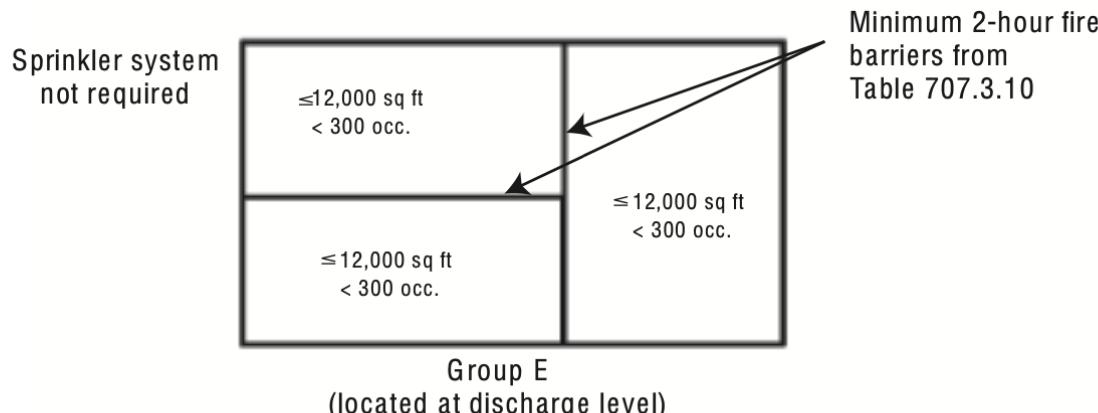


Fire barriers may also be mandated for specific conditions not specifically mentioned in Section 707. Throughout the IBC, as well as the other *International Codes*, fire barriers are identified as the element used to provide the necessary fire separation for compartmentation of building spaces.

Source: 2021 IBC

707.3.10, Table 707.3.10 Fire Areas

Example of the use of fire area concept



For SI: 1 square foot = 0.093 m²

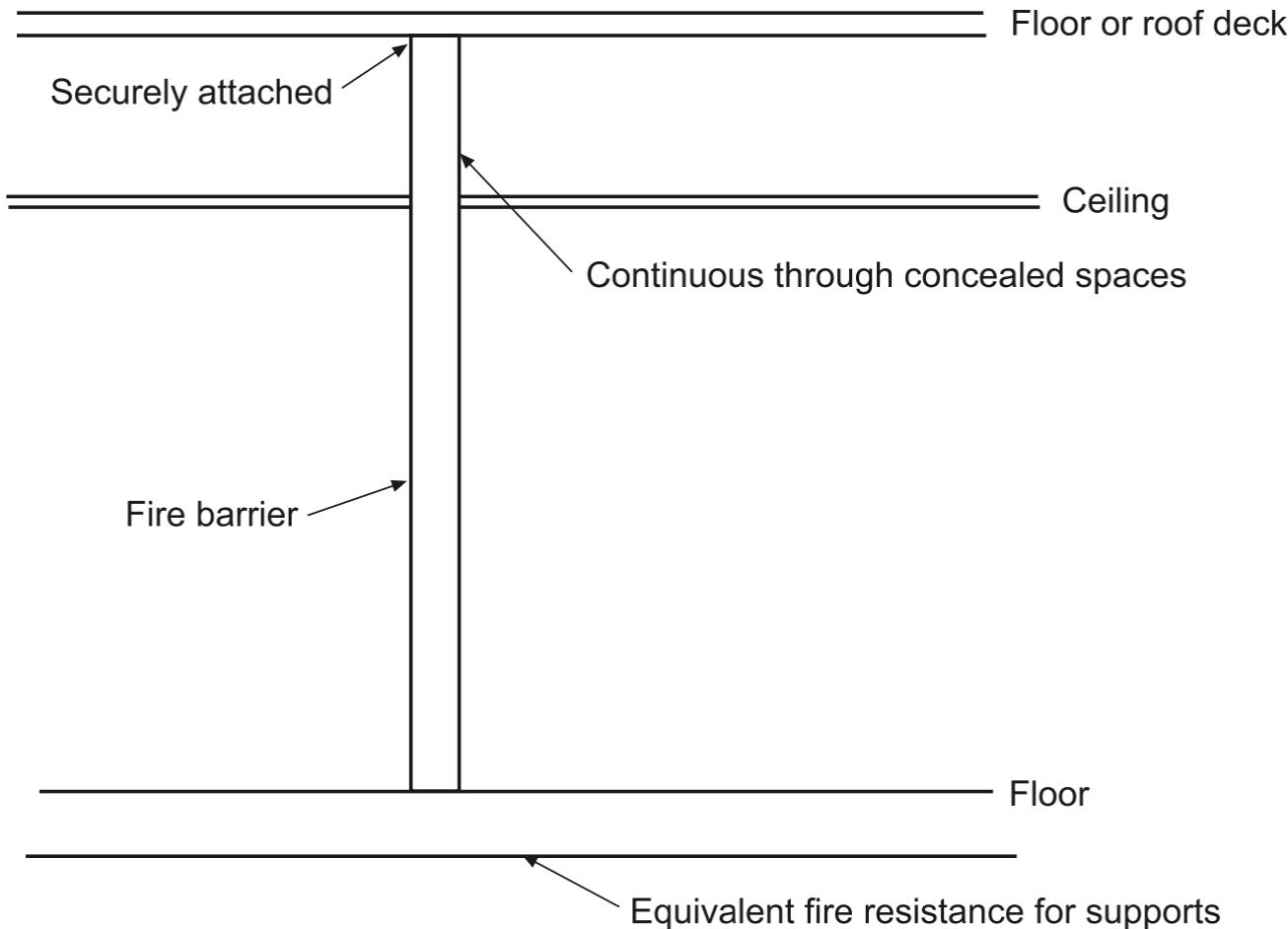
TABLE 707.3.10
FIRE-RESISTANCE RATING REQUIREMENTS FOR
FIRE BARRIERS, FIRE WALLS OR HORIZONTAL
ASSEMBLIES BETWEEN FIRE AREAS

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

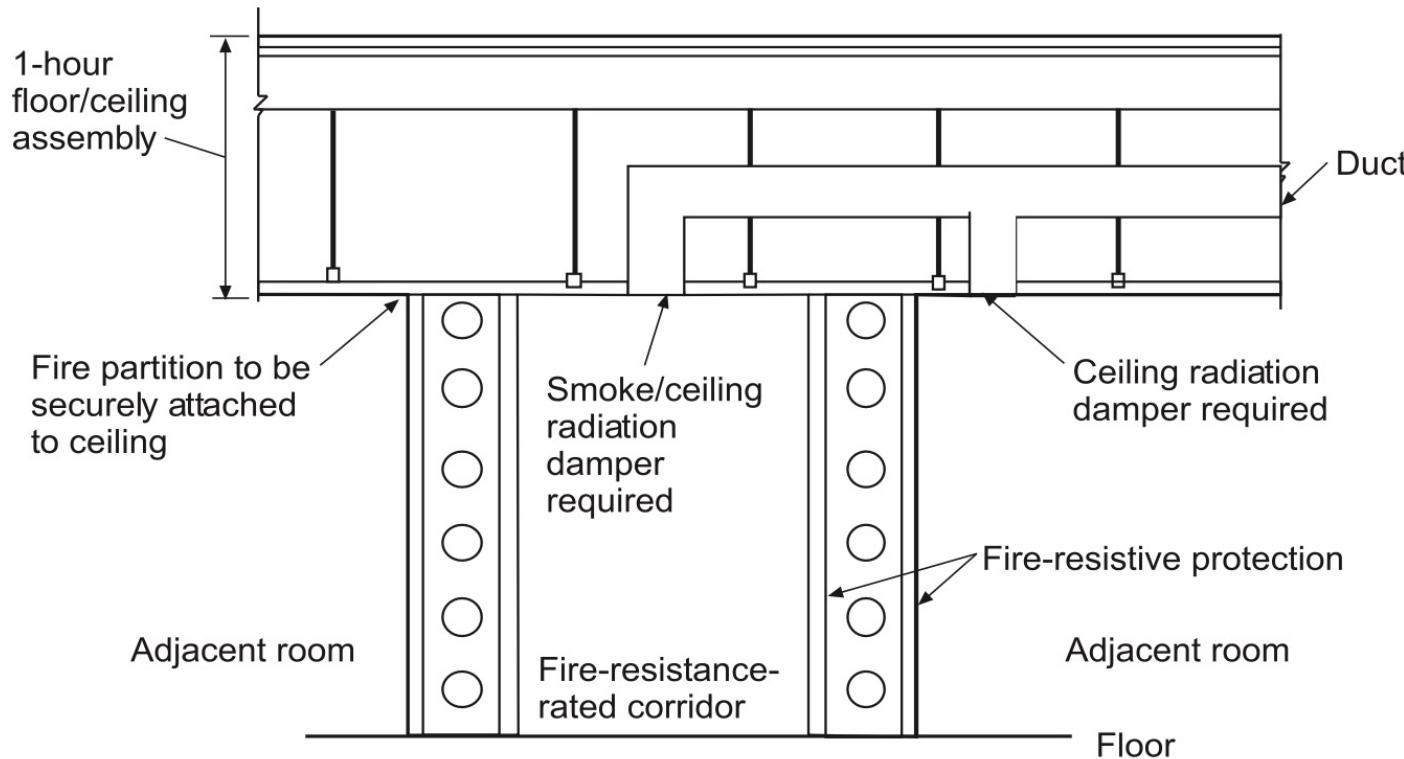
707.5, 707.5.1 Continuity: Fire Barriers



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

708.1, 202 Fire Partitions: Definition and Scope



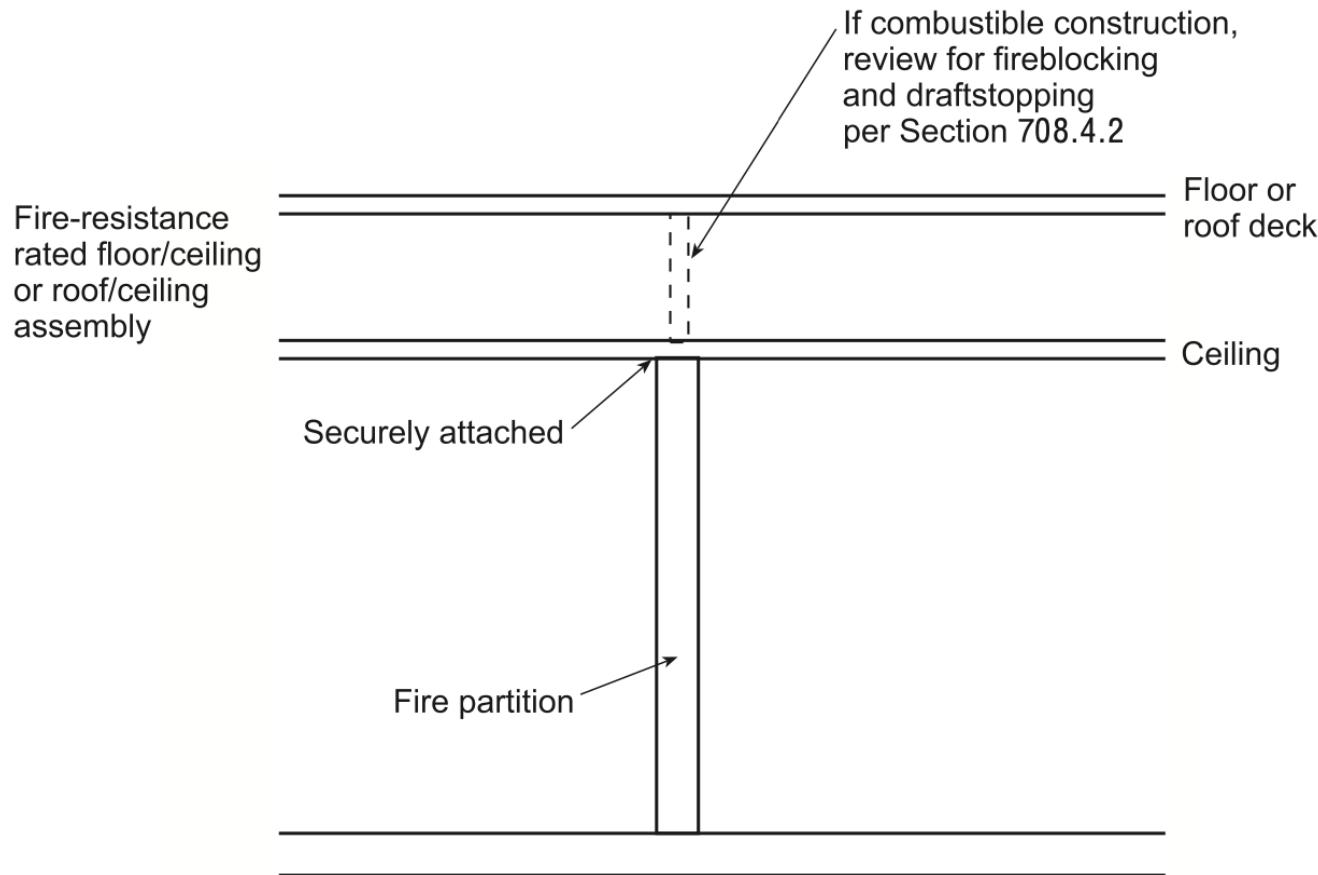
The suspended ceiling is used to provide fire protection for the structural members above. Dampers are required wherever ducts pierce the rated ceiling.

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

708.4 Fire Partitions: Continuity

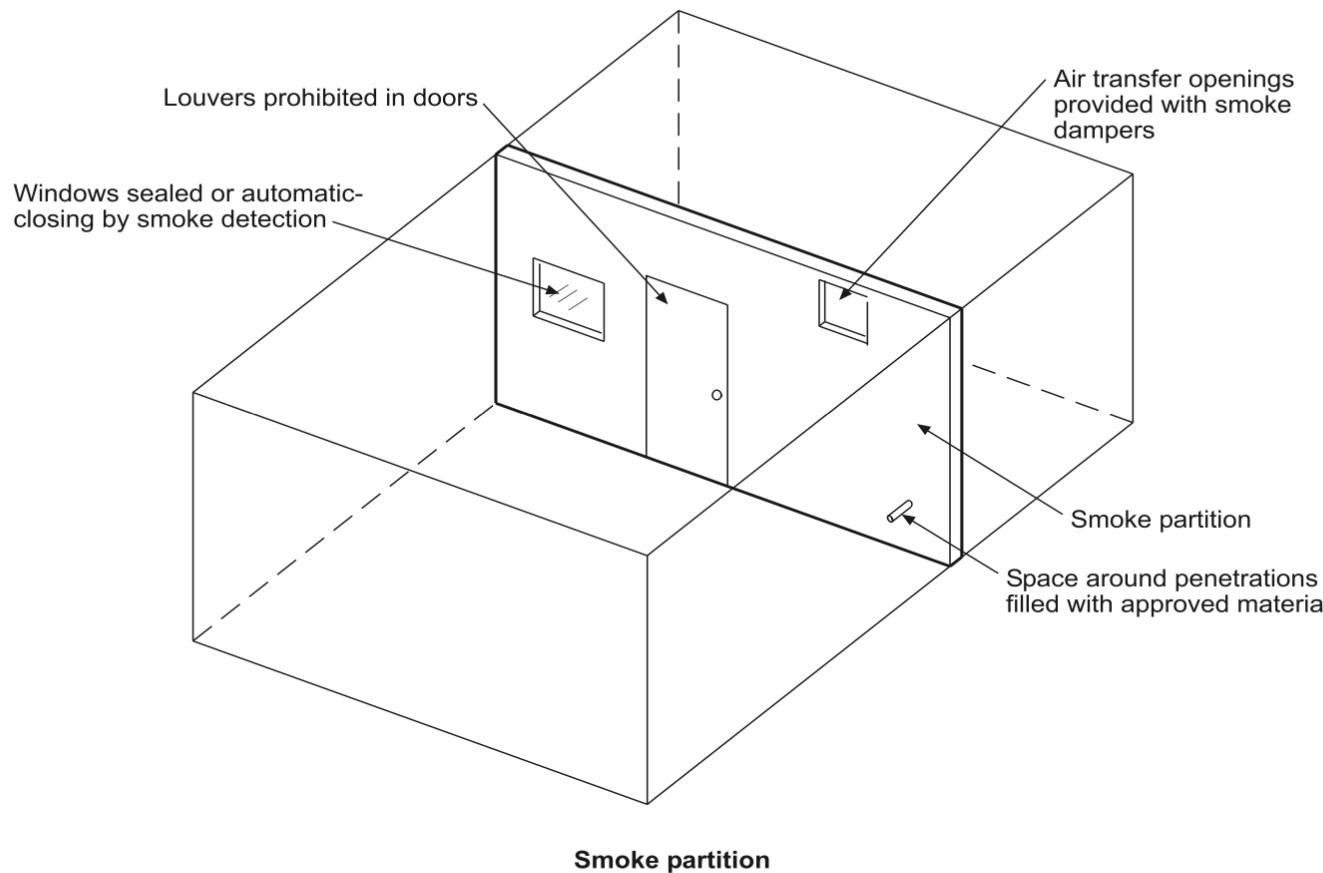


A variety of additional methods are described for creating a fire-resistance-rated corridor. A common construction technique is the “tunnel” corridor, where the corridor ceiling is constructed in a manner consistent with that of the corridor walls.

710 Smoke Partition: General Provisions

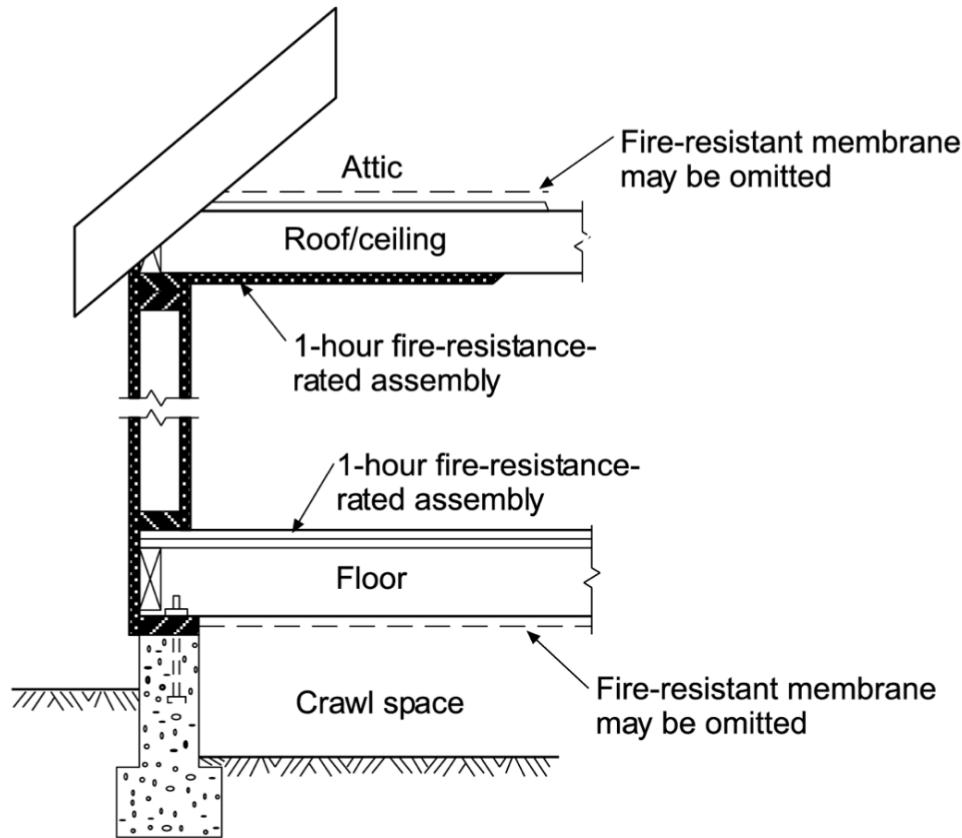
- Smoke partitions installed as required elsewhere in the IBC shall comply with Section 710. The walls shall be of materials permitted by the building type of construction. Unless required elsewhere in the IBC, smoke partitions are not required to have a fire- resistance rating. Smoke partitions shall 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.

711.2 Fire-Resistance Rating



Omission of ceiling and flooring in horizontal assemblies per Section 711.2.6

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.

712.1 Applications: Vertical Openings

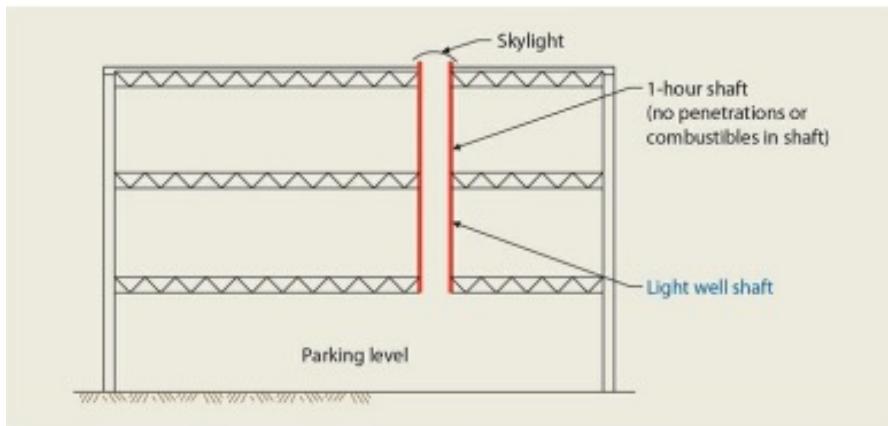


Figure 713-2 Vertical shafts—bottom enclosure.

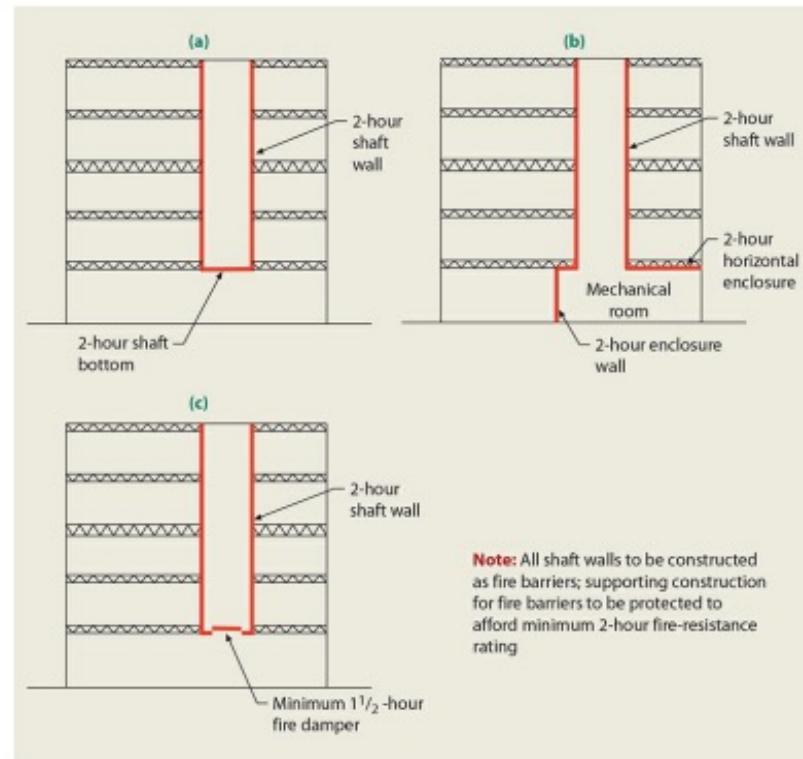


Figure 713-1 Enclosure at shaft bottom.

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

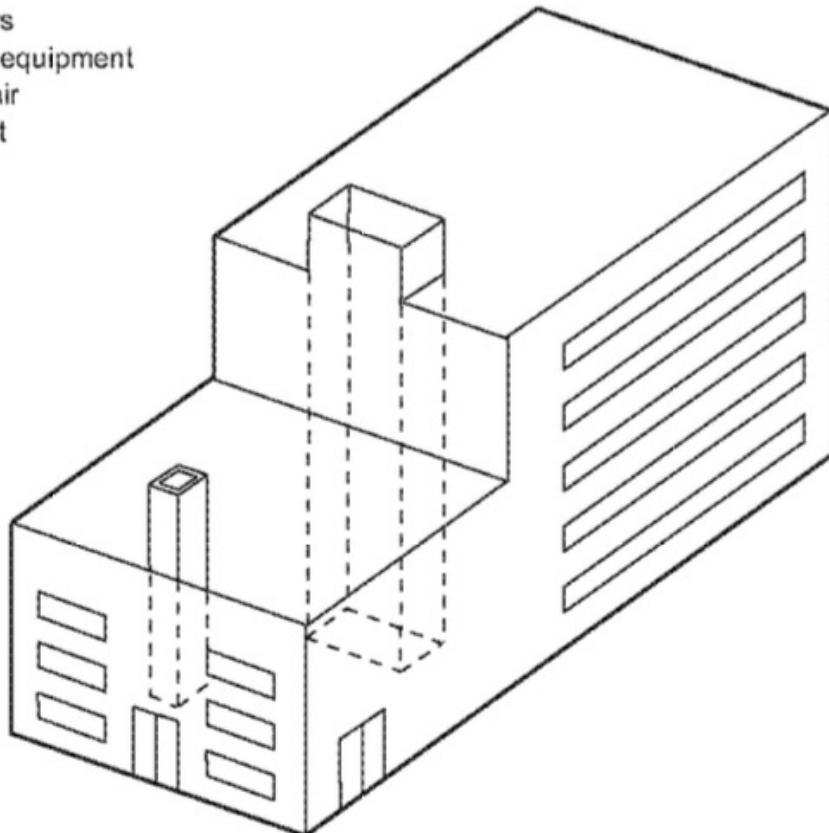
713-720 Objective

- 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

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

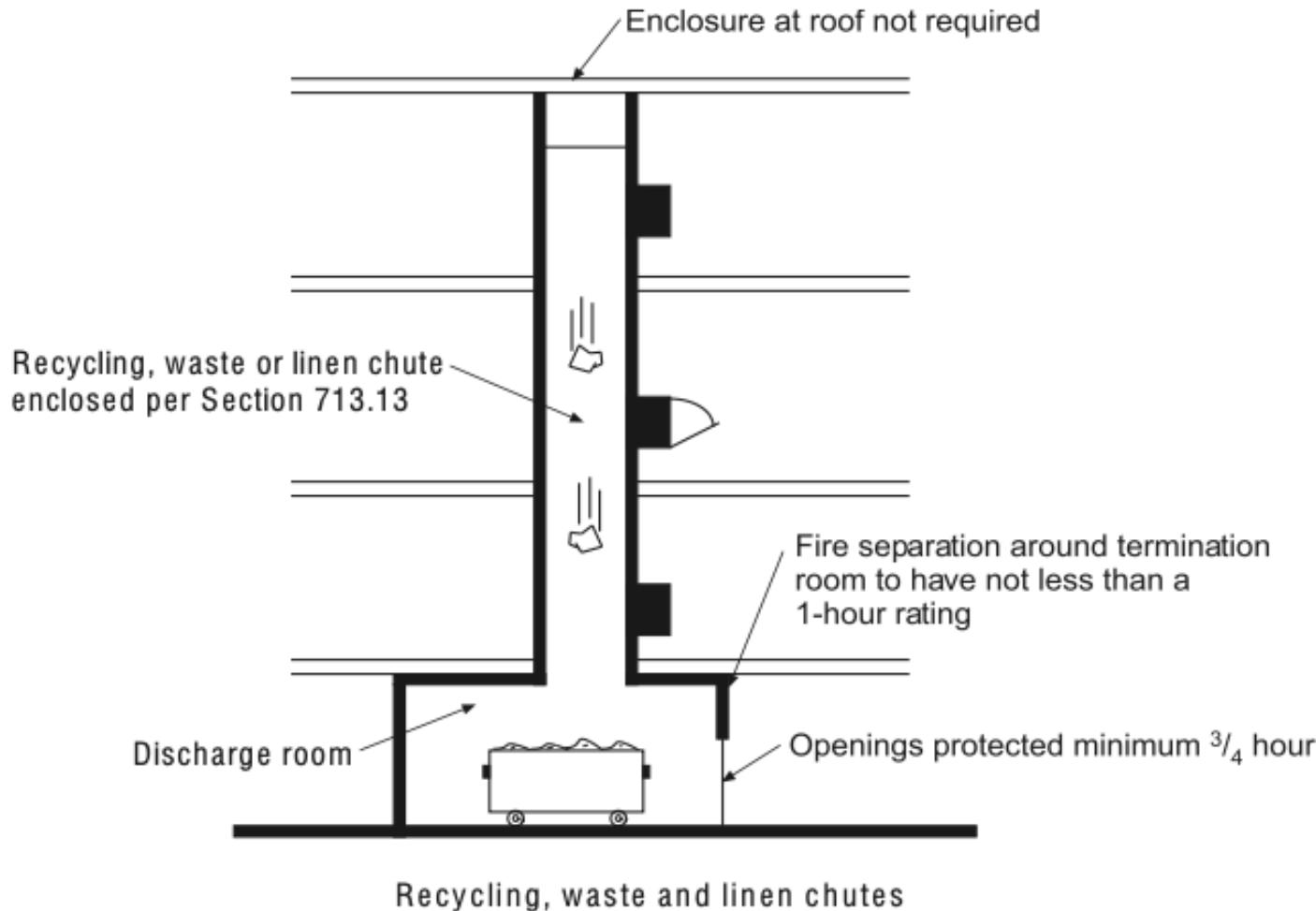
- Elevators
- Dumbwaiters
- Mechanical equipment
- Ventilation air
- Exterior light



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



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

713.13 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

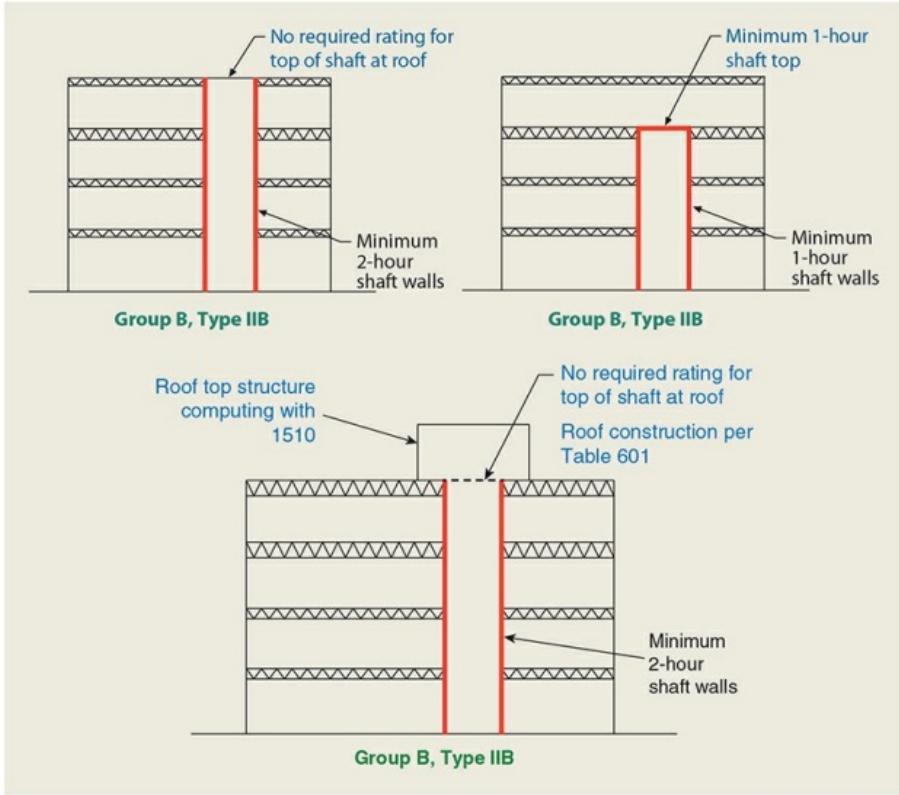


Figure 713-3 **Top enclosure of shaft.**

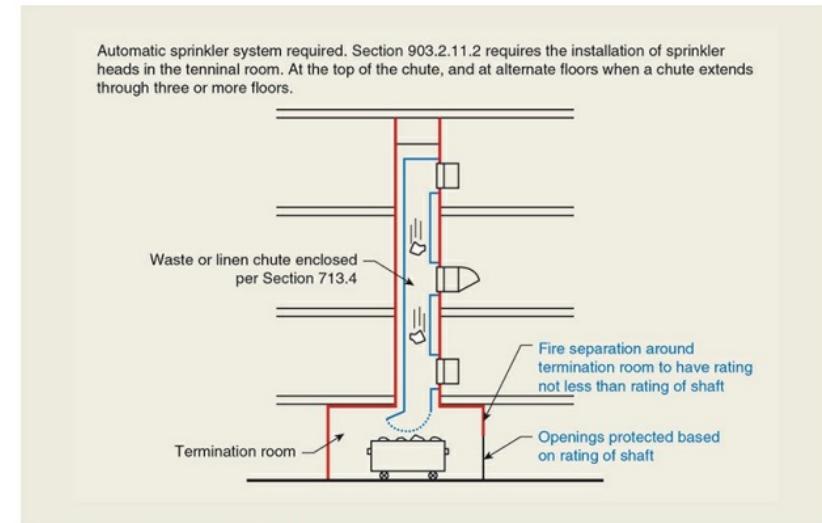
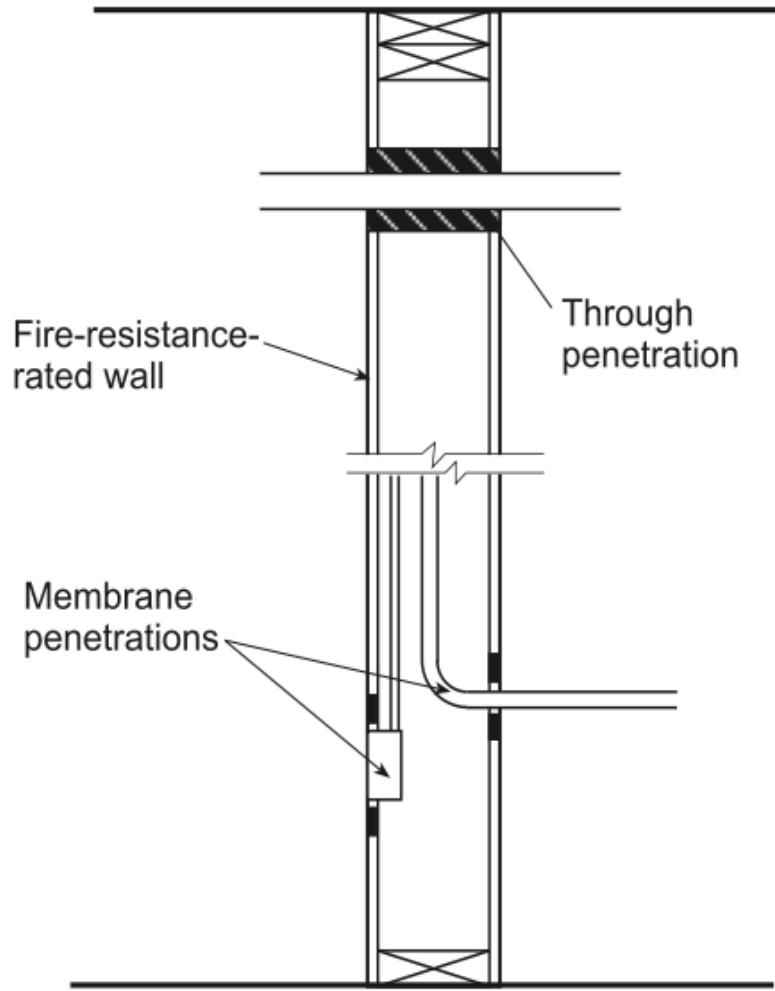


Figure 713-4 **Waste and linen chutes.**

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

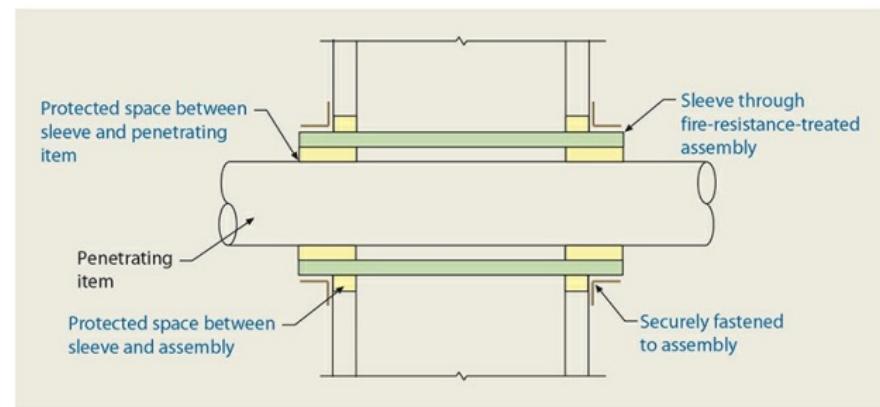
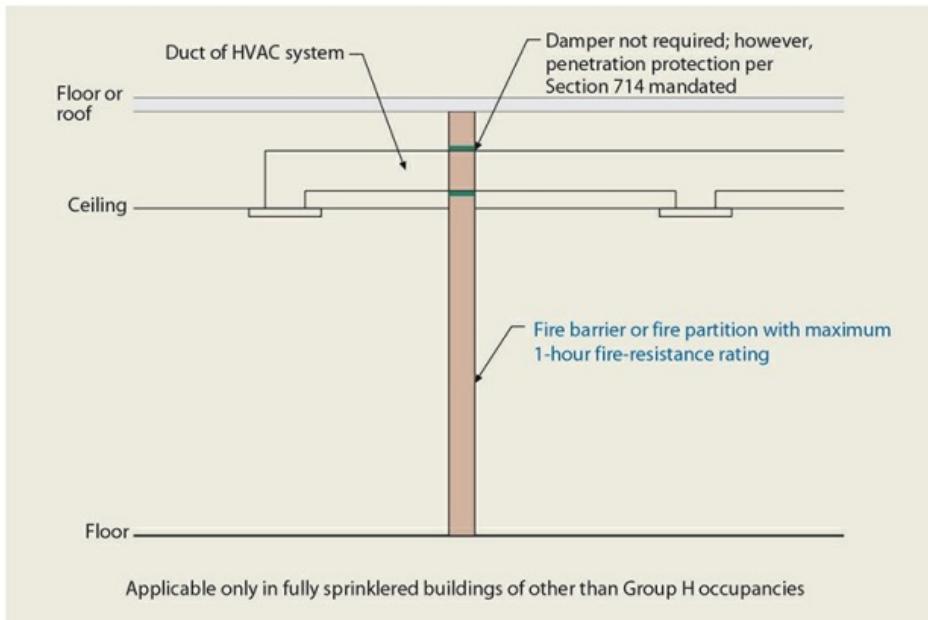
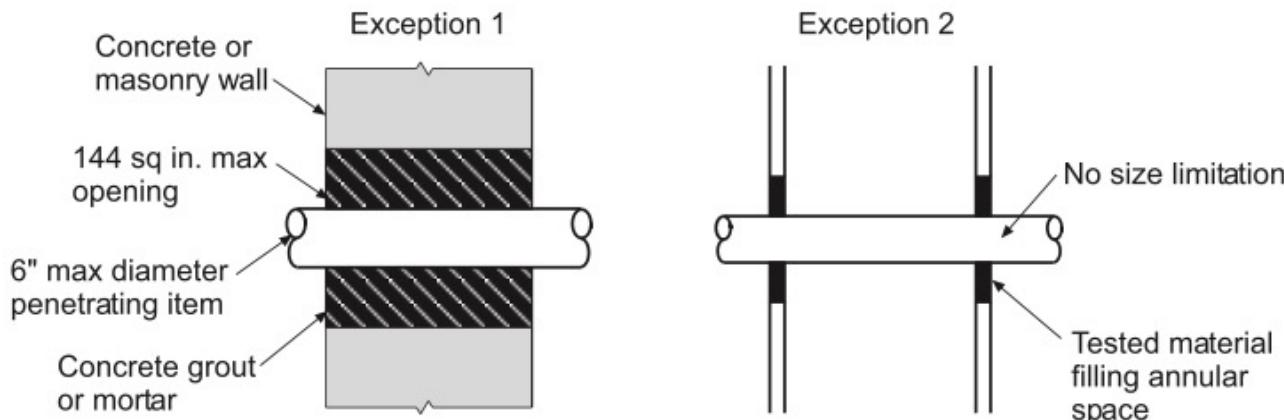
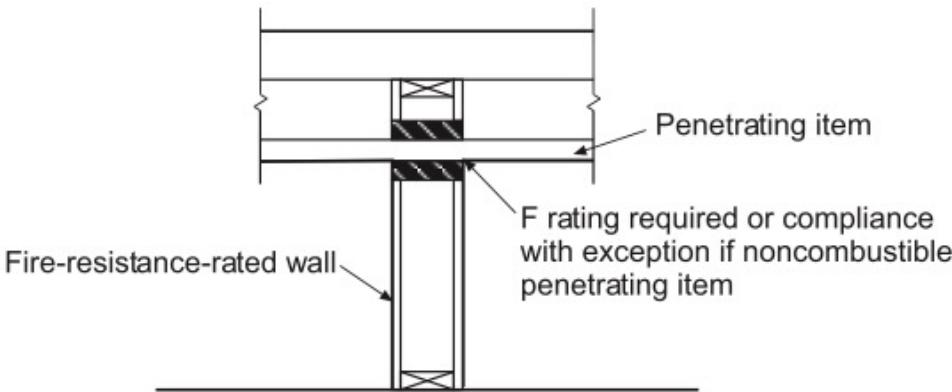


Figure 714-2 Penetration sleeve.

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 mm².

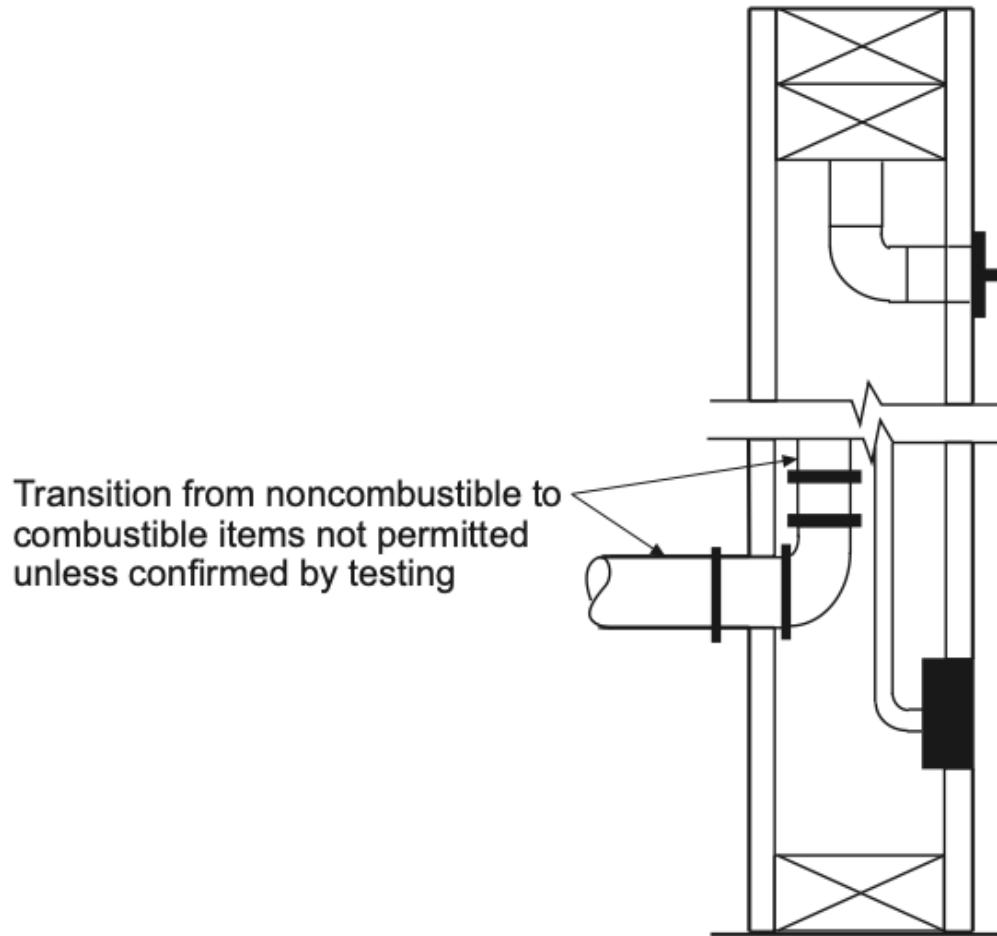
Membrane penetrations are usually addressed in the same manner as through penetrations. Additional exceptions address steel outlet boxes of limited size, listed electrical outlet boxes and fire sprinklers covered by metal escutcheon plates.

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



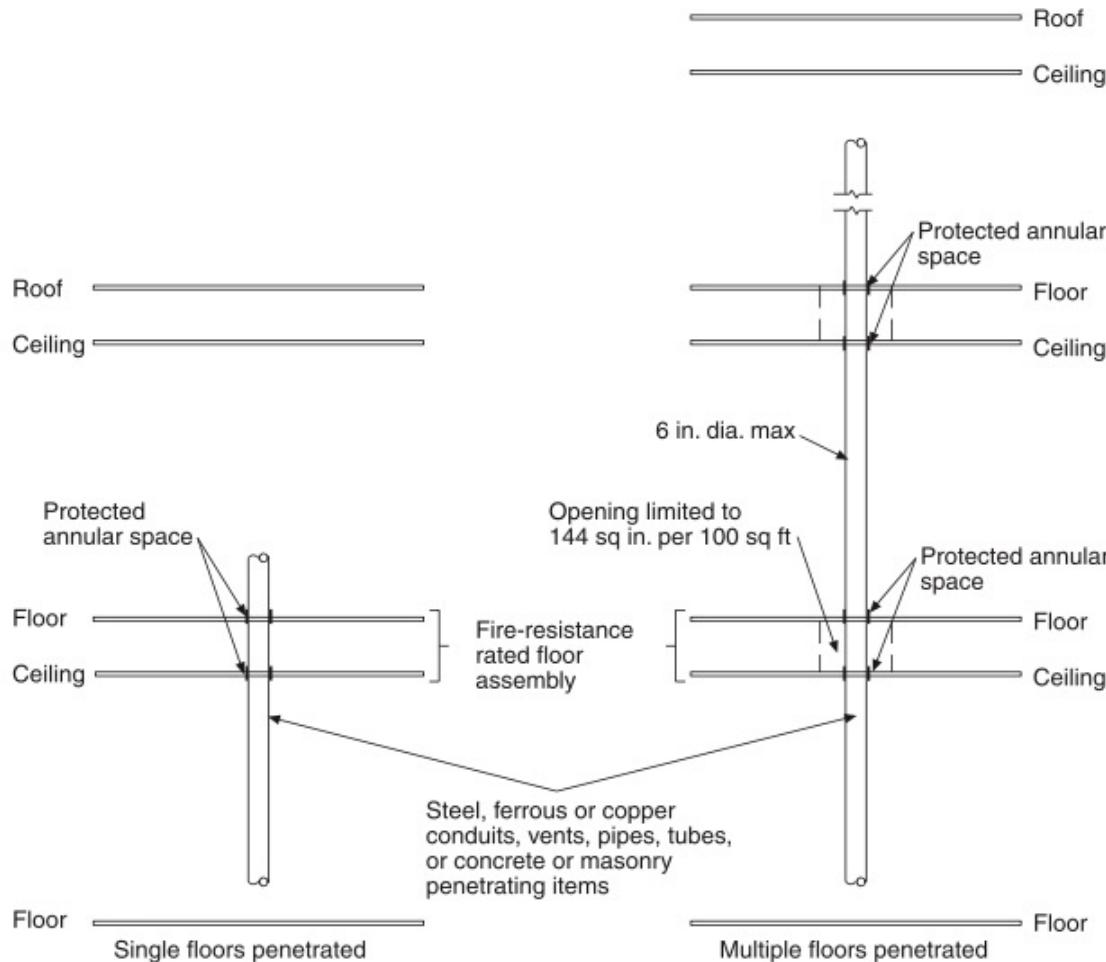
To prevent the creation of an open penetration, the transition from a noncombustible penetrating item to a combustible item is prohibited beyond the point of firestopping. Such a condition is only permitted when its suitability has been demonstrated through testing.

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 mm², 1 square foot = 0.093 m².

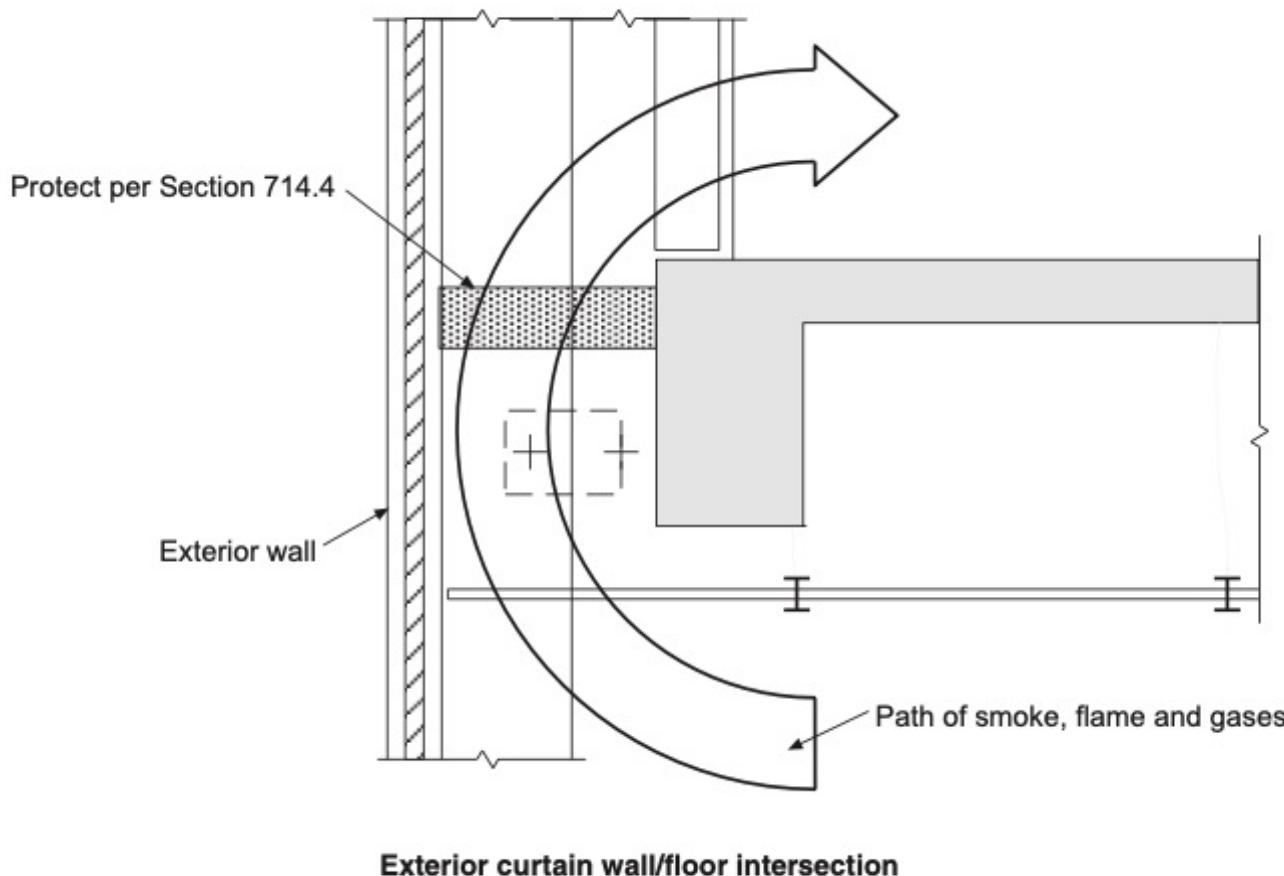
Nonfire-resistance-rated wall assemblies need not be protected where penetrated by conduits, piping and similar penetrating items. However, such protection is mandated for the penetration of nonfire-resistance-rated horizontal assemblies to limit vertical fire spread.

Source: 2021 IBC

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



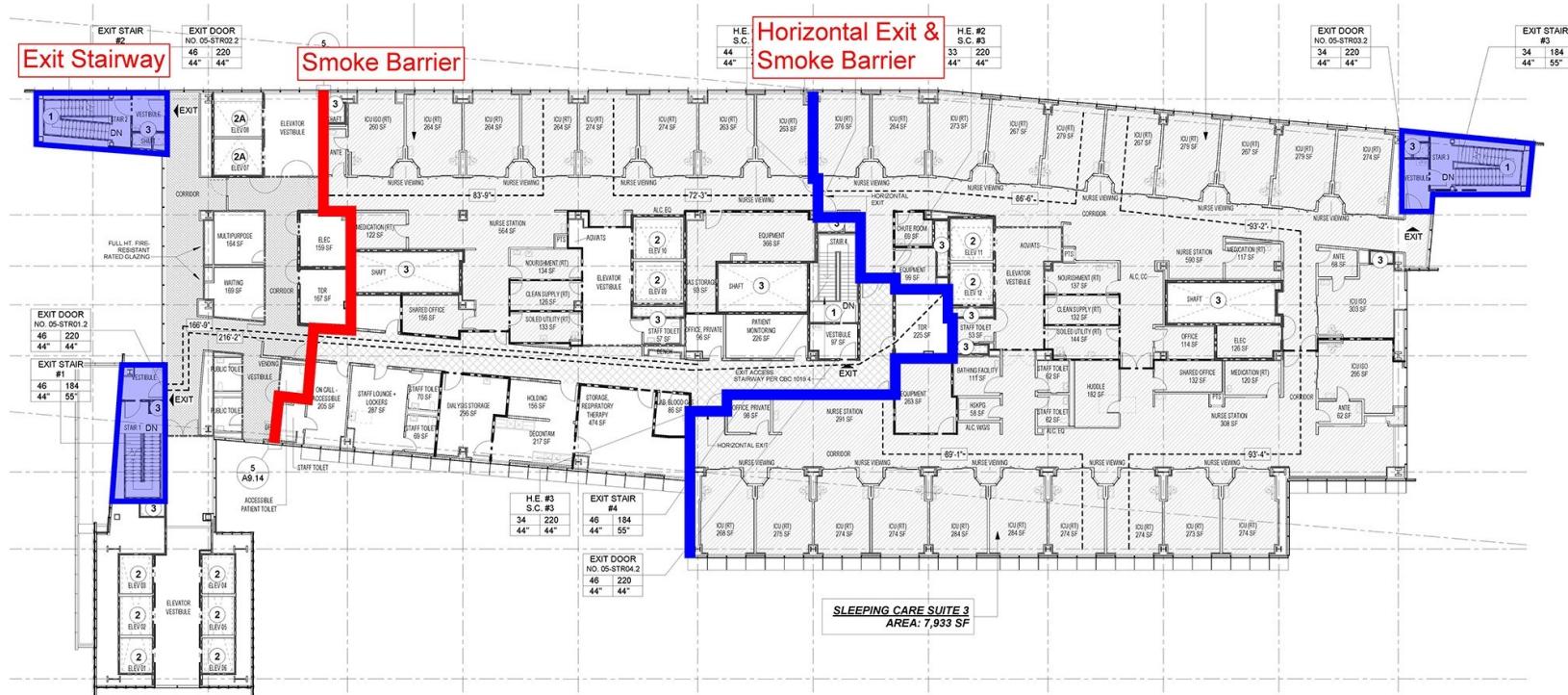
When not utilizing fire-resistant joint systems, the void created at the intersection of a floor/ceiling assembly and an exterior curtain wall assembly must be protected in a similar manner to prevent the spread of flame and hot gases vertically from floor to floor.

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?

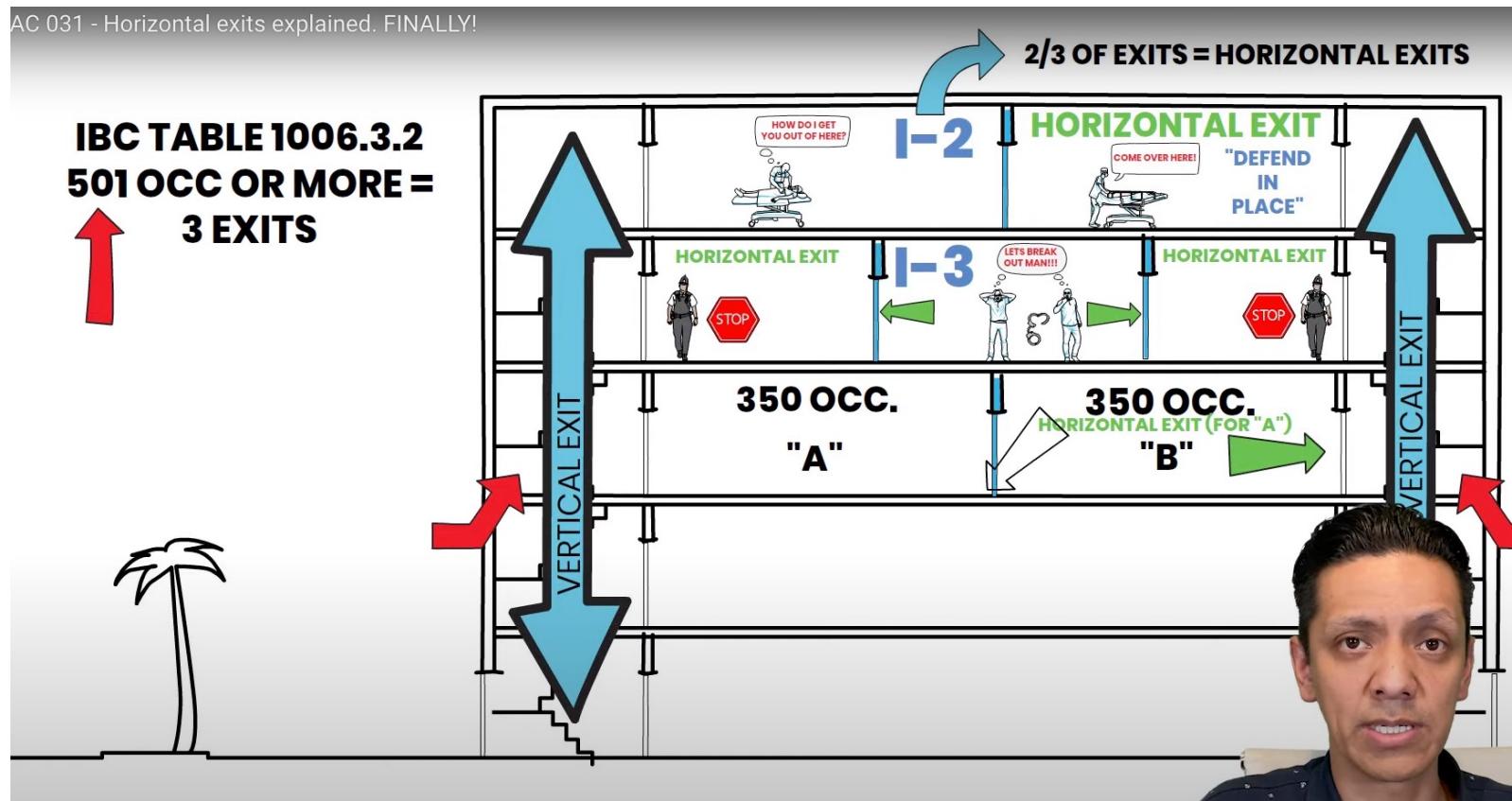
- a. floors within malls
 - b. horizontal exit walls
 - c. mezzanine floors
 - d. roofs where openings are permitted



715.3, 715.2 Fire-Resistant Joint System

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



Source: https://www.youtube.com/watch?v=E_6HVShMG-4

Source: 2021 IBC

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

SECTION 712 VERTICAL OPENINGS

712.1 General. Each vertical opening shall comply in accordance with one of the protection methods in Sections 712.1.1 through 712.1.16.

712.1.1 Shaft enclosures. Vertical openings contained entirely within a *shaft enclosure* complying with Section 713 shall be permitted.

712.1.2 Individual dwelling unit. Unconcealed vertical openings totally within an individual residential *dwelling unit* and connecting four *stories* or less shall be permitted.

712.1.3 Escalator openings. Where a building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, vertical openings for escalators shall be permitted where protected in accordance with Section 712.1.3.1 or 712.1.3.2.

712.1.3.1 Opening size. Protection by a draft curtain and closely spaced sprinklers in accordance with NFPA 13 shall be permitted where the area of the vertical opening between *stories* does not exceed twice the horizontal projected area of the escalator. In other than Groups B and M, this application is limited to openings that do not connect more than four *stories*.

712.1.3.2 Automatic shutters. Protection of the vertical opening by approved shutters at every penetrated floor shall be permitted in accordance with this section. The shutters shall be of noncombustible construction and have a *fire-resistance rating* of not less than 1.5 hours. The shutter shall be so constructed as to close immediately upon the actuation of a smoke detector installed in accordance with Section 907.3.1 and shall completely shut off the well opening. Escalators shall cease operation when the shutter begins to close. The shutter shall operate at a speed of not more than 30 feet per minute (152.4 mm/s) and shall be equipped with a sensitive leading edge to arrest its progress where in contact with any obstacle, and to continue its progress on release therefrom.

712.1.4 Penetrations. Penetrations, concealed and unconcealed, shall be permitted where protected in accordance with Section 714.

712.1.5 Joints. *Joints* shall be permitted where complying with Section 712.1.5.1 or 712.1.5.2, as applicable.

8. Roofs where openings are permitted.

712.1.5.1 Joints in or between horizontal assemblies. *Joints* made in or between *horizontal assemblies* shall comply with Section 715. The void created at the intersection of a floor/ceiling assembly and an exterior curtain wall assembly shall be permitted where protected in accordance with Section 715.4.

712.1.5.2 Joints in or between nonfire-resistance-rated floor assemblies. *Joints* in or between floor assemblies without a required *fire-resistance rating* shall be permitted where they comply with one of the following:

1. The *joint* shall be concealed within the cavity of a wall.
2. The *joint* shall be located above a ceiling.
3. The *joint* shall be sealed, treated or covered with an *approved* material or system to resist the free passage of flame and the products of combustion.

Exception: *Joints* meeting one of the exceptions specified in Section 715.3.

715.3, 715.2 Fire-Resistant Joint System: Exception

10. The intersection of exterior curtain wall assemblies and the roof slab or roof deck.

715.4 Exterior curtain wall/fire-resistance-rated floor intersections. Voids created at the intersection of exterior curtain wall assemblies and fire-resistance-rated floor or floor/ceiling assemblies shall be protected with an *approved perimeter fire containment system* to prevent the interior spread of fire. Such systems shall provide an *F rating* for a time period not less than the *fire-resistance rating* of the floor or floor/ceiling assembly.

715.4.1 Fire test criteria. *Perimeter fire containment systems* shall be tested in accordance with the requirements of ASTM E2307.

Exception: Voids created at the intersection of the exterior curtain wall assemblies and floor assemblies where the vision glass extends to the finished floor level shall be permitted to be protected with an approved material to prevent the interior spread of fire. Such material shall be securely installed and capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste where subjected to ASTM E119 time-temperature fire conditions under a minimum positive pressure differential of 0.01 inch (0.254 mm) of water column (2.5 Pa) for the time period not less than the fire-resistance rating of the floor assembly.

715.5 Exterior curtain wall/nonfire-resistance-rated floor assembly intersections. Voids created at the intersection of exterior curtain wall assemblies and nonfire-resistance-rated floor or floor/ceiling assemblies shall be filled with an *approved* material or system to retard the interior spread of fire and hot gases between *stories*.

715.6 Exterior curtain wall/vertical fire barrier intersections. Voids created at the intersection of nonfire-resistance-rated exterior curtain wall assemblies and vertical *fire barriers* shall be filled with an approved material or system to retard the interior spread of fire and hot gases.

715.7 Curtain wall spandrels. Height and *fire-resistance* requirements for curtain wall spandrels shall comply with Section 705.8.5. Where Section 705.8.5 does not require fire-resistance-rated curtain wall spandrels, the requirements of Sections 715.4 and 715.5 shall still apply to the intersection between the curtain wall spandrels and the floor.

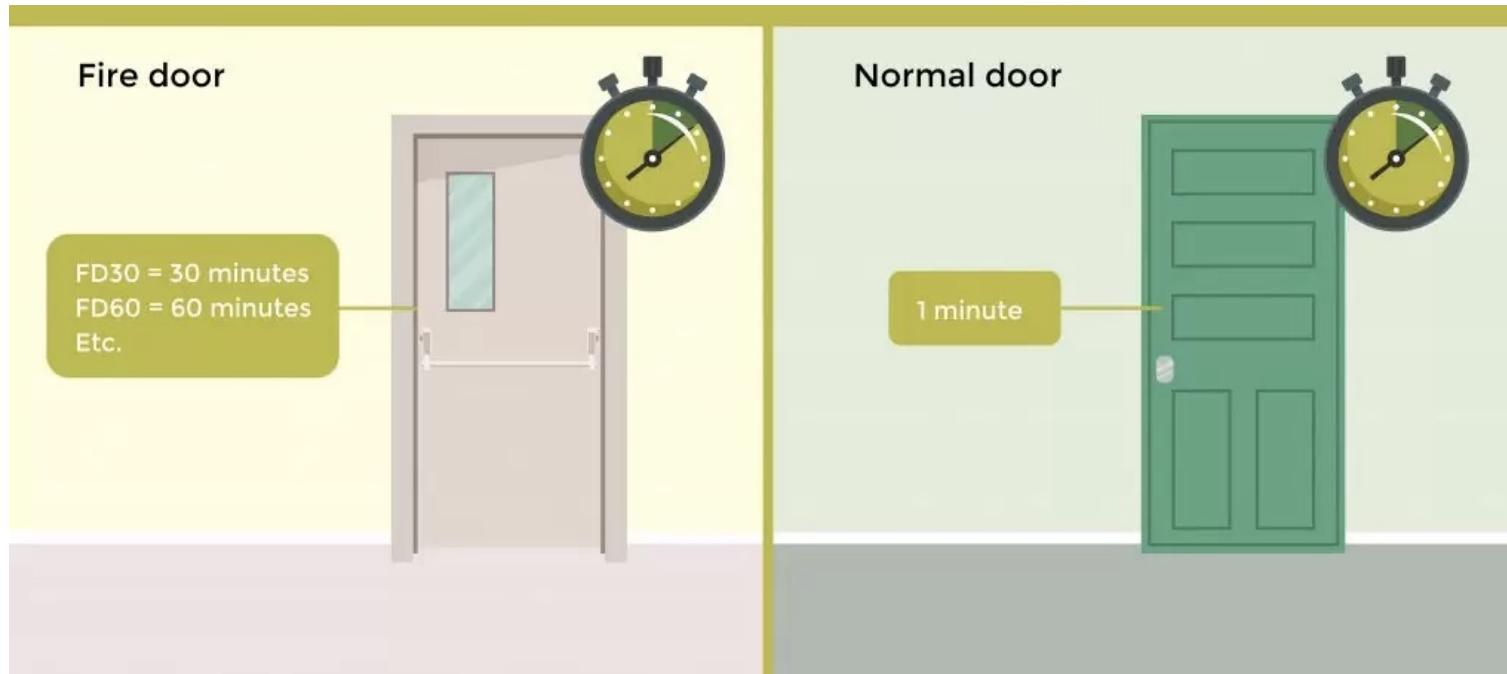
715.8 Joints and voids in smoke barriers. *Fire-resistant joint systems* protecting joints in *smoke barriers*, and perime-

ter fire containment systems protecting voids at the intersection of a horizontal *smoke barrier* and an exterior curtain wall, shall be tested in accordance with the requirements of UL 2079 for air leakage. The L rating of the joint system shall not exceed 5 cubic feet per minute per linear foot ($0.00775 \text{ m}^3/\text{s m}$) of joint at 0.30 inch (74.7 Pa) of water for both the ambient temperature and elevated temperature tests.

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

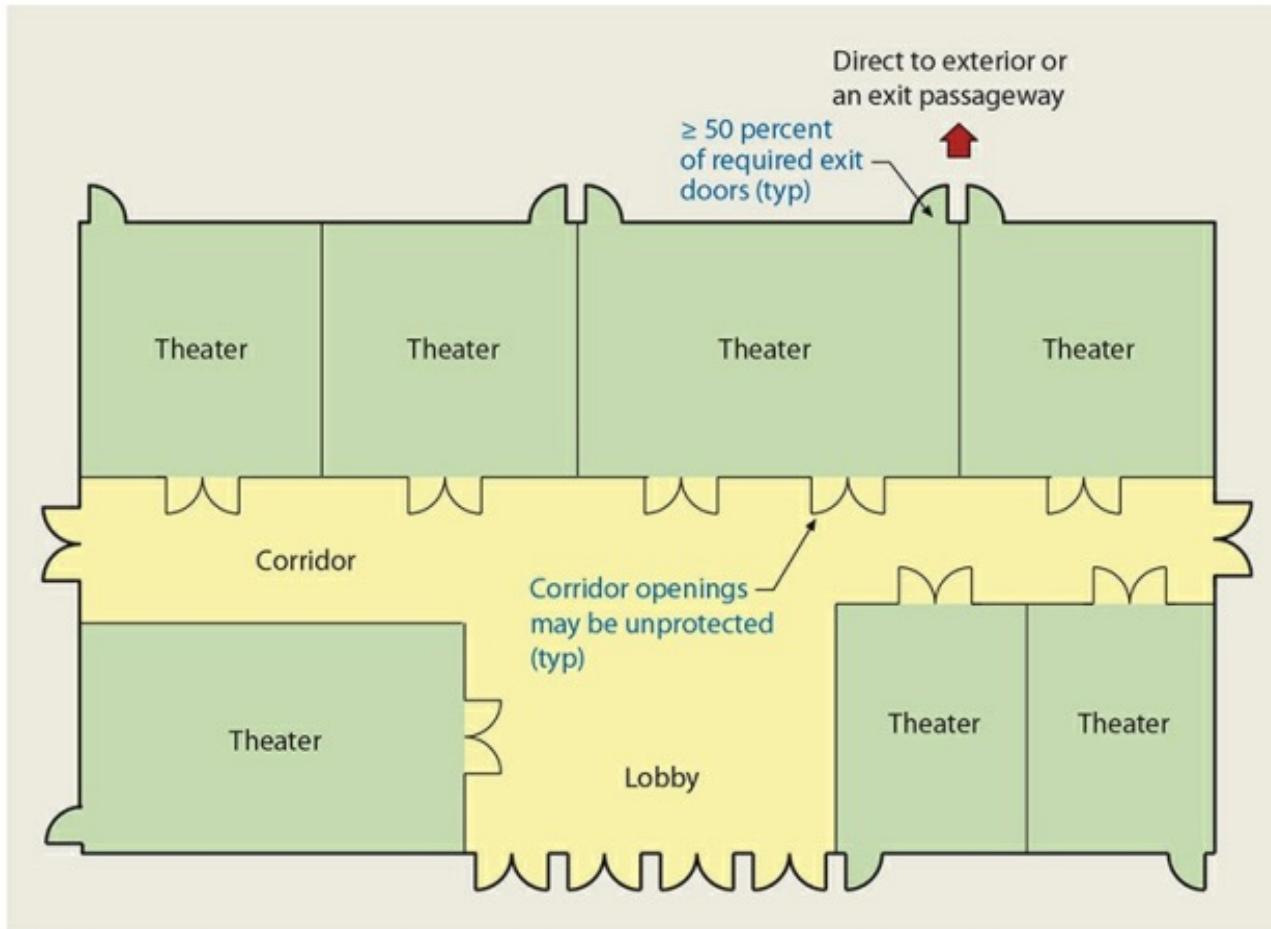


Figure 716-2 Corridor doors in a multitheater complex.

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 ^a	FIRE-RATED GLAZING MARKING DOOR VISION PANEL ^{b,c}	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 ^d	See Note a	D-H-W-180	Not Permitted	3	Not Permitted	W-180
	2	1 ^{1/2}	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 ^{1/2}	1 ^{1/2}	100 sq. in.	$\leq 100 \text{ sq. in.} = \text{D-H-90}$ $>100 \text{ sq. in.} = \text{D-H-W-90}$	Not Permitted	1 ^{1/2}	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)—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 ^a	FIRE-RATED GLAZING MARKING DOOR VISION PANEL ^{b,c}	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 ^d	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 ^d	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 ^b		D-H ^b	
Fire partitions: Corridor walls	1	1/3 ^a	Maximum size tested	D-20	3/4 ^b		D-H-OH-45	
	0.5	1/3 ^a	Maximum size tested	D-20	1/3		D-H-OH-20	
Other fire partitions	1	3/4 ⁱ	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. ^s	≤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 ^b	2	D-H-OH-90 ^b	W-120
					Fire protection			
	1	3/4	Maximum size tested	D-H-45	3/4 ^b		D-H-45 ^b	

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

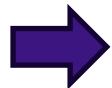


A common belief is that the rating of a fire door assembly is always equal to three quarters of the required rating of the wall.

Answer:

<https://www.youtube.com/watch?v=ABOzoK6PNBA&t=107s>

4



Fuel load less since wall has furniture fuel load.

<https://www.youtube.com/watch?v=9cADBexRFIY>

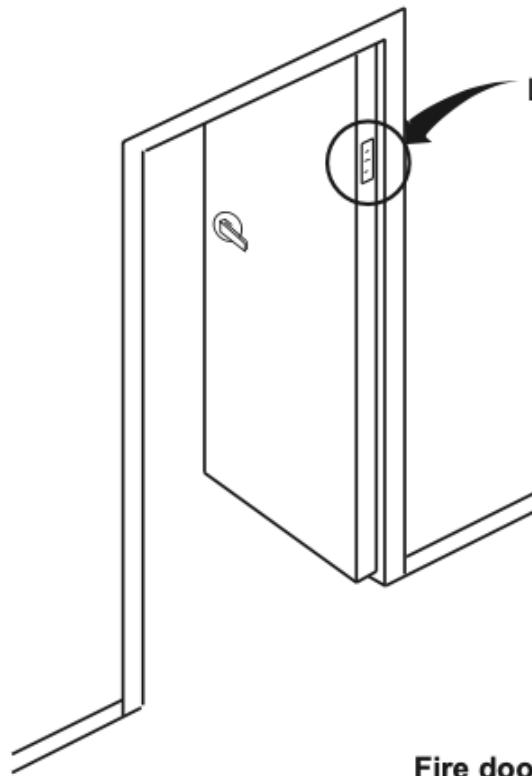
Fire load examples on door:

<https://www.youtube.com/watch?v=1FJdWTITXG0>

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)

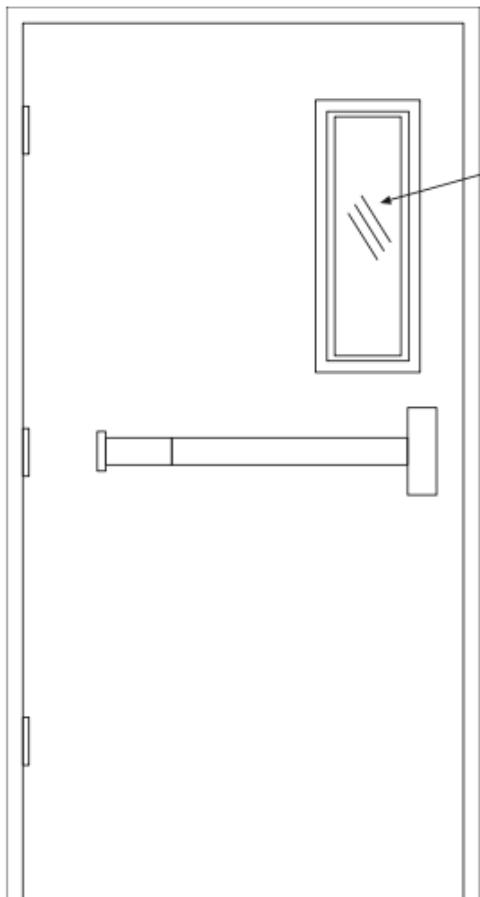
Fire door assembly

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).

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.

717, 202: Fire and Smoke Dampers: Definitions

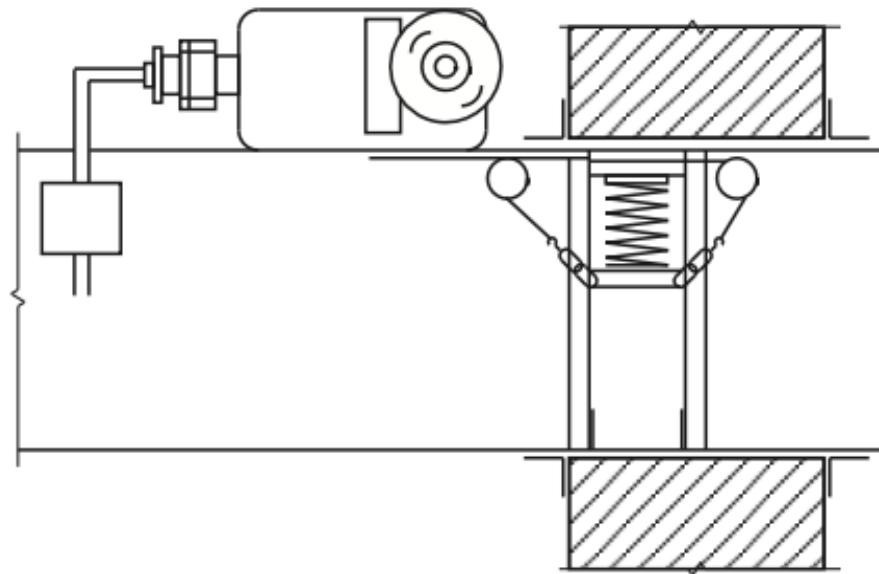


Figure courtesy
Sheet Metal and Air Conditioning Contractors National Association

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

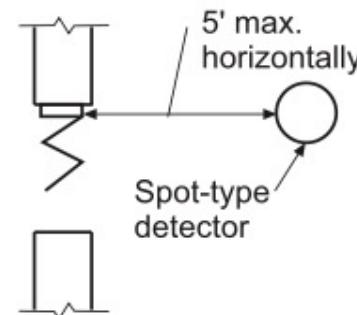
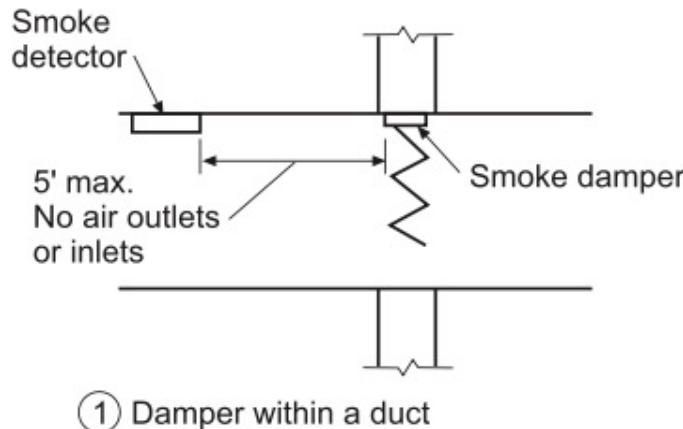
Where both a fire and a smoke damper are mandated, the use of a combination damper is permitted. This type of listed device is designed to close automatically upon detecting heat and to resist the passage of air and smoke.

Source: 2021 IBC

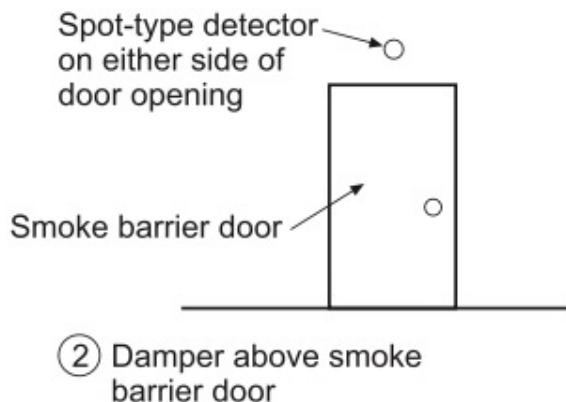
717.3.1: Ducts and Air Transfer Openings.

- 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

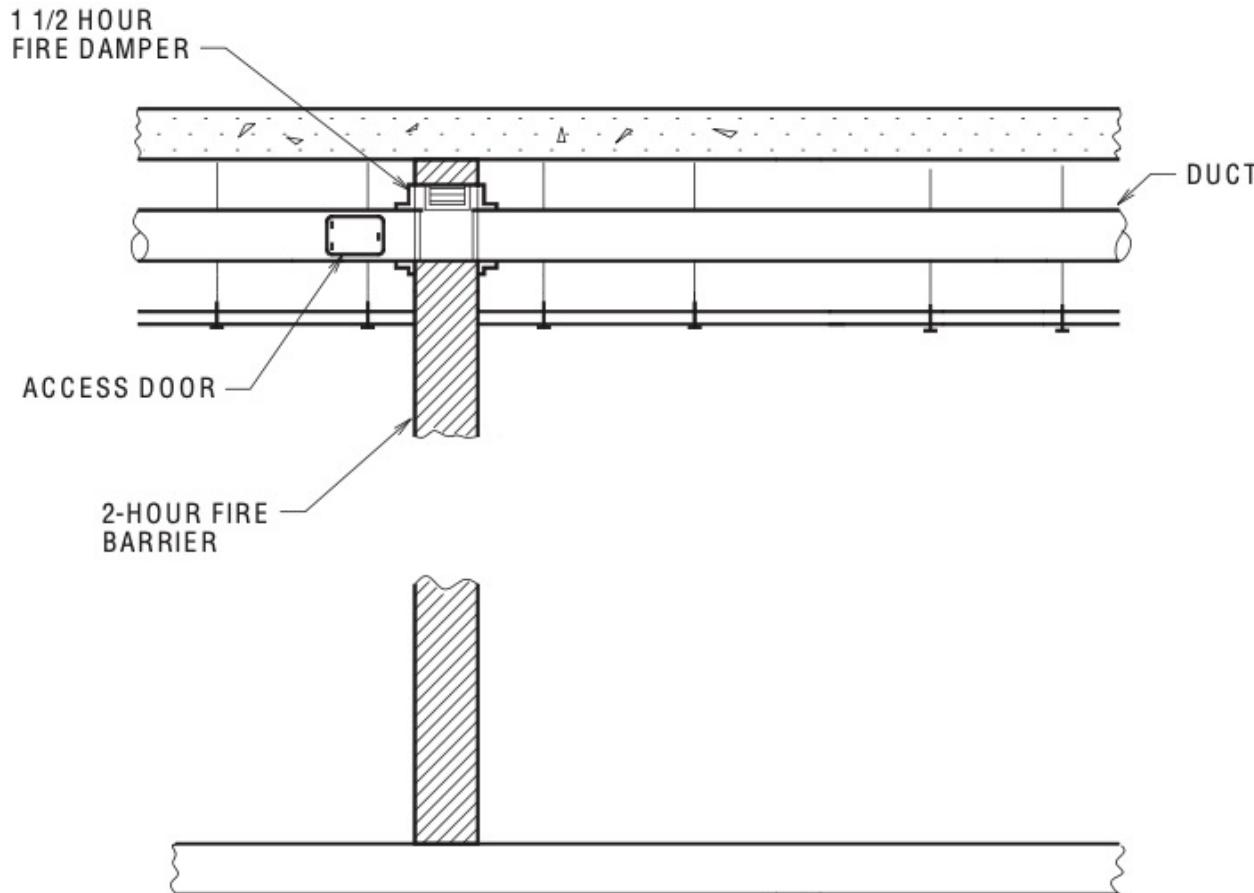
A smoke damper must close upon actuation of a listed smoke detector or smoke detection system. The IBC identifies five methods, one or more of which may be applicable, for the detector location and/or actuation.

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



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

717.5 Where required. *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.*

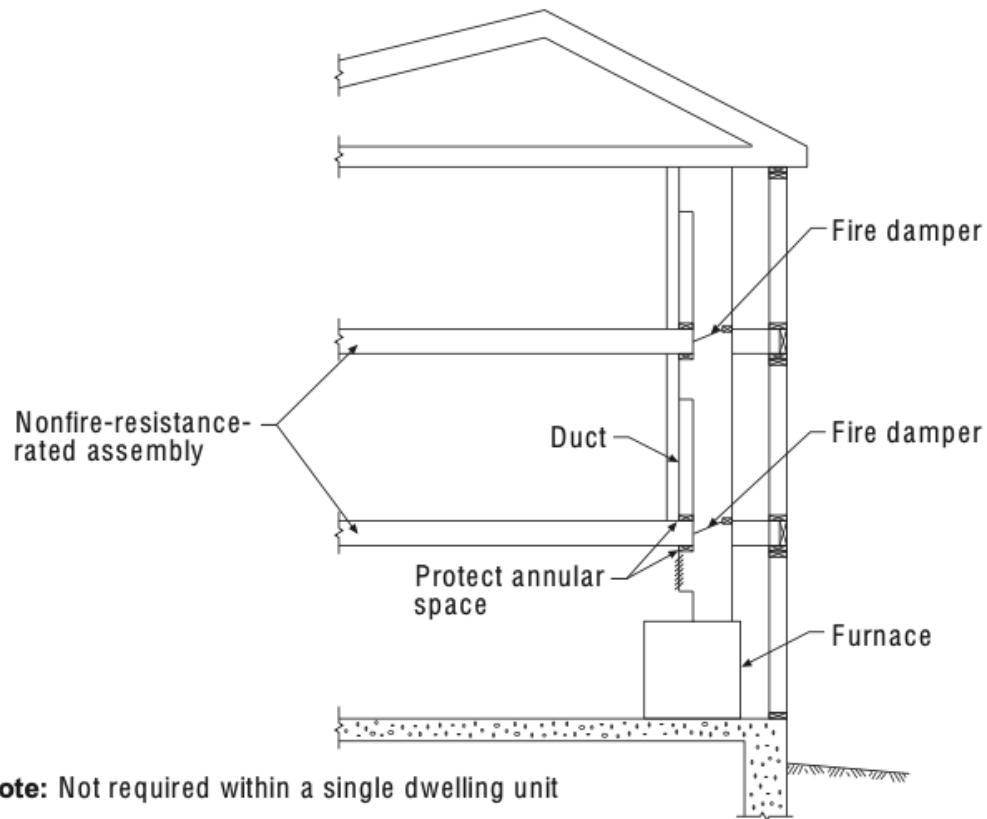
717.5.1 Fire walls. Ducts and air transfer openings permitted in *fire walls* in accordance with Section 706.11 shall be protected with *listed fire dampers* installed in accordance with their listing.

717.5.1.1 Horizontal exits. A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *fire wall* that serves as a *horizontal exit*.

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

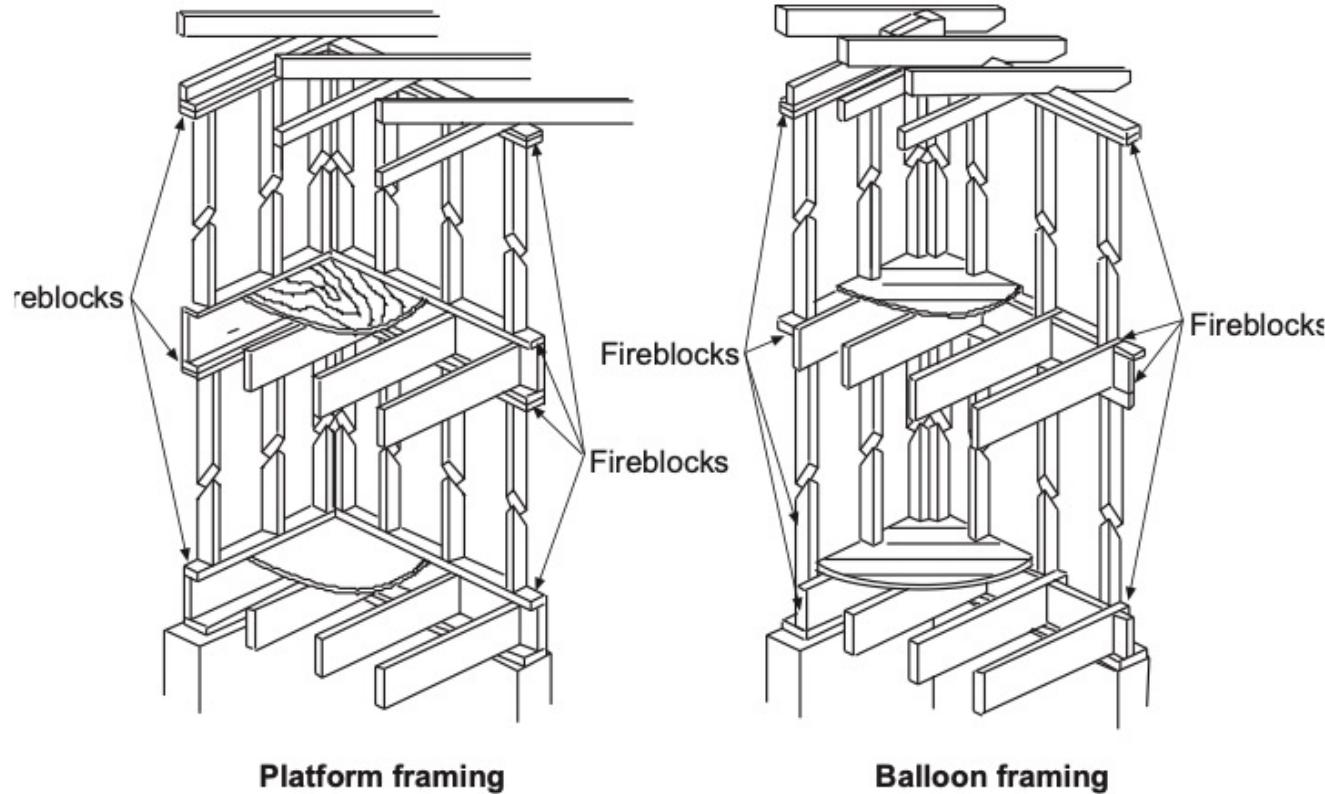


Where Item 3 is utilized for a duct that connects three stories, a minimum $1\frac{1}{2}$ -hour fire damper is required at each floor line even though the floor or floor/ceiling assembly is not required to have a fire-resistance rating, because the damper is an alternative to a 1-hour shaft enclosure.

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

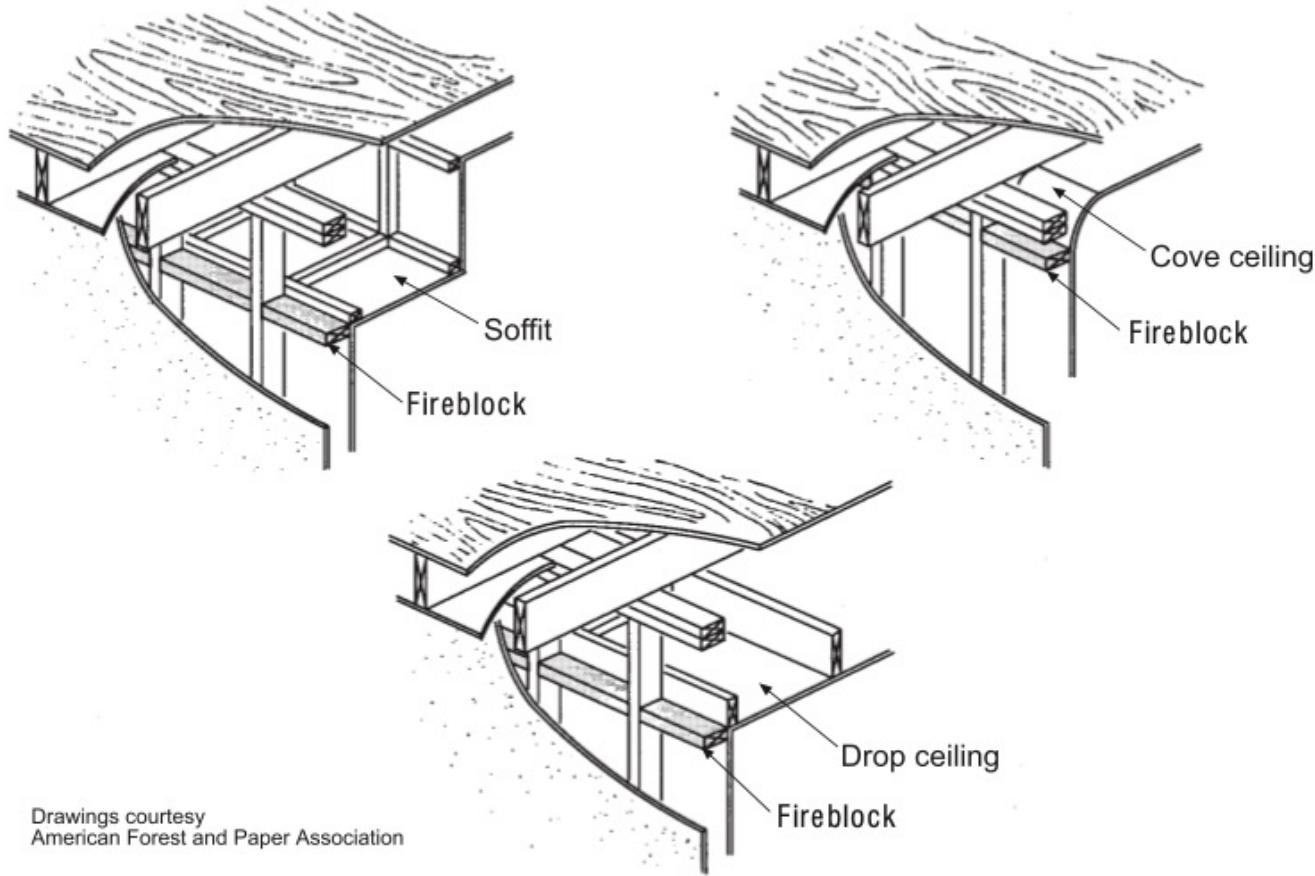


In noncombustible construction, building materials located in concealed areas of the building construction do not contribute to the spread of fire. Therefore, fireblocking and draftstopping are required only in buildings of combustible construction.

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



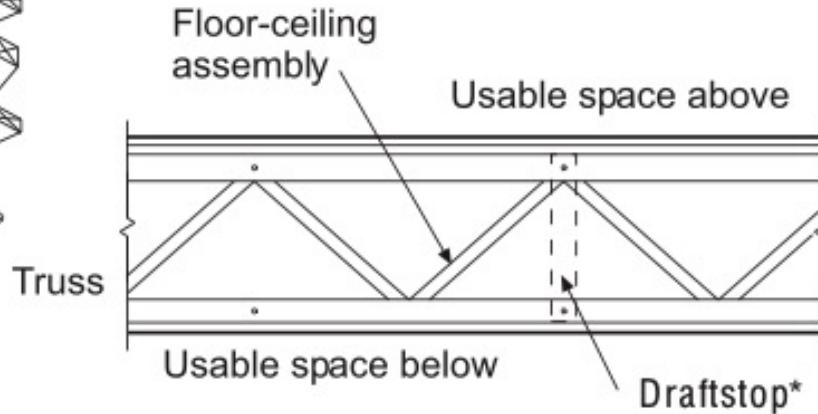
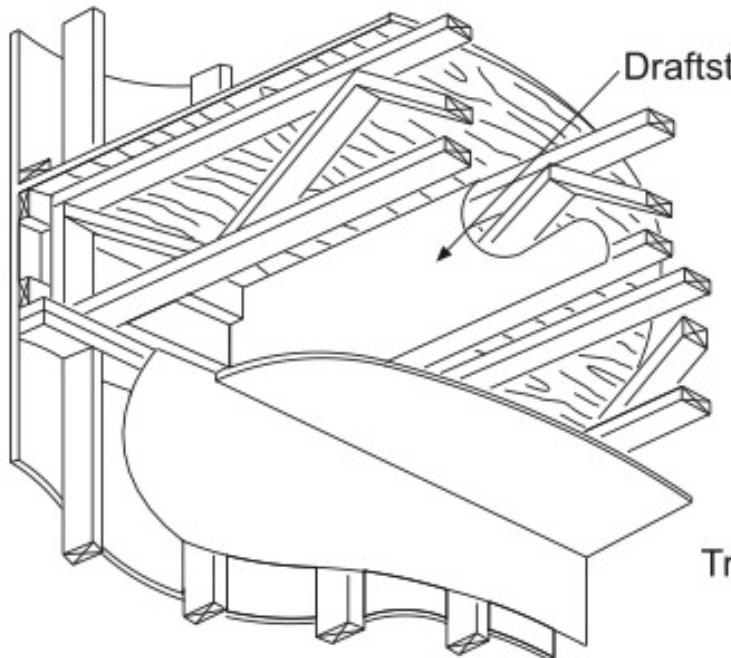
Drawings courtesy
American Forest and Paper Association

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 m².

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

Source: <https://www.youtube.com/watch?v=OzDQHs6zt6k&t=45s>

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

718.3 Draftstopping in floors. Draftstopping shall be installed to subdivide floor/ceiling assemblies where required by Section 708.4.2. In other than Group R occupancies, draftstopping shall be installed to subdivide combustible floor/ceiling assemblies so that horizontal floor areas do not exceed 1,000 square feet (93 m^2).

Exception: Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

718.3.1 Draftstopping materials. Draftstopping materials shall be not less than $\frac{1}{2}$ -inch (12.7 mm) gypsum board, $\frac{3}{8}$ -inch (9.5 mm) wood structural panel, $\frac{3}{8}$ -inch (9.5 mm) particleboard, 1-inch (25-mm) nominal lumber, cement fiberboard, batts or blankets of mineral wool or glass fiber, or other *approved* materials adequately supported. The integrity of *draftstops* shall be maintained.

718.4 Draftstopping in attics. Draftstopping shall be installed to subdivide *attic* spaces where required by Section 708.4.2. In other than Group R, draftstopping shall be

Question 1

0.15 / 0.15 pts

A shaft enclosure shall have a minimum 2-hour fire-resistance rating where connecting a minimum of _____ stories.

- two
- three
- four
- five

Where the annular space at the penetration of horizontal assemblies is filled with an approved material, noncombustible piping may connect a maximum of _____ stories, provided the horizontal assemblies require no fire-resistance rating.

- 2
- 3
- 4
- 5

Question 3

0.15 / 0.15 pts

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

- floors within malls
- horizontal exit walls
- mezzanine floors
- roofs where openings are permitted

horizontal exit walls. You selected this answer.

713.1 General. The provisions of this section shall apply to shafts required to protect openings and penetrations through floor/ceiling and roof/ceiling assemblies. *Interior exit stairways and ramps* shall be enclosed in accordance with Section 1023.

713.2 Construction. *Shaft enclosures* shall be constructed as *fire barriers* in accordance with Section 707 or *horizontal assemblies* in accordance with Section 711, or both.

713.3 Materials. *Shaft enclosures* shall be of materials permitted by the building type of construction.

713.4 Fire-resistance rating. *Shaft enclosures* shall have a *fire-resistance rating* of not less than 2 hours where connecting **four stories** or more, and not less than 1 hour where connecting less than four stories. The number of stories connected by the *shaft enclosure* shall include any *basements* but not any *mezzanines*. *Shaft enclosures* shall have a *fire-resistance rating* not less than the floor assembly penetrated, but need not exceed 2 hours. *Shaft enclosures* shall meet the requirements of Section 703.2.1.1.

714.6 Nonfire-resistance-rated assemblies. Penetrations of nonfire-resistance-rated floor or floor/ceiling assemblies or the ceiling membrane of a nonfire-resistance-rated roof/ceiling assembly shall meet the requirements of Section 713 or shall comply with Section 714.6.1 or 714.6.2.

714.6.1 Noncombustible penetrating items. Noncombustible penetrating items that connect not more than **five stories** are permitted, provided that the *annular space* is filled to resist the free passage of flame and the products

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.

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.

Question 4

0.15 / 0.15 pts

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.

- 0.25
- 0.375
- 0.5
- 0.625

Question 5

0.15 / 0.15 p

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.

- 250°F
- 450°F
- 600°F
- 650°F

Question 6

0.15 / 0.15 pts

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

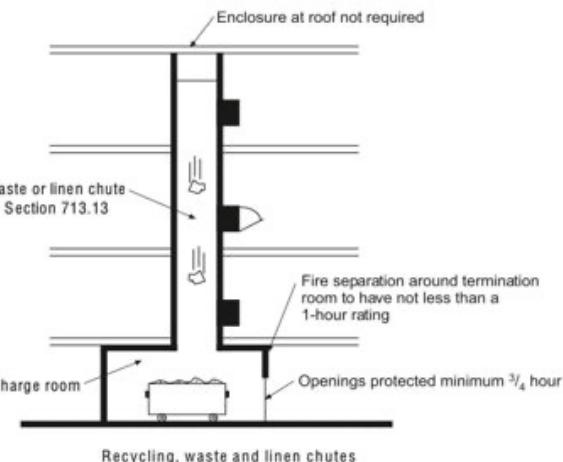
- 20 minutes
- 45 minutes
- 1 hour
- 11/2 hours

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

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.

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.



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.

Question 7

0.15 / 0.15 pts

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. (Hint: use Table 716.1(2))

- 1/3
- 1/2
- 3/4
- 1

5

Fire door assemblies required in a 2-hour exterior wall shall have a minimum fire protection rating of _____
(Hint Use Table 716.1(2))

- 20 minutes
- 45 minutes
- 1 hour
- 90 minutes

Question 9

0.15 / 0.15 pts

Penetrations in _____ shall be tested for air leakage in accordance with the requirements of UL 1479.

- smoke partitions
- smoke barriers
- fire barriers
- fire walls

714.5.4 Penetrations in smoke barriers. Penetrations in **smoke barriers** shall be protected by an approved *through-penetration firestop system* installed and tested in accordance with the requirements of UL 1479 for air leakage. The *L rating* of the system measured at 0.30 inch (7.47 Pa) of water in both the ambient temperature and elevated temperature tests shall not exceed either of the following:

1. 5.0 cfm per square foot ($0.025 \text{ m}^3/\text{s} \times \text{m}^2$) of penetration opening for each *through-penetration firestop system*.
2. A total cumulative leakage of 50 cfm ($0.024 \text{ m}^3/\text{s}$) for any 100 square feet (9.3 m^2) of wall area, or floor area.

Question 10

0.15 / 0.15 pts

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

- fire damper only
- smoke damper only
- both a fire damper and a smoke damper
- neither a fire damper nor a smoke damper

717.5 Where required. *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.*

717.5.1 Fire walls. Ducts and air transfer openings permitted in *fire walls* in accordance with Section 706.11 shall be protected with *listed fire dampers* installed in accordance with their listing.

717.5.1.1 Horizontal exits. A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *fire wall* that serves as a *horizontal exit*.

Class 8: Chapter 9, Fire Protection and Live Safety Systems

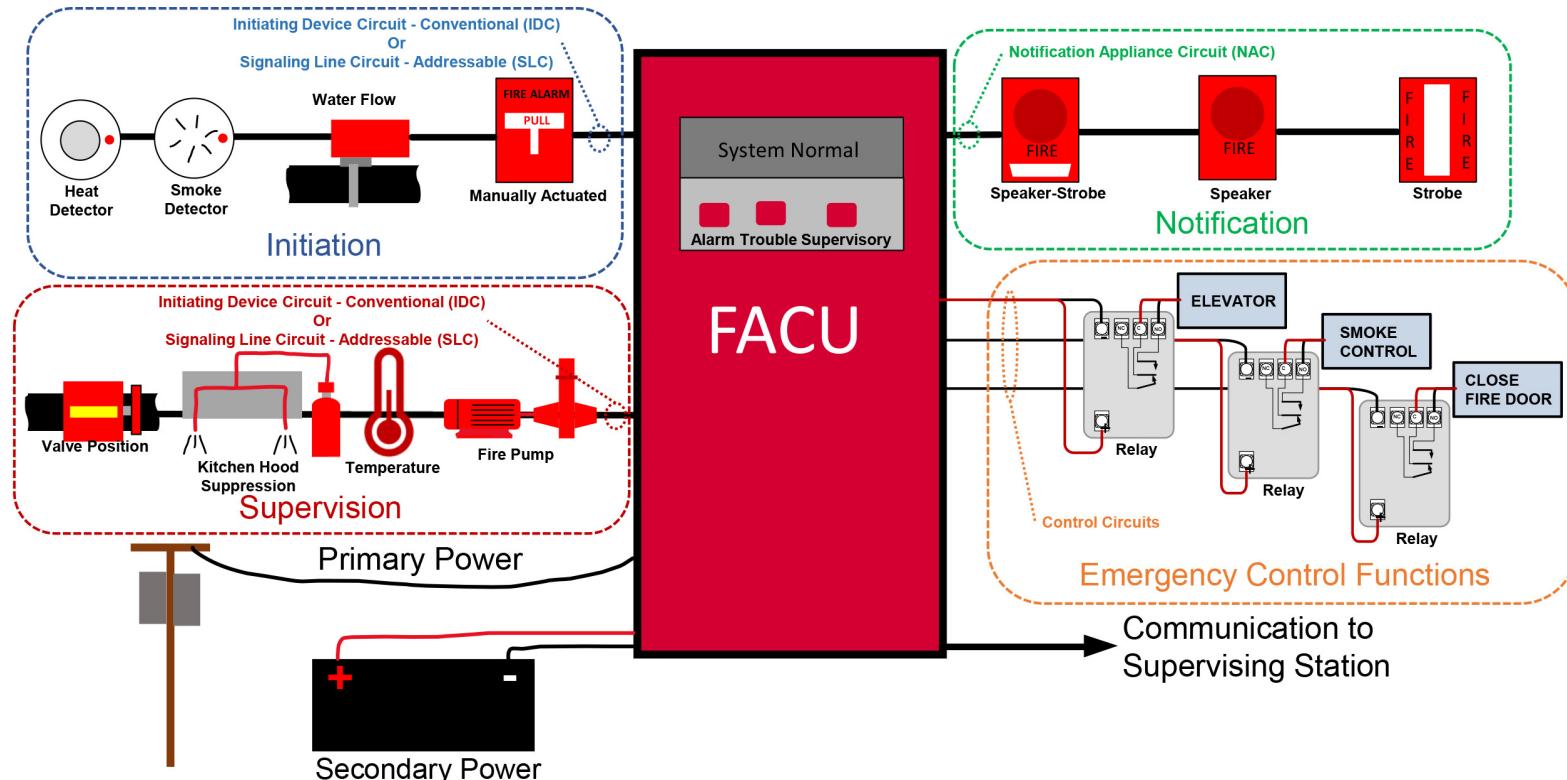
901, 202 Objective

- To obtain an understanding of the design and installation of fire protection systems, including automatic sprinkler systems, standpipe systems, fire alarm and detection systems, smoke control systems, and smoke and heat vents.

901, 202 Objective

- A *fire protection system* consists of approved devices, equipment and systems or combinations of systems used to detect a fire, activate an alarm, extinguish or control a fire, control or manage smoke and products of a fire or any combination thereof. *The provisions of Chapter 9 shall specify where fire protection systems are required and shall apply to the design, installation and operation of fire protection and life safety systems. Fire protection and life safety systems shall be installed, repaired, operated and maintained in accordance with the International Building Code and the International Fire Code.*
- The code provides requirements for three distinct systems considered vital to a safe building environment. The first system is intended to control and limit fire spread and to provide building occupants and fire personnel with the means of fighting a fire. The second system provides for detection of a fire condition and a means of notification. The third system is intended to control smoke migration.

901, 202 Objective



NFPA 72 outlines the requirements for four different types that are permitted in new installations, which includes both wired and wireless methods.

901, 202 Objective

General requirements for fire protection systems:

- Systems to be installed, repaired, operated and maintained in accordance with the *International Building Code* and *International Fire Code*.
- Systems not required by the IBC are permitted to be installed for partial or complete protection, provided such systems meet the requirements of the IBC.
- Any system for which an exception to, or reduction in, the provisions of the IBC has been granted shall be considered a required system.
- No person shall remove or modify any system installed or maintained under the provisions of either code without approval of the building official.
- All systems shall be tested in accordance with the requirements of the IBC and IFC, in the presence of the building official and at the expense of the owner or owner's representative.
- It is unlawful to occupy portions of a structure until the required fire protection systems within that portion have been tested and approved.

Unless specifically excepted, approved supervising stations in accordance with NFPA 72 are mandated for automatic sprinkler systems, fire alarm systems and Group H occupancy emergency alarm, detection and automatic fire-extinguishing systems.

Source: 2021 IBC

901.6, 202 Objective

1. Where a fire protection system is required to be monitored, the approved supervising station must comply with _____.
 - a. NFPA 4
 - b. NFPA 13
 - c. NFPA 70
 - d. NFPA 72

901.7, 202 Fire Areas

- A *fire area is the aggregate floor area enclosed and bounded by fire walls, fire barriers, exterior walls or horizontal assemblies of a building. Where buildings, or portions thereof, are divided into fire areas so as not to exceed the limits established for requiring a fire protection system in accordance with Chapter 9, such fire areas shall be separated by fire walls, fire barriers or horizontal assemblies, or a combination thereof, having a fire-resistance rating of, not less than that determined in accordance with Section 707.3.10.*
- The concept behind fire areas is that of compartmentalization. As a building is subdivided into smaller spaces through the use of fire-resistance-rated elements, the potential hazards tend to be confined to each compartment. Therefore, as the level of hazards decreases, the need for protection diminishes. In the IBC, this reduced level of protection is reflected in the fact that an automatic sprinkler system may not be required. The primary purpose for the creation of fire areas is to address the requirements of Section 903.2 for sprinkler protection.

901.7, 202 Fire Areas

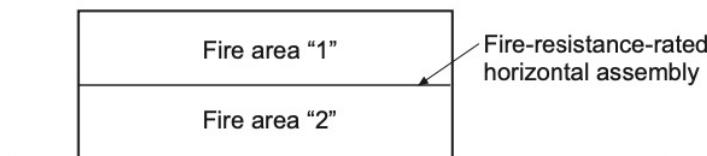
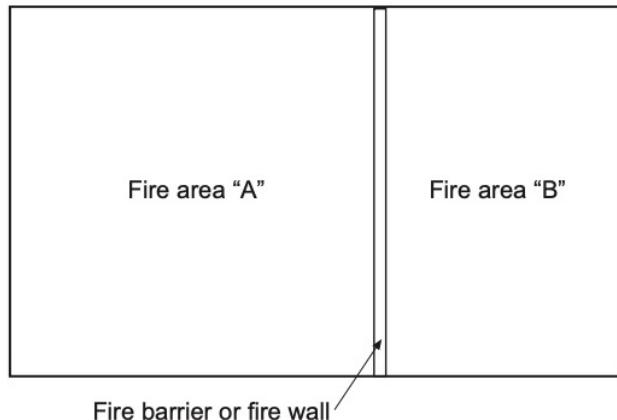


TABLE 707.3.10
FIRE-RESISTANCE RATING REQUIREMENTS FOR FIRE
BARRIER ASSEMBLIES OR HORIZONTAL ASSEMBLIES
BETWEEN FIRE AREAS

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

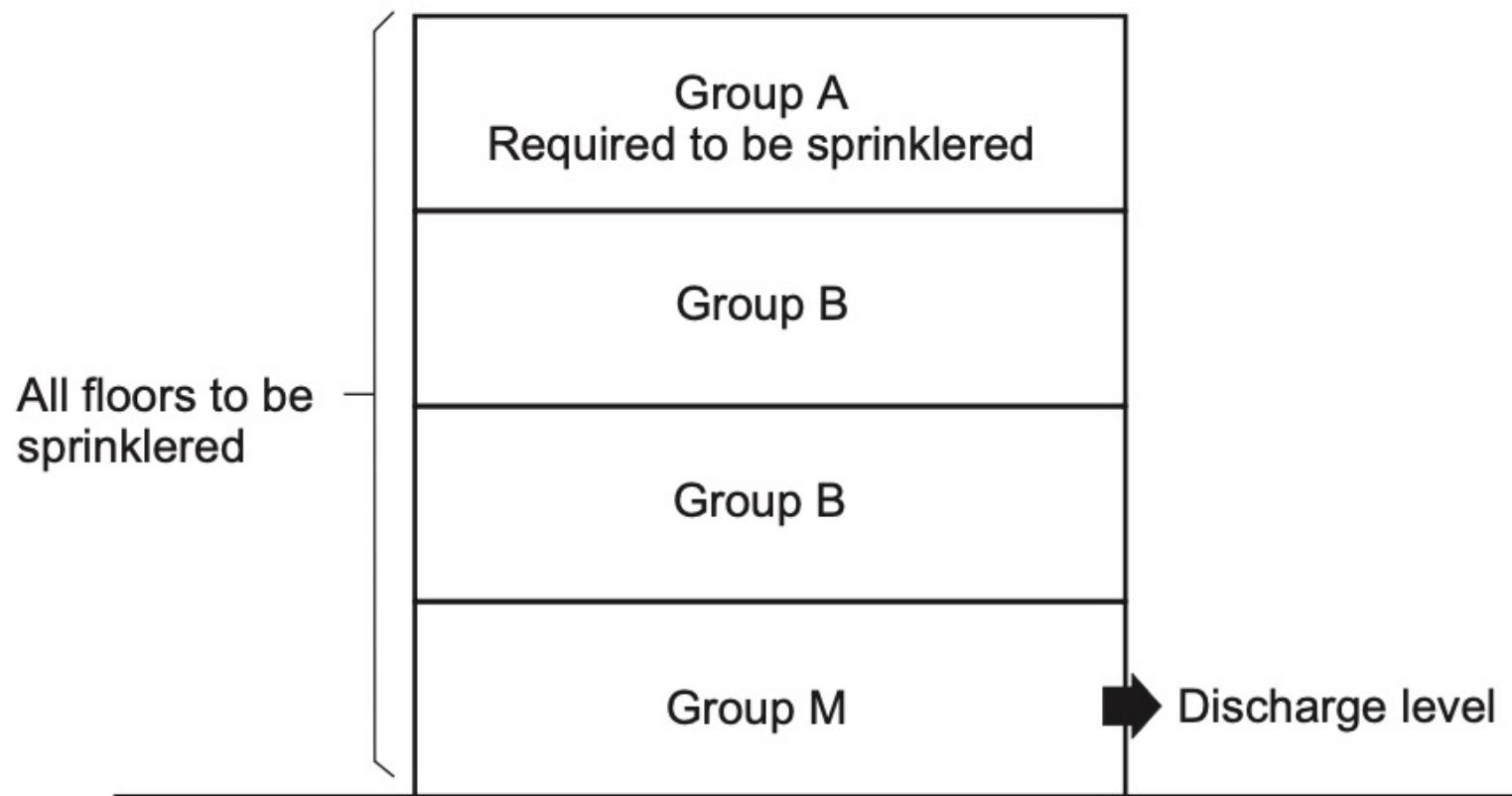
To determine the appropriate level of fire resistance for fire barriers used to create one or more fire areas, refer to Table 707.3.10. This table mandates the minimum hourly rating for fire barriers separating one or more occupancies into different fire areas.

Source: 2021 IBC

903.2.1, Group A Occupancies

- *An automatic sprinkler system shall be provided throughout buildings and portions thereof used as Group A occupancies as provided in Section 903.2.1. For Group A-1, A-2, A-3 and A-4 occupancies, the automatic sprinkler system shall be provided throughout stories containing the Group A-1, A-2, A-3 or A-4 occupancy and throughout all stories from the Group A occupancy to, and including, the levels of exit discharge serving the Group A occupancy.*
- Although most Group A occupancies lack the combustible loading that creates a high degree of fire severity, protection provided by an automatic sprinkler system is deemed necessary due to the hazards of having large numbers of people in concentrated areas. Based on varying thresholds, a sprinkler system may be required in any of the five assembly occupancies.

903.2.1, Group A Occupancies



In all Group A occupancies, other than Group A-5, that require sprinkler protection, the sprinkler system must be provided throughout the entire story on which the Group A is located. In multistory buildings, the sprinkler system must also be provided on all stories between, and including, the Group A occupancy and the level of exit discharge.

903.2.1.1–903.2.1.5, Group A Occupancies

- An automatic sprinkler system shall be provided throughout stories containing Group A-1 occupancies and throughout all stories from the Group A-1 occupancy to and including the levels of exit discharge serving that occupancy where one of the following conditions exists: (1) the fire area exceeds 12,000 square feet (1115 m^2), (2) the fire area has an occupant load of 300 or more, or (3) the fire area is located on a floor other than a level of exit discharge serving such occupancies. The same criteria apply to Group A-3 and A- 4 occupancies. An automatic sprinkler system shall be provided for fire areas containing Group A-2 occupancies where one of the following conditions exist: (1) the fire area exceeds 5,000 square feet (465 m^2), (2) the fire area has an occupant load of 100 or more, or (3) the fire area is located on a floor other than a level of exit discharge serving such occupancies. An automatic sprinkler system shall be provided for all enclosed Group A-5 accessory use areas in excess of 1,000 square feet (93 m^2).
- The thresholds at which Group A occupancies are required to be sprinklered vary based upon fire records and the hazards associated with the different types of assembly uses.

903.2.1.1–903.2.1.5, Group A Occupancies

Automatic sprinkler system required where:

A-1
A-3
A-4

> 12,000 sq ft, or
≥ 300 occupants, or
located above or below discharge level

A-2

> 5,000 sq ft, or
≥ 100 occupants, or
located above or below discharge level

For SI: 1 square foot = 0.093 m²

Sprinkler protection may also be required in a building where a Group A occupancy occurs on the roof, with a threshold of 100 or more occupants in a Group A-2 occupancy and 300 or more occupants in other Group A occupancies.

Source: 2021 IBC

903.2.1.1–903.2.1.5, Group A Occupancies

A stadium press box in a Group A-5 occupancy having a maximum floor area of _____ square feet need not be sprinklered.

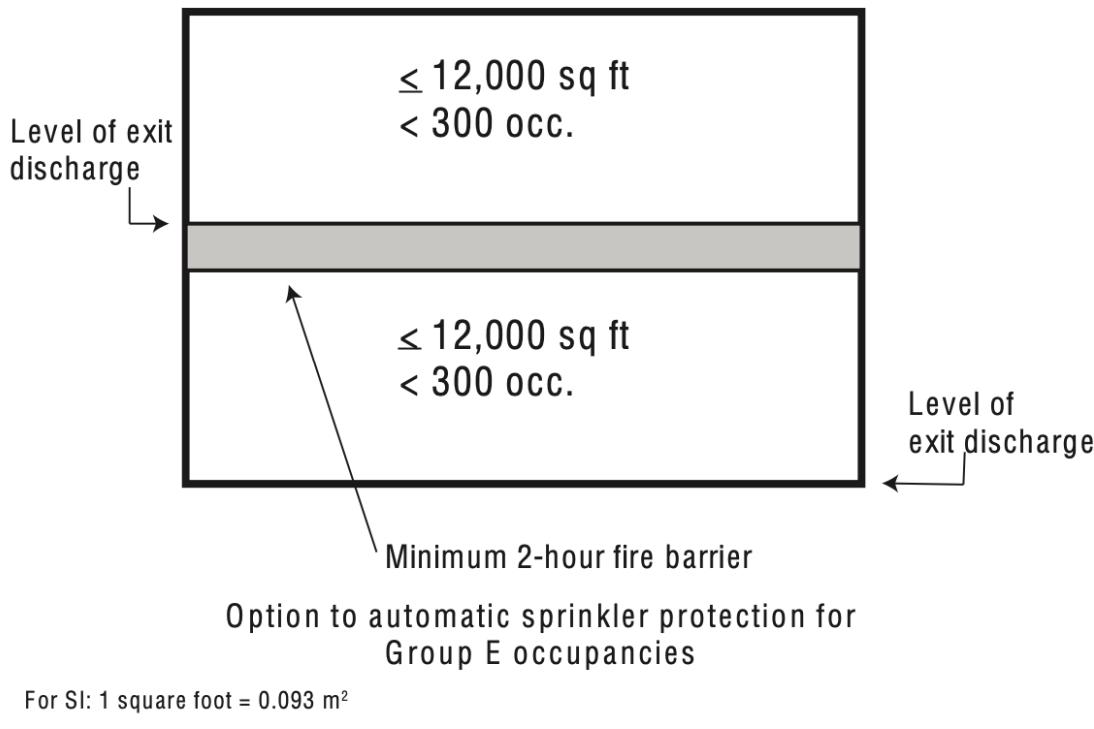
- a. 400
- b. 1,000
- c. 5,000
- d. 12,000

903.2.3, Group E Occupancies

- An automatic sprinkler system shall be provided for Group E occupancies as follows: (1) throughout all Group E fire areas greater than 12,000 square feet (1115 m^2) in area, (2) the Group E fire area is located on a floor other than a level of exit discharge serving such occupancies (see exception), or (3) the Group E fire area has an occupant load of 300 or more.
- As a group, educational occupancies tend to have a very good fire record. This stems from the ongoing supervision of activities in the building, as well as the rapid egress of students in response to emergencies. However, because of the amount of combustibles in Group E occupancies and the potentially high occupant load, it is typically necessary to provide sprinkler systems for those undivided floor areas in a manner somewhat consistent with Group A-1, A-2 and A-4 occupancies.

903.2.3, Group E Occupancies

Automatic fire sprinkler system required throughout all Group E fire areas exceeding 12,000 square feet or 299 occupants in fire area



Minimum 2-hour fire-resistance-rated fire barriers (Table 707.3.10) can be used to subdivide the building into small fire areas, thereby eliminating the sprinkler requirement. Direct egress at ground level from each classroom in the building is considered as an alternative to basement sprinkler protection.

Source: 2021 IBC

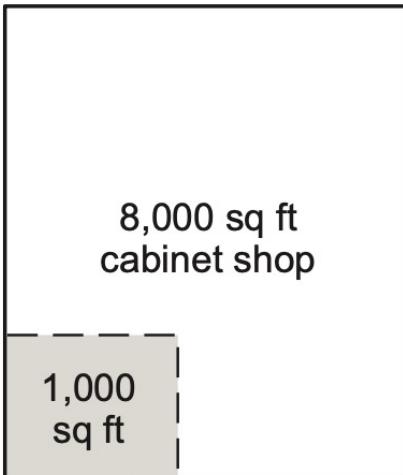
903.2.4, 903.2.7, 903.2.9, Group F-1, M and S-1 Occupancies

- An automatic sprinkler system shall be provided throughout all buildings containing a Group F-1 occupancy where one of the following conditions exists: (1) where a Group F-1 fire area exceeds 12,000 square feet (1115 m²); (2) where a Group F-1 fire area is located more than three stories above grade plane; or (3) where the combined area of all Group F-1 fire areas on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m²). Same criteria applies to Group M and S-1 occupancies. A sprinkler system is also required in such occupancies where the manufacture, storage or display and sale of upholstered furniture or mattresses occurs in a significant amount. In addition, a sprinkler system is required in Group F-1 and S-1 fire areas where distilled spirits are manufactured or stored.
- Because of the potential presence of high levels of combustible materials in factories, sales buildings and warehouses, the IBC limits the size and location of fire areas not protected by an automatic sprinkler system. If any fire area in the building exceeds the threshold, the sprinkler system must be provided throughout the entire building, not just in the fire area that exceeds the area or height limitations.

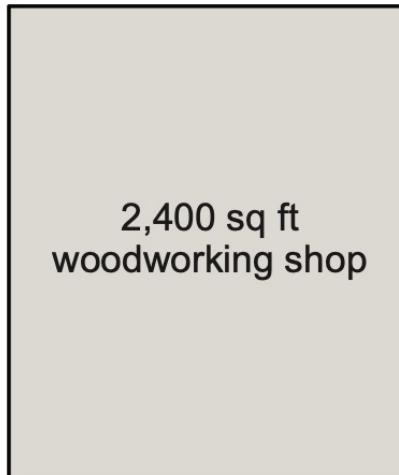
Source: 2021 IBC

903.2.4, 903.2.7, 903.2.9, Group F-1, M and S-1 Occupancies

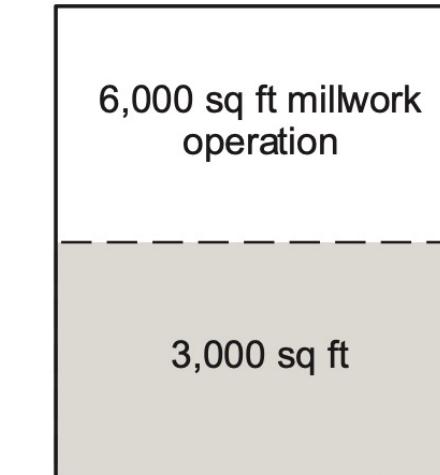
Sprinkler protection
not required



Sprinkler protection
not required



Sprinkler protection required
throughout building
(single fire area)



- Denotes area where finely divided combustible waste is generated or
finely divided combustible material is used

Woodworking operations

For SI: 1 square foot = 0.093 m².

In addition to the general provisions for sprinkler protection in manufacturing occupancies, IBC Section 903.2.4.1 mandates a more restrictive limitation for woodworking operations. Sprinkler protection for high-piled or rack storage is also addressed in the *International Fire Code*.

903.2.4, 903.2.7, 903.2.9, Group F-1, M and S-1 Occupancies

Where woodworking operations in a Group F-1 occupancy generate finely divided combustible waste, an automatic sprinkler system is required where such operations occupy a minimum size floor area of _____ square feet.

- a. 1,001
- b. 2,501
- c. 5,001
- d. 12,001

903.2.5.1, 903.2.6, Group H and I Occupancies

- An automatic sprinkler system shall be installed in Group H occupancies. An automatic sprinkler system shall be provided throughout buildings with a Group I fire area. See the exceptions for Group I-1 and day-care facilities.
- Hazardous occupancies require automatic sprinkler systems to protect not only the building's occupants and contents, but also the surrounding property. The sprinkler system only need be provided in the portion of the building classified as Group H. Buildings containing institutional uses must be protected throughout due to the lack of mobility of the occupants. The sprinkler system is intended to limit the size and the spread of a fire, thereby allowing extra time for moving occupants of the institutional building into an adjoining smoke compartment or through a horizontal exit.

903.2.5.1, 903.2.6, Group H and I Occupancies

[F] TABLE 903.2.5.2
GROUP H-5 SPRINKLER DESIGN CRITERIA

LOCATION	OCCUPANCY HAZARD CLASSIFICATION
Fabrication areas	Ordinary Hazard Group 2
Service corridors	Ordinary Hazard Group 2
Storage rooms without dispensing	Ordinary Hazard Group 2
Storage rooms with dispensing	Extra Hazard Group 2
Corridors	Ordinary Hazard Group 2

In a semiconductor fabrication facility classified as a Group H-5 occupancy, the sprinkler system must be installed throughout the entire building. For sprinkler design criteria, the code identifies the occupancy hazard classifications based on the various areas and locations.

903.2.8, Group R Occupancies

- An automatic sprinkler system installed in accordance with Section 903.3 shall be provided throughout all buildings with a Group R fire area.
- Statistics bear out that the majority of fire deaths and injuries occur in residential occupancies. It has also been statistically shown that buildings provided with sprinkler systems perform quite well under fire conditions. This mandate for the installation of automatic sprinkler systems in all buildings containing any Group R occupancy is based upon the desire to reduce such fire deaths and injuries in all residential buildings regulated by the International Building Code. This provision, like most requirements found in Chapter 9, is also found in the International Fire Code.

903.2.8, Group R Occupancies



The scope of the IBC, *Section 101.2*, defers certain residential occupancies to the construction regulations of the *International Residential Code*. As such, this sprinkler requirement applies only to those residential structures constructed under the requirements of the *International Building Code*.

903.2.8, Group R Occupancies

Buildings containing which of the following residential occupancies must be sprinklered under all conditions?

- a. Groups R-1 and R-2 only
- b. Groups R-1, R-2 and R-4 only
- c. Groups R-2 and R-4 only
- d. All Group R occupancies

903.2.10, Group S-1 Parking Garages

4. A Group S-1 *fire area* used for the storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m^2).

[F] **903.2.9.1 Repair garages.** An *automatic sprinkler system* shall be provided throughout all buildings used as *repair garages* in accordance with Section 406, as shown:

1. Buildings having two or more *stories above grade plane*, including basements, with a *fire area* containing a *repair garage* exceeding 10,000 square feet (929 m^2).
2. Buildings not more than one *story above grade plane*, with a *fire area* containing a *repair garage* exceeding 12,000 square feet (1115 m^2).
3. Buildings with *repair garages* servicing vehicles parked in basements.
4. A Group S-1 *fire area* used for the repair of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m^2).

[F] **903.2.9.2 Bulk storage of tires.** Buildings and structures where the area for the storage of tires exceeds 20,000 cubic feet (566 m^3) shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

[F] **903.2.9.3 Group S-1 Distilled spirits or wine.** An *automatic sprinkler system* shall be provided throughout a Group S-1 *fire area* used for the bulk storage of distilled spirits or wine.

[F] **903.2.9.4 Group S-1 upholstered furniture and mattresses.** An *automatic sprinkler system* shall be provided throughout a Group S-1 *fire area* where the area used for the storage of upholstered furniture or mattresses exceeds 2,500 square feet (232 m^2).

Exception: Self-service storage facilities not greater than one story above grade plane where all storage spaces can be accessed directly from the exterior.

[F] **903.2.9 Group S-1.** An *automatic sprinkler system* shall be provided throughout all buildings containing a Group S-1 occupancy where one of the following conditions exists:

1. A Group S-1 *fire area* exceeds 12,000 square feet (1115 m^2).
2. A Group S-1 *fire area* is located more than three stories above *grade plane*.
3. The combined area of all Group S-1 *fire areas* on all floors, including any *mezzanines*, exceeds 24,000 square feet (2230 m^2).

903.2.10, Group S-2 Parking Garages

- An automatic sprinkler system shall be provided throughout buildings classified as enclosed parking garages where any of the following conditions exist: (1) where the fire area of the enclosed parking garage exceeds 12,000 square feet (1115 m^2), (2) where the enclosed parking garage is located beneath other groups (see the exception for enclosed parking garages located beneath Group R-3 occupancies), or (3) where the fire area of the open parking garage exceeds 48,000 square feet (4460 m^2).
- Although parking garages are shown to have a very good fire record, the fire behavior in an enclosed parking garage is of greater concern than in an open parking garage. Because of the lack of exterior openings, smoke ventilation will be more difficult in the enclosed environment. Therefore, an automatic sprinkler system is required once the enclosed garage is sizeable in fire area. An additional concern occurs where the parking facility is in a mixed-occupancy building. If another occupancy group is located above the enclosed parking area, a sprinkler system is mandated regardless of the garage's fire area size. Sprinkler requirements also apply to open parking garages, but at a much higher threshold.

Source: 2021 IBC

903.2.10, Group S-2 Parking Garages

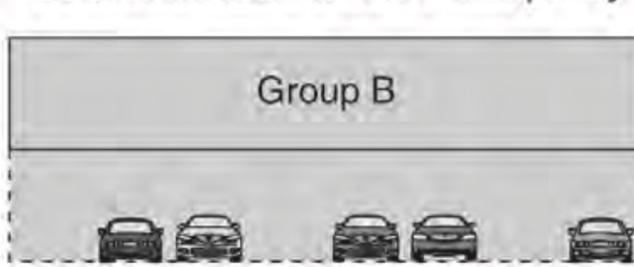
Sprinkler system required throughout building where:

Fire area exceeds
12,000 sq ft



2-story Group S-2
enclosed parking garage

OR



Group B office building with Group S-2
enclosed parking garage below

Sprinkler protection of Group S-2 enclosed parking garages

Where the vehicles being stored consist of commercial trucks or buses, a more stringent fire area threshold is appropriate. The limitation of 5,000 square feet without sprinkler protection is typically applied to garages housing larger vehicles rather than pick-up trucks and similar-sized vehicles used for business activities.

Source: 2021 IBC

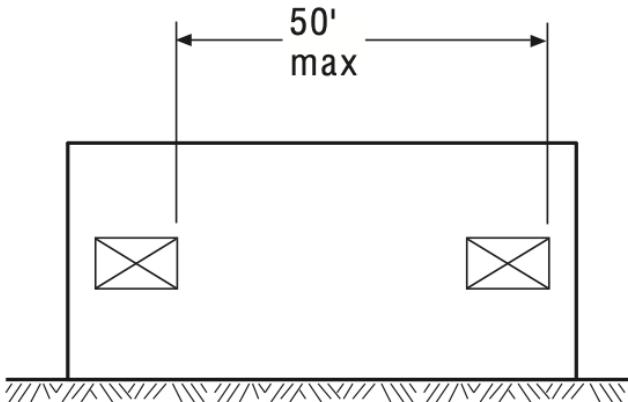
903.2.10, Group S-2 Parking Garages

- A Group S-2 parking garage used to store commercial buses need not be sprinklered where the fire area has a maximum size of _____ square feet.
- a. 2,500
 - b. 5,000
 - c. 10,000
 - d. 12,000

903.2.11.1, Fire Department Access

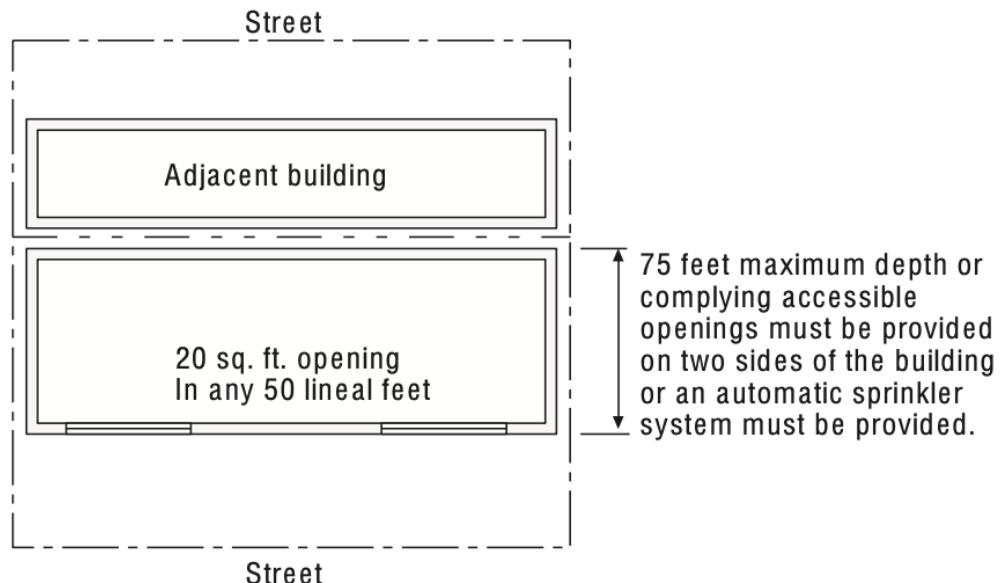
- *An automatic sprinkler system shall be installed throughout all stories, including basements of all buildings where the floor area exceeds 1,500 square feet (139.4 m²) and where the story does not comply with the criteria for exterior wall openings. The criteria addresses the minimum size and required locations of such openings.*
- The IBC considers those structures with inadequate exterior openings for fire department access and/or rescue to be “windowless buildings,” which require the installation of an automatic sprinkler system. Two methods of providing appropriate openings are set forth; one method is for openings below grade, and the other is for openings entirely above adjoining ground level. In all cases, at least one side of the building must be provided with complying openings in each 50 lineal feet of exterior wall. Basements are more highly regulated than floors above grade.

903.2.11.1, Fire Department Access



Required exterior opening:

1. Twenty square feet of opening in any 50 lineal feet or fraction thereof.
2. Minimum dimension of 30 inches.
3. Accessible to the fire department from the exterior.
4. Cannot be obstructed in a manner that prevents firefighting or rescue from the exterior.



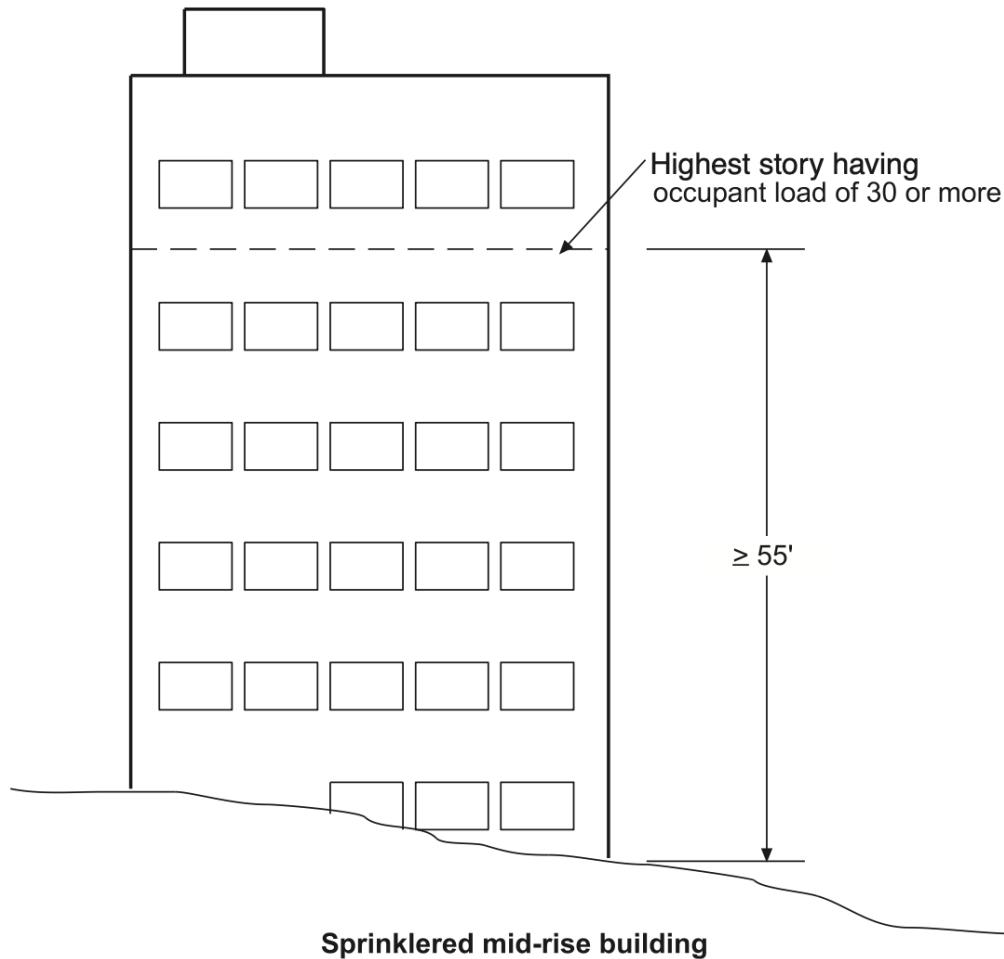
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

If complying openings are provided on two or more sides of the building, or if an exterior wall is less than 75 feet from an opposing exterior wall provided with complying openings, then an automatic sprinkler system is not required by this provision.

903.2.11.3, Buildings Over 55 ft in Height

- *An automatic sprinkler system shall be installed throughout buildings that have one or more stories with an occupant load of 30 or more located 55 feet (16 764 mm) or more above the lowest level of fire department vehicle access, measured to the finished floor. See the exception that exempts Group F-2 occupancies.*
- Because of difficulties associated with manual suppression of a fire in buildings constructed a substantial height above the fire department's point of attack, an automatic sprinkler system is required throughout the building, regardless of occupancy. Note that buildings that qualify for a sprinkler system by this provision, often termed "mid-rise" buildings, are not necessarily high-rise buildings as defined in Section 202.

903.2.11.3, Buildings Over 55 ft in Height



For SI: 1 foot = 304.8 mm.

Low-hazard manufacturing facilities are exempt from the sprinkler requirement due to their lack of combustible contents.

Source: 2021 IBC

905.3, Required Installations



Source: 2021 IBC

905.3, Required Installations

- Standpipe systems shall be installed where required by Sections 905.3.1 through 905.3.8. See the exception for Group R-3 occupancies. Standpipe systems are allowed to be combined with automatic sprinkler systems.
- Installed exclusively for the fighting of fires, a standpipe system is a wet or dry system composed of piping, valves, outlets and related equipment designed to provide water at specified pressures. Standpipe systems are permitted to be combined with automatic sprinkler systems. Divided into Classes I, II and III, standpipe systems are generally required in structures of substantial height. Connections for Class I standpipes, which are solely for use by the fire department, shall be located in protected areas to allow for staging operations. Enclosures for interior exit stairways are typical locations for Class I connections.

905.3, Required Installations

REQUIRED STANDPIPE INSTALLATIONS

LOCATION OR USE	NONSPRINKLERED BUILDING	SPRINKLERED BUILDING
Buildings of 4 or more stories above grade plane or with floor level of the highest story located at more than 30 feet above lowest level of fire department vehicle access	Class III ^{1,2,5,6}	Class I
Buildings of 4 or more stories below grade plane or with floor level of the lowest story located at more than 30 feet below highest level of fire department vehicle access	Class III ^{1,2,5,6}	Class I
Group A occupancies with occupant load exceeding 1,000	Class I ⁴	No requirement
Covered mall buildings	—	Class I
Stages more than 1,000 square feet	Class III	Class III ⁵
Underground buildings	—	Class I

1 Class I standpipes permitted in basements equipped with automatic sprinkler system
2 Class I standpipes permitted in parking garages
3 Not required in open-air seating spaces without enclosed spaces
4 Hose connections permitted to be supplied by sprinkler system
5 Class I standpipes permitted in Groups B and E
6 Class I standpipes permitted in buildings where occupant-use hose lines will not be utilized by trained personnel or the fire department

Fire hose cabinets in which hoses are attached to outlets on Class II standpipes (as well as the use of portable fire extinguishers) are provided as a means by which the building occupants can control the fire prior to either sprinkler activation or fire personnel arrival.

Source: 2021 IBC

905.3, Required Installations

SECTION 905 STANDPIPE SYSTEMS

[F] 905.1 General. Standpipe systems shall be provided in new buildings and structures in accordance with Sections 905.2 through 905.11. In buildings used for high-piled combustible storage, fire protection shall be in accordance with the *International Fire Code*.

[F] 905.2 Installation standard. Standpipe systems shall be installed in accordance with this section and NFPA 14. Fire department connections for standpipe systems shall be in accordance with Section 912.

[F] 905.5 Location of Class II standpipe hose connections. Class II standpipe hose connections located so that all portions of the building are within 30 feet (9144 mm) of a nozzle attached to 100 feet (30 480 mm) of hose. Class II standpipe hose connections shall be located where they will have *ready access*.

[F] 905.5.1 Groups A-1 and A-2. In Group A-1 and A-2 occupancies having *occupant loads* exceeding 1,000 persons, hose connections shall be located on each side of any stage, on each side of the rear of the auditorium, on each side of the balcony and on each tier of dressing rooms.

[F] 905.5.2 Protection. Fire-resistance-rated protection of risers and laterals of Class II standpipe systems is not required.

[F] 905.5.3 Class II system 1-inch hose. A minimum 1-inch (25 mm) hose shall be allowed to be used for hose stations in light-hazard occupancies where investigated and *listed* for this service and where *approved* by the fire code official.

905.3, Required Installations

- . Connections for Class II standpipe systems shall be located so that all portions of the building are within _____ feet of a nozzle attached to _____ feet of hose.
- a. 20, 50
 - b. 30, 100
 - c. 40, 125
 - d. 40, 150

906.1, Where Required

- Portable fire extinguishers shall be installed in all of the following locations: (1) in Group A, B, E, F, H, I, M, R-1, R-2, R-4 and S occupancies (see exceptions for Group E, R-2 and S occupancies); (2) within 30 feet (9144 mm) of commercial cooking equipment and from domestic cooking equipment in Group I-1, I-2 Condition 1, and R-2 college dormitory occupancies; (3) in areas where flammable or combustible liquids are stored, used or dispensed; (4) on each floor of structures under construction, except Group R-3 occupancies, in accordance with Section 3315.1 of the IFC; (5) where required by the IFC sections indicated in Table 906.1; and (6) special-hazard areas, including but not limited to laboratories, computer rooms and generator rooms, where required by the fire code official.
- Portable fire extinguishers are typically required in all but Group R-3 and U occupancies to give occupants the means to suppress a fire in its incipient stage. The capability for manual fire suppression can contribute to the protection of the occupants by controlling the fire in its early stages.

906.1, Where Required

3. In storage areas of Group S Occupancies where forklift, powered industrial truck or powered cart operators are the primary occupants, fixed extinguishers, as specified in NFPA 10, shall not be required where in accordance with all of the following:

- 3.1. Use of vehicle-mounted extinguishers shall be approved by the fire code official.
 - 3.2. Each vehicle shall be equipped with a 10-pound, 40A:80B:C extinguisher affixed to the vehicle using a mounting bracket approved by the extinguisher manufacturer or the fire code official for vehicular use.
 - 3.3. Not less than two spare extinguishers of equal or greater rating shall be available on site to replace a discharged extinguisher.
 - 3.4. Vehicle operators shall be trained in the proper operation, use and inspection of extinguishers.
 - 3.5. Inspections of vehicle-mounted extinguishers shall be performed daily.
2. Within 30 feet (9144 mm) distance of travel from commercial cooking equipment and from domestic cooking equipment in Group I-1; I-2, Condition 1; and R-2 college *dormitory* occupancies.
 3. In areas where flammable or *combustible liquids* are stored, used or dispensed.
 4. On each floor of structures under construction, except Group R-3 occupancies, in accordance with Section 3315.1 of the *International Fire Code*.
 5. Where required by the *International Fire Code* sections indicated in Table 906.1.
 6. Special-hazard areas, including but not limited to laboratories, computer rooms and generator rooms, where required by the fire code official.

Exception: Portable fire extinguishers are not required at normally unmanned Group U occupancy buildings or structures where a portable fire extinguisher suitable to the hazard of the location is provided on the vehicle of visiting personnel.

Source: 2021 IBC

906.1, Where Required



In addition to portable fire extinguishers, many of the other fire protection components and systems found in the IBC are also replicated directly from the *International Fire Code* (IFC). IFC provisions addressing automatic sprinkler systems, standpipe systems, fire alarm systems, smoke and heat vents, fire pumps and emergency responder safety features are also inserted into the IBC to provide for greater convenience to the code user.

907.2, Where Required

- An approved fire alarm system installed in accordance with the provisions of the IBC and NFPA 72 shall be provided in new buildings and structures in accordance with Sections 907.2.1 through 907.2.23 and provide occupant notification in accordance with Section 907.5, unless other requirements are provided by another section of the IBC. Not fewer than one manual fire alarm box shall be provided at an approved location to initiate a fire alarm signal for fire alarm systems employing automatic fire detectors or waterflow detection devices. See exceptions for elevator recall control and Group R-2.
- For many of the occupancies identified by the IBC, it is necessary to provide some level of notification to the building occupants and/or a supervised location reserved for a fire emergency. The threshold at which an alarm and/or detection system is required varies according to the occupancy classification.

907.2, Where Required



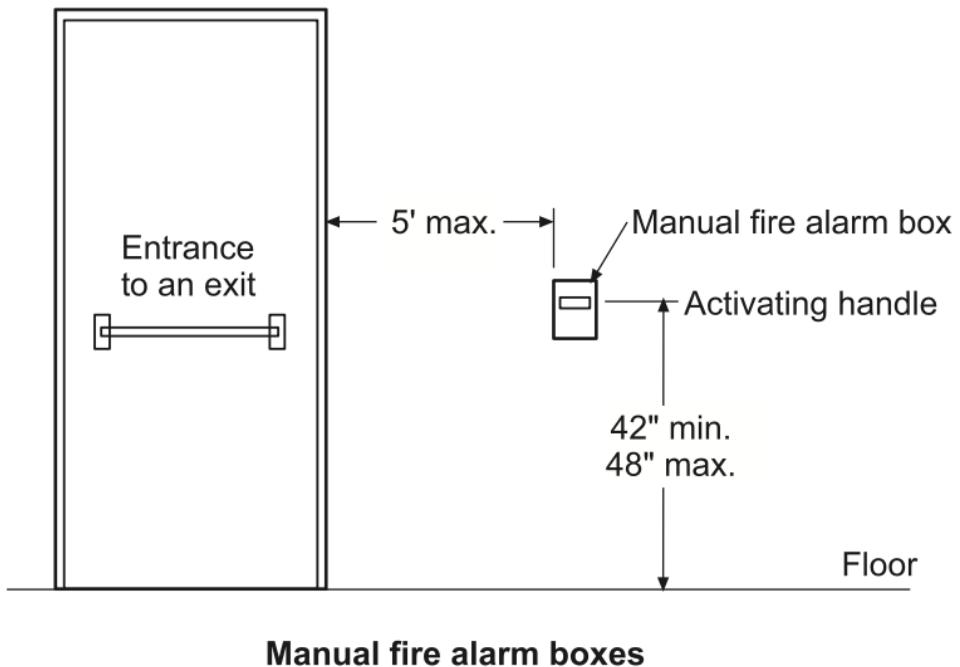
Audible alarm notification appliances are to be provided and shall create a distinctive sound that is used for no other purpose. Visual alarm notification appliances are also required, to varying degrees, in public and common areas, employee work areas, and Group I-1, R-1 and R-2 occupancies.

Source: 2021 IBC

907.4.2, Where Required

- Manual fire alarm boxes shall be located not more than 5 feet (1524 mm) from the entrance to each exit. In buildings not protected by an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2, additional manual fire alarm boxes shall be located so that the distance of travel to the nearest box does not exceed 200 feet (60 960 mm). The height of the manual fire alarm boxes shall be not less than 42 inches (1067 mm) and not more than 48 inches (1219 mm), measured vertically, from the floor level to the activating handle or lever of the box. Manual fire alarm boxes shall be red in color.
- The required location of fire alarm boxes adjacent to exit doors provides an opportunity for the alarm to be transmitted in a timely manner. In multistory buildings, such locations also encourage the actuation of a manual fire alarm box on the fire floor prior to entering the stair enclosure, resulting in the alarm being received from the actual fire floor and not another floor along the path of egress.

907.4.2, Where Required



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

Where a manual fire alarm system is required, manual fire alarm boxes (pull stations) must be installed. However, in some occupancies the code permits the elimination of such boxes if water flow in an automatic sprinkler system installed throughout the building activates the notification appliances.

907.4.2, Where Required

Manual fire alarm boxes, where required, shall be located a maximum of _____ feet from the entrance to each exit.

-
- a. 5
 - b. 10
 - c. 12
 - d. 20

TABLE 907.5.2.3.2

[F] 907.5.2.3 Visible alarms. Visible alarm notification appliances shall be provided in accordance with Sections 907.5.2.3.1 through 907.5.2.3.3.

Exceptions:

1. Visible alarm notification appliances are not required in *alterations*, except where an existing fire alarm system is upgraded or replaced, or a new fire alarm system is installed.
2. Visible alarm notification appliances shall not be required in *exits* as defined in Chapter 2.
3. Visible alarm notification appliances shall not be required in elevator cars.
4. Visual alarm notification appliances are not required in critical care areas of Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.
5. A visible *alarm notification appliance* installed in a nurses' control station or other continuously attended staff location in a Group I-2, Condition 2 suite shall be an acceptable alternative to the installation of visible alarm notification appliances throughout the suite or unit in Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.

[F] 907.5.2.3.1 Public use areas and common use areas. Visible alarm notification appliances shall be provided in *public use areas* and *common use areas*.

Exception: Where *employee work areas* have audible alarm coverage, the notification appliance circuits serving the *employee work areas* shall be initially designed with not less than 20-percent spare capacity to account for the potential of adding visible notification appliances in the future to accommodate hearing-impaired employee(s).

[F] 907.5.2.3.2 Groups I-1 and R-1. Habitable spaces in *dwelling units* and *sleeping units* in Group I-1 and R-1 occupancies in accordance with Table 907.5.2.3.2 shall be provided with visible alarm notification. Visible alarms shall be activated by the in-room smoke alarm and the building fire alarm system.

[F] 907.5.2.3.3 Group R-2. In Group R-2 occupancies required by Section 907 to have a fire alarm system, each story that contains *dwelling units* and *sleeping units* shall be provided with the capability to support future visible alarm notification appliances in accordance with Chapter 11 of ICC A117.1. Such capability shall accommodate wired or wireless equipment.

[F] 907.5.2.3.3.1 Wired equipment. Where wired equipment is used to comply with the

future capability required by Section 907.5.2.3.3, the system shall include one of the following capabilities:

1. The replacement of audible appliances with combination audible/visible appliances or additional visible notification appliances.
2. The future extension of the existing wiring from the unit smoke alarm locations to required locations for visible appliances.
3. For wired equipment, the fire alarm power supply and circuits shall have not less than 5-percent excess capacity to accommodate the future addition of visible alarm notification appliances, and a single access point to such circuits shall be available on every story. Such circuits shall not be required to be extended beyond a single access point on a story. The fire alarm system shop drawings required by Section 907.1.2 shall include the power supply and circuit documentation to accommodate the future addition of visible notification appliances.

[F] 907.6 Installation and monitoring. A fire alarm system shall be installed and monitored in accordance with Sections 907.6.1 through 907.6.6.3 and NFPA 72.

[F] 907.6.1 Wiring. Wiring shall comply with the requirements of NFPA 70 and NFPA 72. Wireless protection systems utilizing radio-frequency transmitting devices shall comply with the special requirements for supervision of low-power wireless systems in NFPA 72.

[F] 907.6.2 Power supply. The primary and secondary power supply for the fire alarm system shall be provided in accordance with NFPA 72.

Exception: Back-up power for single-station and multiple-station smoke alarms as required in Section 907.2.11.6.

**[F] TABLE 907.5.2.3.2
VISIBLE ALARMS**

NUMBER OF SLEEPING UNITS	SLEEPING ACCOMMODATIONS WITH VISIBLE ALARMS
6 to 25	2
26 to 50	4
51 to 75	7
76 to 100	9
101 to 150	12
151 to 200	14
201 to 300	17
301 to 400	20
401 to 500	22
501 to 1,000	5% of total
1,001 and over	50 plus 3 for each 100 over 1,000

Source: 2021 IBC

TABLE 907.5.2.3.2

[F] TABLE 907.5.2.3.2
VISIBLE ALARMS

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1,001 and over	50 plus 3 for each 100 over 1,000

TABLE 907.5.2.3.2

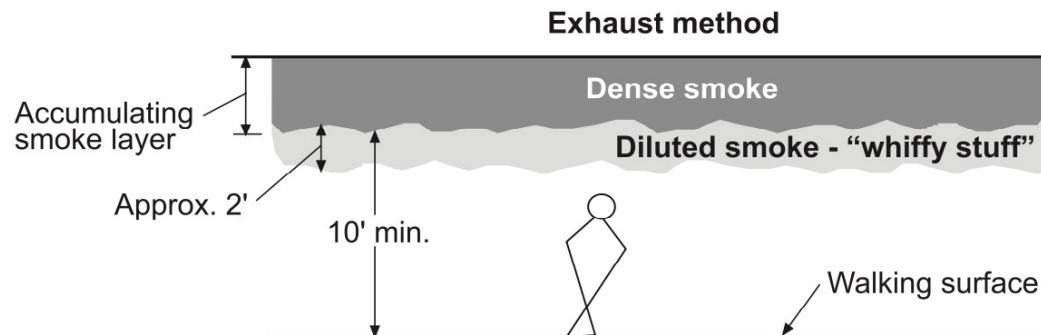
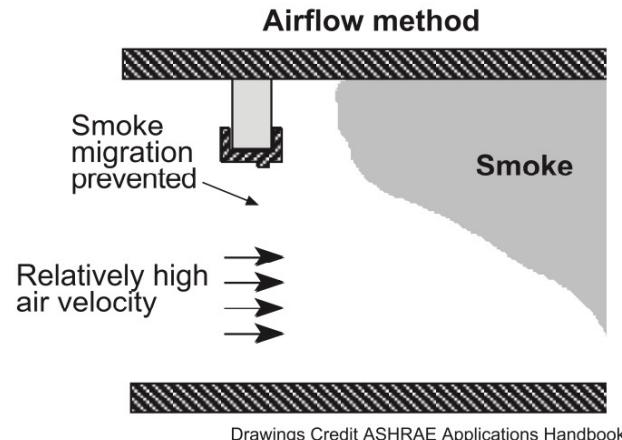
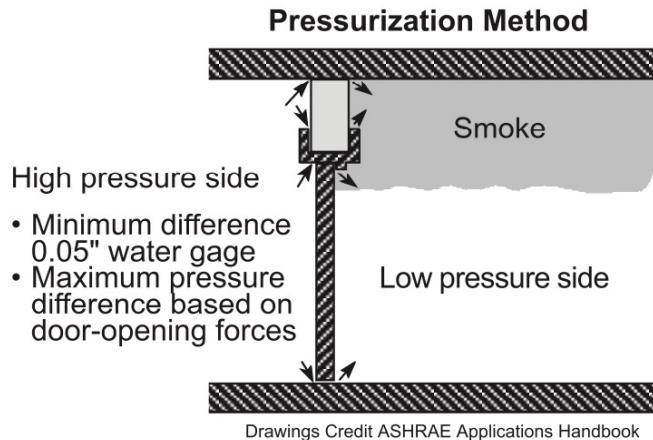
In a Group R-1 hotel providing 220 sleeping units, a minimum of _____ such units shall be provided with visible alarm notification devices.

- a. 3
- b. 11
- c. 17
- d. 22

909.1, Scope

- Section 909 applies to mechanical or passive smoke control systems when they are required by some other provision of the IBC. The purpose of Section 909 is to provide a tenable environment for the evacuation or relocation of occupants. Smoke control systems regulated by Section 909 serve a different purpose than the smoke-and heat-venting provisions found in Section 910.
- The provisions Section 909 do not apply unless specifically mandated for a special use, such as an atrium. It is the intent that none of the requirements apply unless directed by other provisions of the code. Where a smoke control system is provided, it may be either passive or mechanical, or a combination of the two systems. A mechanical system is an engineered system that uses mechanical fans either to produce pressure differences across smoke barriers or to establish airflows to limit and direct smoke movement. A passive system is a system of smoke barriers arranged to limit the migration of smoke.

909.1, Scope



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

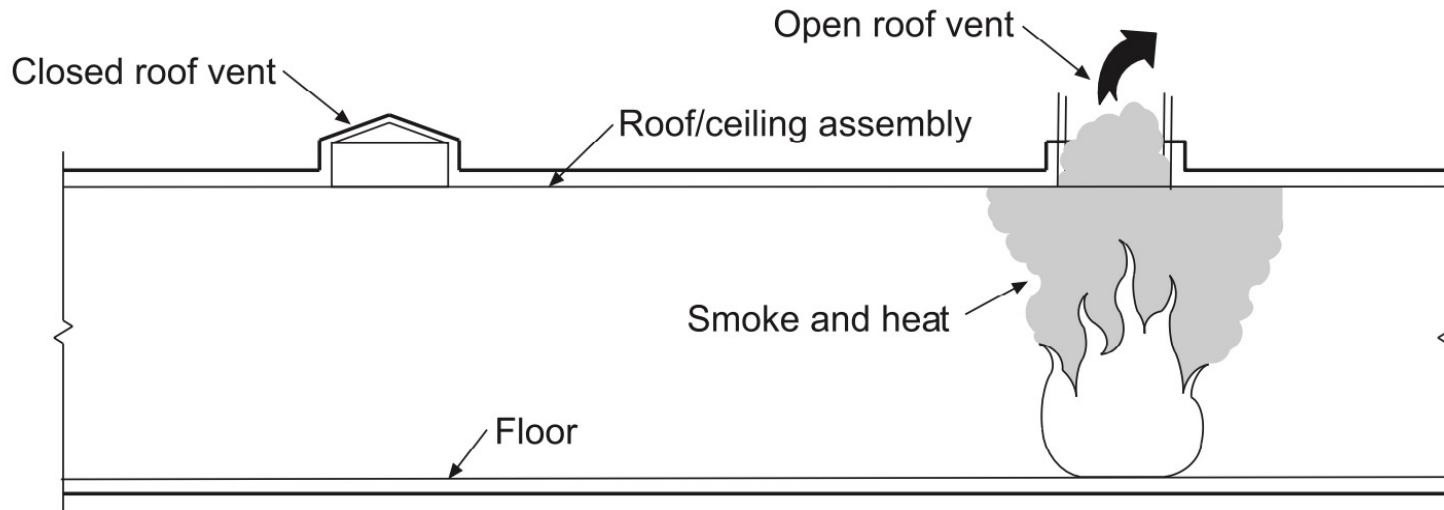
Three methods of mechanical smoke control are addressed: pressurization, airflow and exhaust. Pressure differences across smoke barriers shall be the primary means of smoke control. The building official may accept the airflow or exhaust methods in specific situations.

Source: 2021 IBC

910.2, 910.3.5 Where Required

- Smoke and heat vents or a mechanical smoke removal system shall be installed as required by Sections 910.2.1 and 910.2.2. See the exceptions for (1) frozen food ware-houses, and (2) buildings equipped with ESFR sprinklers. The vents or smoke removal system shall be installed in buildings and portions thereof: (1) used as Group F-1 or S-1 occupancies having more than 50,000 square feet (4645 m²) in undivided area (see the exception for aircraft repair hangars), (2) containing high-piled combustible storage, and (3) buildings equipped with control mode special application sprinklers.
- Smoke and heat vents shall be uniformly located within the roof in the areas of the building where the vents are required to be installed. Those areas of buildings that are equipped with early suppression fast response (ESFR) sprinklers are not required to be provided with automatic smoke and heat vents.

910.2, 910.3.5 Where Required



Note: In general, several small vents are more effective than a larger vent of equal area.

Roof vents

A mechanical smoke exhaust system is also permitted to ventilate the building as an alternative to smoke and heat vents. In addition to other conditions of acceptance, the exhaust fans in such a system are regulated for size, location, operation, wiring, control, supply air and interlocks.

910.2, 910.3.5 Where Required

Other than for an aircraft repair hangar, a one-story Group S-1 occupancy shall be provided with smoke and heat vents or a mechanical smoke removal system where it exceeds _____ square feet in undivided area.

- a. 8,000
- b. 10,000
- c. 15,000
- d. 50,000

915 Carbon Monoxide Detection

SECTION 915 CARBON MONOXIDE DETECTION

[F] 915.1 General. Carbon monoxide detection shall be installed in new buildings in accordance with Sections 915.1.1 through 915.6. Carbon monoxide detection shall be installed in existing buildings in accordance with Chapter 11 of the *International Fire Code*.

[F] 915.1.1 Where required. Carbon monoxide detection shall be provided in Group I-1, I-2, I-4 and R occupancies and in classrooms in Group E occupancies in the locations specified in Section 915.2 where any of the conditions in Sections 915.1.2 through 915.1.6 exist.

[F] 915.1.2 Fuel-burning appliances and fuel-burning fireplaces. Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms that contain a fuel-burning appliance or a fuel-burning fireplace.

[F] 915.1.3 Fuel burning, forced-air furnaces. Carbon monoxide detection shall be provided in dwelling units, sleeping units and classrooms served by a fuel-burning, forced-air furnace.

Exception: Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms if a carbon monoxide detector is provided in the first room or area served by each main duct leaving the furnace, and the carbon monoxide alarm signals are automatically transmitted to an approved location.

sleeping units and classrooms located in buildings that contain fuel-burning appliances or fuel-burning fireplaces.

Exceptions:

1. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms without communicating openings between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit*, *sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms where a carbon monoxide detector is provided in one of the following locations:
 - 2.1. In an *approved* location between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit*, *sleeping unit* or classroom.
 - 2.2. On the ceiling of the room containing the fuel-burning appliance or fuel-burning fireplace.

[F] 915.1.5 Private garages. Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms in buildings with attached *private garages*.

Exceptions:

1. Carbon monoxide detection shall not be required in dwelling units, sleeping units and classrooms without communicating openings between the *private garage* and the *dwelling unit*, *sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms located more than one story above or below a *private garage*.
3. Carbon monoxide detection shall not be required where the *private garage* connects to the building through an *open-ended corridor*.
4. Where a carbon monoxide detector is provided in an *approved* location between openings to a *private garage* and *dwelling units*, *sleeping units* or classrooms.

[F] 915.1.6 Exempt garages. For determining compliance with Section 915.1.5, an *open parking garage* complying with Section 406.5 or an enclosed parking garage complying with Section 406.6 shall not be considered a *private garage*.

[F] 915.2 Locations. Where required by Section 915.1.1, carbon monoxide detection shall be installed in the locations specified in Sections 915.2.1 through 915.2.3.

[F] 915.2.1 Dwelling units. Carbon monoxide detection shall be installed in *dwelling units* outside of each separate sleeping area in the immediate vicinity of the bedrooms. Where a fuel-burning appliance is located within a bedroom or its attached bathroom, carbon monoxide detection shall be installed within the bedroom.

[F] 915.2.2 Sleeping units. Carbon monoxide detection shall be installed in *sleeping units*.

Exception: Carbon monoxide detection shall be allowed to be installed outside of each separate sleeping area in the immediate vicinity of the *sleeping unit* where the *sleeping unit* or its attached bathroom does not contain a fuel-burning appliance and is not served by a forced air furnace.

[F] 915.2.3 Group E occupancies. Carbon monoxide detectors shall be installed in classrooms in Group E occupancies. Carbon monoxide alarm signals shall be automatically transmitted to an on-site location that is staffed by school personnel.

Exception: Carbon monoxide alarm signals shall not be required to be automatically transmitted to an on-site location that is staffed by school personnel in Group E occupancies with an *occupant load* of 30 or less.

[F] 915.3 Carbon monoxide detection. Carbon monoxide detection required by Sections 915.1 through 915.2.3 shall be provided by carbon monoxide alarms complying with Section 915.4 or carbon monoxide detection systems complying with Section 915.5.

[F] 915.4 Carbon monoxide alarms. Carbon monoxide alarms shall comply with Sections 915.4.1 through 915.4.4.

[F] 915.4.1 Power source. Carbon monoxide alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source, and when primary power is interrupted, shall receive power from a battery. Wiring shall be permanent and without a disconnecting switch other than that required for overcurrent protection.

Exception: Where installed in buildings without commercial power, battery-powered carbon monoxide alarms shall be an acceptable alternative.

[F] 915.4.2 Listings. Carbon monoxide alarms shall be listed in accordance with UL 2034.

[F] 915.4.3 Locations. Carbon monoxide alarms shall only be installed in *dwelling units* and in *sleeping units*. They shall not be installed in locations where the code requires carbon monoxide detectors to be used.

[F] 915.4.4 Combination alarms. Combination carbon monoxide/smoke alarms shall be an acceptable alternative to carbon monoxide alarms. Combination carbon monoxide/smoke alarms shall be listed in accordance with UL 217 and UL 2034.

[F] 915.5 Carbon monoxide detection systems. Carbon monoxide detection systems shall be an acceptable alternative to carbon monoxide alarms and shall comply with Sections 915.5.1 through 915.5.3.

[F] 915.5.1 General. Carbon monoxide detection systems shall comply with NFPA 720. Carbon monoxide detectors shall be listed in accordance with UL 2075.

[F] 915.5.2 Locations. Carbon monoxide detectors shall be installed in the locations specified in Section 915.2.

915 Carbon Monoxide Detection

Carbon monoxide detection, when required, shall be provided in all but which one of the following locations?

- a. Group E classrooms
- b. Group I-1 group home sleeping units
- c. Group I-3 housing units
- d. Group R-1 sleeping units