2

Fire and Smoke Resistant Construction Overview

- Key Concepts
- Exterior Walls and Projections
- Fire Walls, Fire Barriers, Fire Partitions
- Structural Members and Bearing Walls
- Vertical Openings and Shaft Enclosures

3

Fire and Smoke Resistant Construction Overview

- Basement, Floor and Roof Construction
- Opening and Penetration Protection
- Interior Finishes

4

Key Concepts

Relation to other requirements

"Passive" fire protection

Assemblies

Tests

5

Fire Hazard Protection

The code incorporates requirements that reflect interrelated strategies for protecting people and property from fire and related hazards.

- Means of egress
- Passive fire resistance
- Active fire detection and protection

6

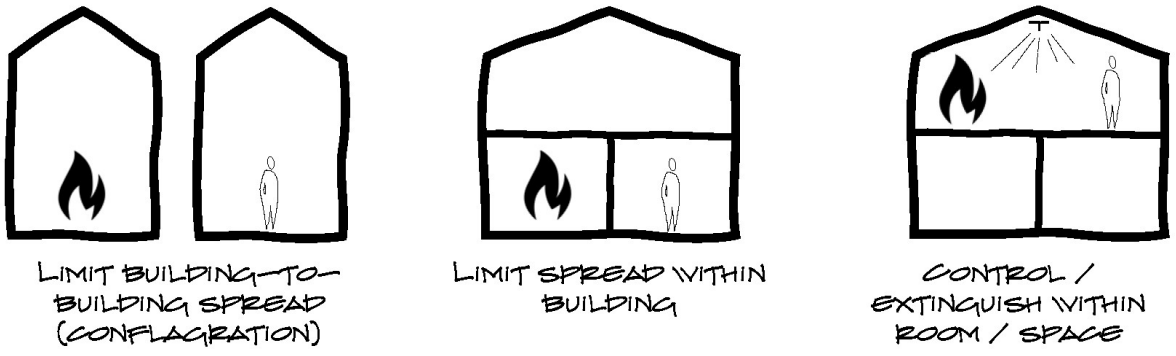

Figure 103

7

Ratings

Fire-resistance ratings apply to elements, components, or assemblies.

Fire protection ratings apply to opening protectives (doors, windows, etc.)

Both are determined by testing a mock-up under standardized procedures.

8

Multiple Use Assemblies

Building elements that are required to be fire-resistance-rated construction by more than one code provision may be required to comply with more than one section of Chapter 7.

9

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Exterior Walls and Exterior Projections

What are they?

Fire separation distance

Requirements

11

Exterior walls may be required to be fire-resistance rated based on either construction type (if load bearing) or fire-separation distance.

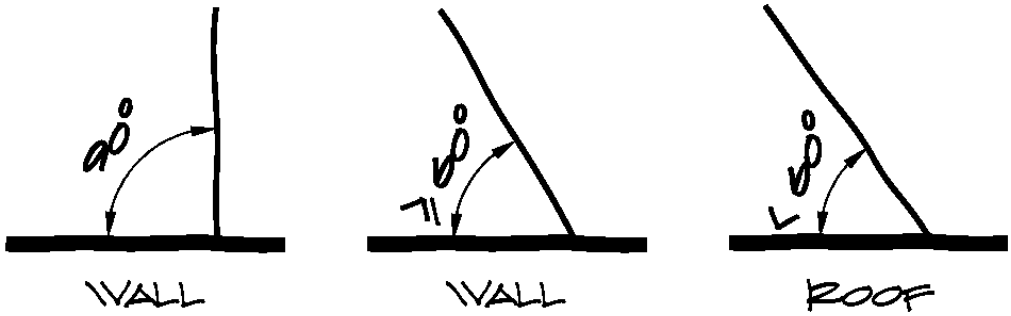
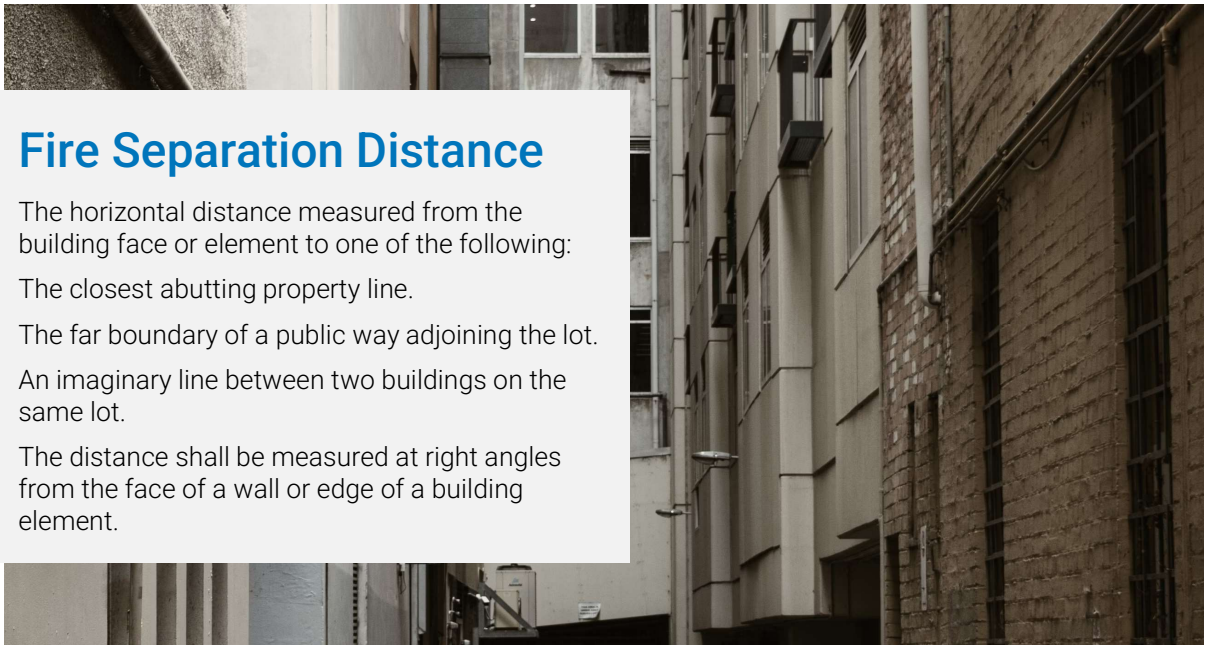


Figure 104

12



Fire Separation Distance

The horizontal distance measured from the building face or element to one of the following:

The closest abutting property line.

The far boundary of a public way adjoining the lot.

An imaginary line between two buildings on the same lot.

The distance shall be measured at right angles from the face of a wall or edge of a building element.

13

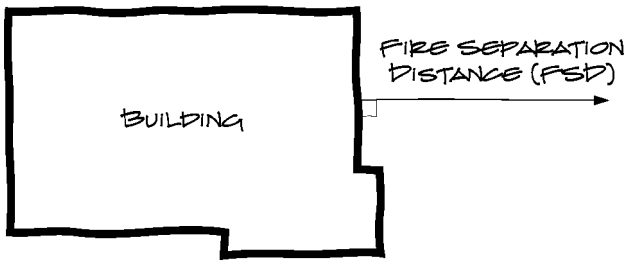


Figure 105

14

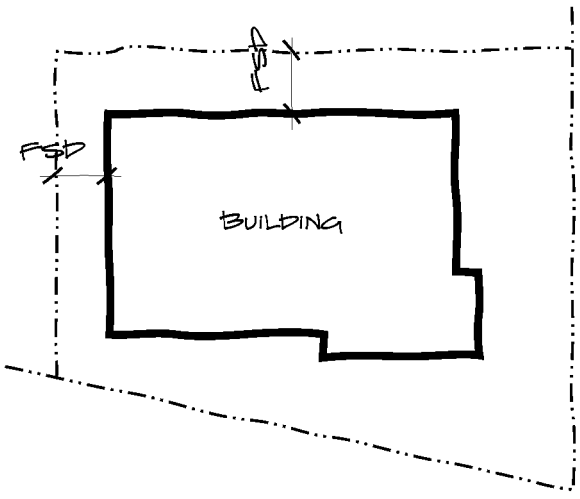


Figure 106

15

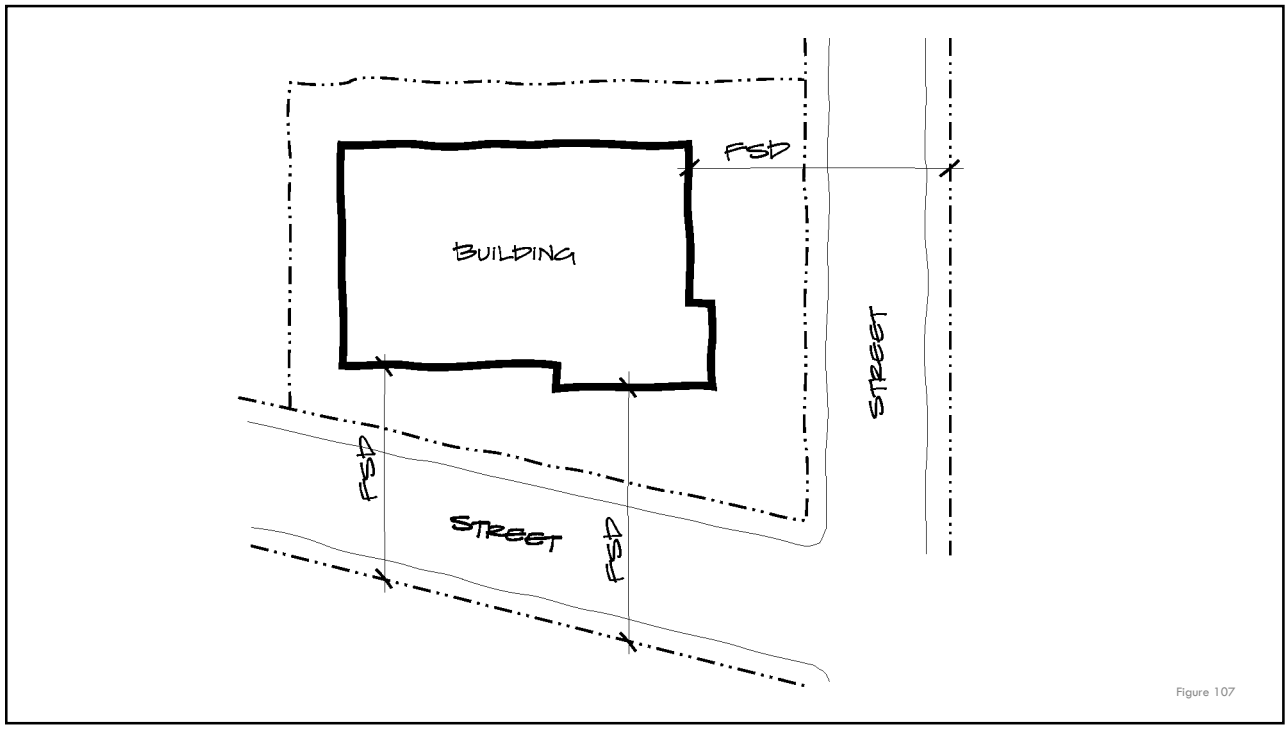


Figure 107

16

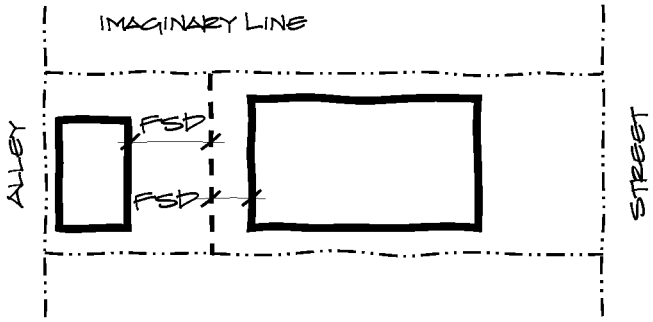


Figure 108

17

Exterior wall requirements include:

- Materials
- Fire-resistance rating
- Opening protectives
- Ducts and air transfer openings
- Parapets
- Joints

18

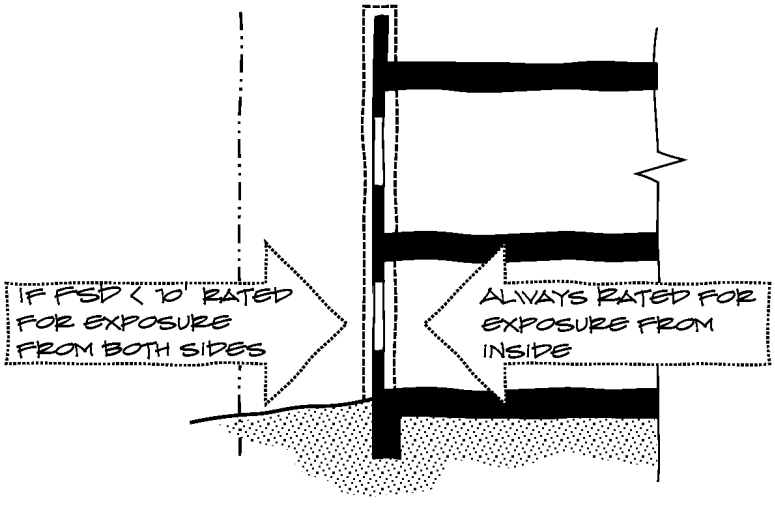
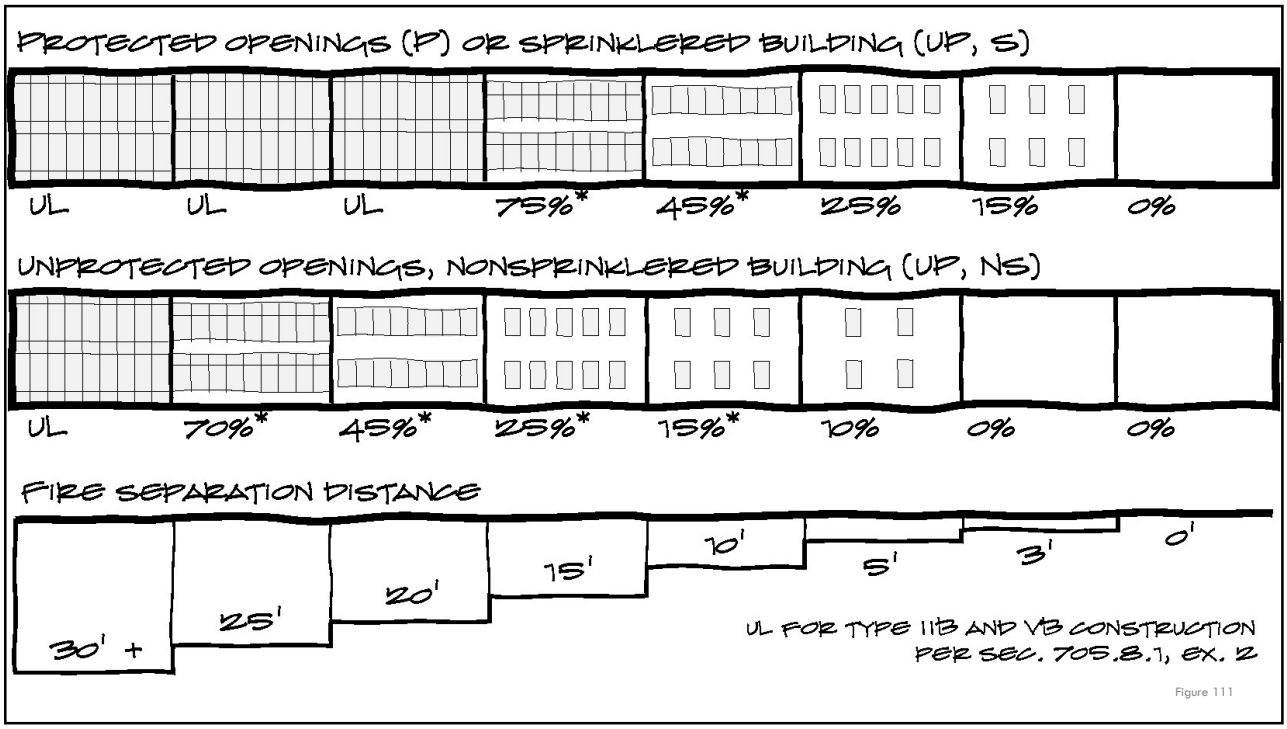
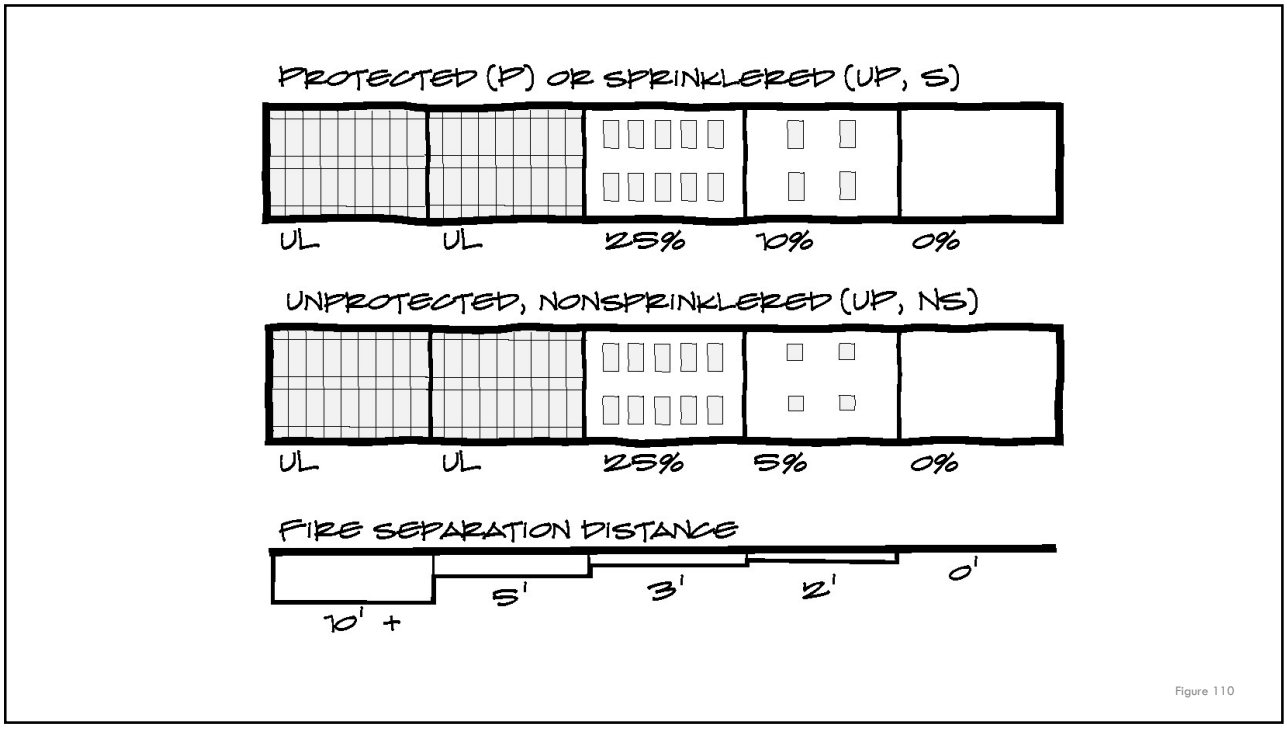


Figure 109

19


PROTECTED OPENINGS (P) OR SPRINKLERED BUILDING (UP, S)
UL
UL
UL
75%*
45%*
25%
15%
0%
UNPROTECTED OPENINGS, NONSPRINKLERED BUILDING (UP, NS)
UL
70%*
45%*
25%*
15%*
10%
0%
0%
FIRE SEPARATION DISTANCE
30' +
25'
20'
15'
10'
5'
3'
0'
UL FOR TYPE IIB AND VB CONSTRUCTION
PER SEC. 705.8.1, EX. 2
Figure 111

20


PROTECTED (P) OR SPRINKLERED (UP, S)
UL
UL
25%
10%
0%
UNPROTECTED, NONSPRINKLERED (UP, NS)
UL
UL
25%
5%
0%
FIRE SEPARATION DISTANCE
10' +
5'
3'
2'
0'
Figure 110

21

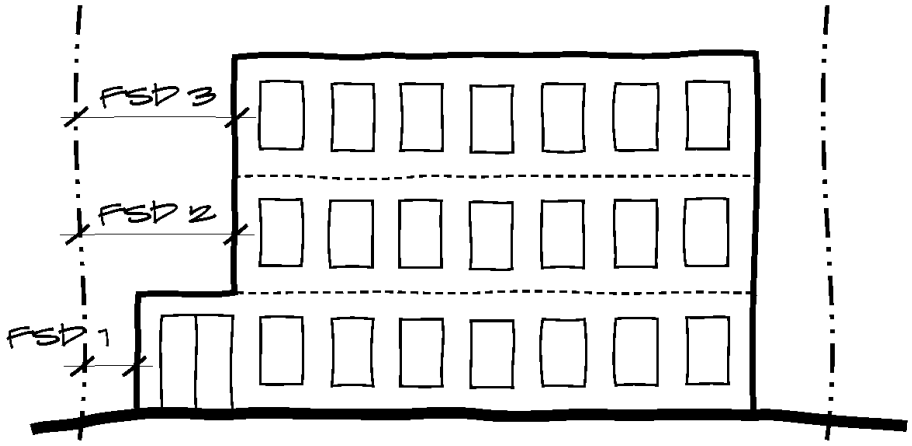
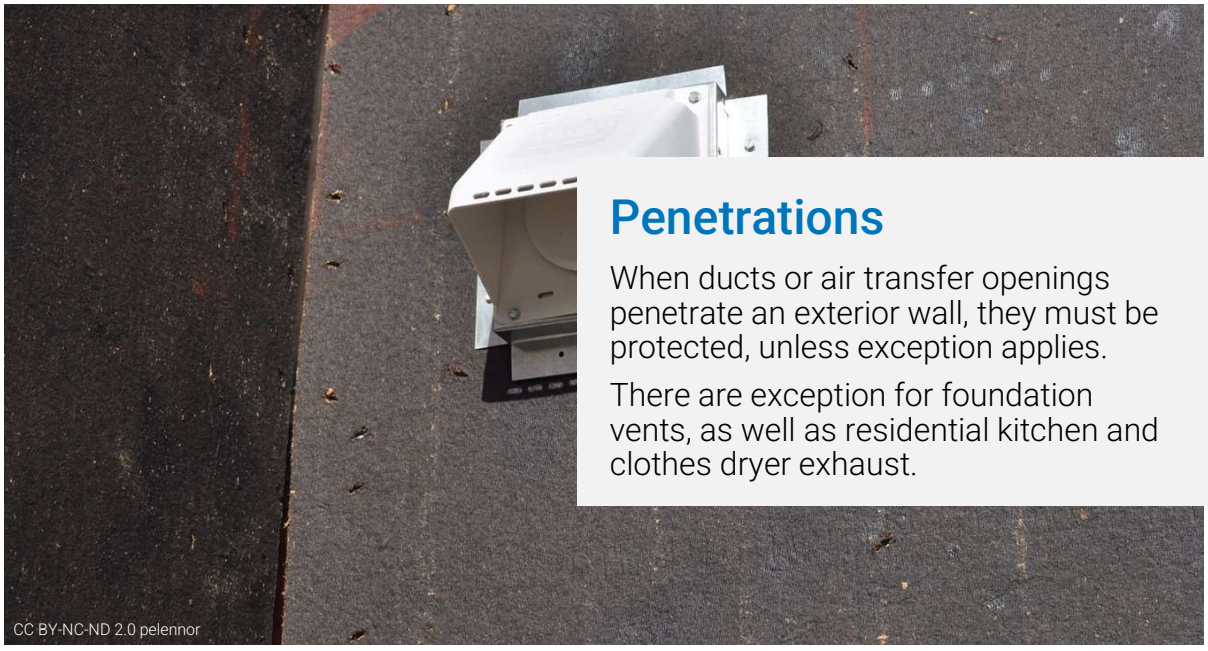
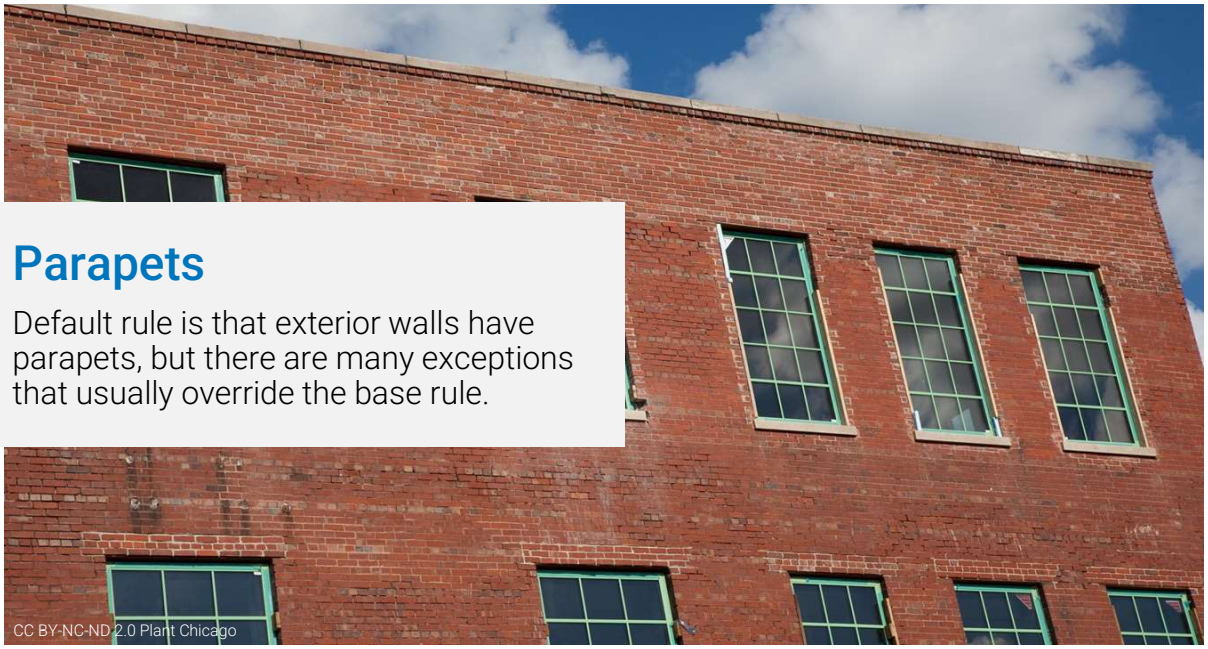


Figure 112

22



23



Parapets

Default rule is that exterior walls have parapets, but there are many exceptions that usually override the base rule.

24

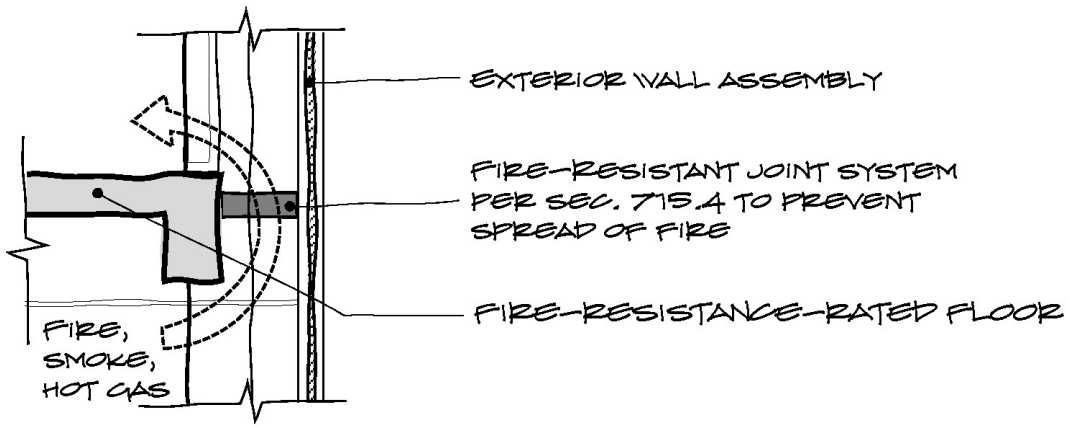


Figure 116

25

Projections

Chicago has specific requirements for and limitations on projections from exterior walls. These vary based on type of projection, building height, and fire separation distance.

26

TABLE 705.2.1
PROJECTIONS FROM WALLS OF ANY TYPE OF CONSTRUCTION[a]

Type of Projection	MATERIAL TYPE	Fire Separation Distance (feet) [b]			
		0 to less than 3	3 to less than 5	5 to less than 10	10 or greater
Cornices, eave overhangs, bay windows, oriel windows and similar decorative projections on *buildings* not exceeding 40 feet in *building height*	U	No	Yes	Yes	Yes
	P	Yes	Yes	Yes	Yes
Cornices, eave overhangs, bay windows, oriel windows and similar decorative projections on *buildings* greater than 40 feet in *building height*	U	No	No	No	No
	P	No	No	No	Yes
	PNC	Yes	Yes	Yes	Yes
Gutters and downspouts on buildings not exceeding 40 feet in *building height*	U	No	Yes	Yes	Yes
	UNC	Yes	Yes	Yes	Yes
Gutters and downspouts on buildings greater than 40 feet in *building height*	U	No	No	No	No
	UNC	Yes	Yes	Yes	Yes
Exterior balconies, each not exceeding 100 square feet in area, on *buildings* not exceeding 55 feet in *building height*	U	No	Yes	Yes	Yes
	UNC	Yes	Yes	Yes	Yes
Exterior balconies, each not exceeding 100 square feet in area, on *build*	U	No	No	No	No

27

TABLE 705.2.1
PROJECTIONS FROM WALLS OF ANY TYPE OF CONSTRUCTION[a]

Type of Projection	MATERIAL TYPE	Fire Separation Distance (feet) [b]			
		0 to less than 3	3 to less than 5	5 to less than 10	10 or greater
Cornices, eave overhangs, bay windows, oriel windows and similar decorative projections on *buildings* not exceeding 40 feet in *building height*	U	No	Yes	Yes	Yes
	P	Yes	Yes	Yes	Yes
Cornices, eave overhangs, bay windows, oriel windows and similar decorative projections on *buildings* greater than 40 feet in *building height*	U	No	No	No	No
	P	No	No	No	Yes
	PNC	Yes	Yes	Yes	Yes
Gutters and downspouts on buildings not exceeding 40 feet in *building height*	U	No	Yes	Yes	Yes
	UNC	Yes	Yes	Yes	Yes
Gutters and downspouts on buildings greater than 40 feet in *building height*	U	No	No	No	No
	UNC	Yes	Yes	Yes	Yes
Exterior balconies, each not exceeding 100 square feet in area, on *buildings* not exceeding 55 feet in *building height*	U	No	Yes	Yes	Yes
	UNC	Yes	Yes	Yes	Yes
Exterior balconies, each not exceeding 100 square feet in area, on *build*	U	No	No	No	No

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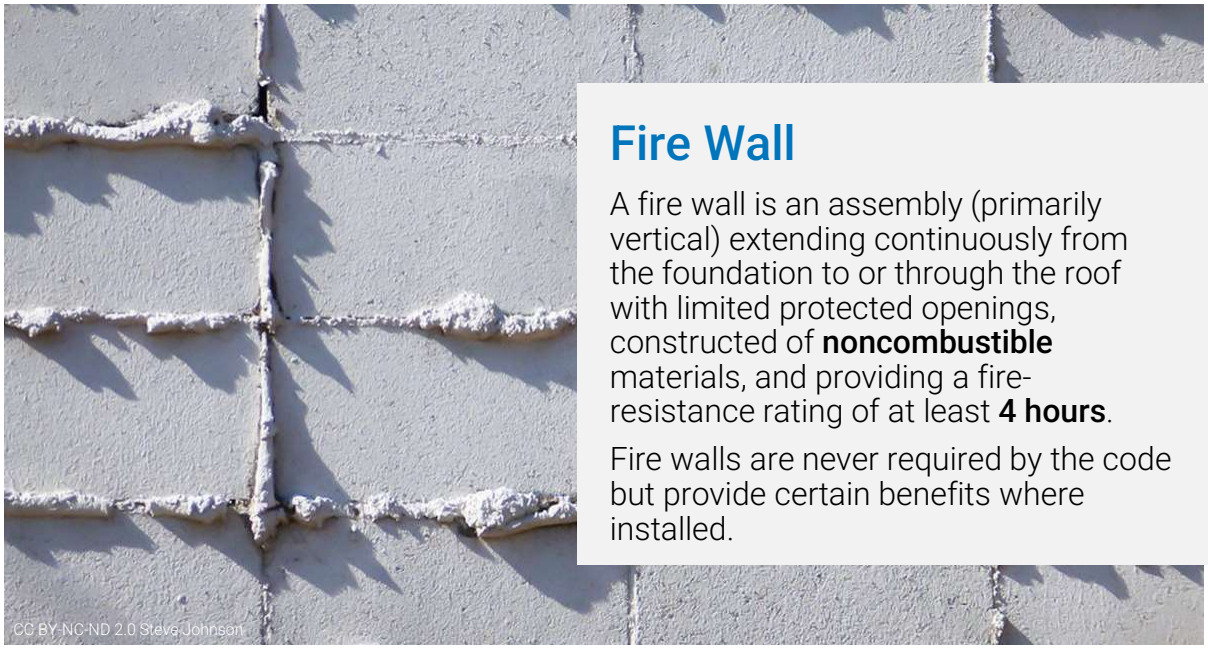
Fire Walls, Fire Barriers, and Fire Partitions

What are they?

Typical requirements

Required locations

30

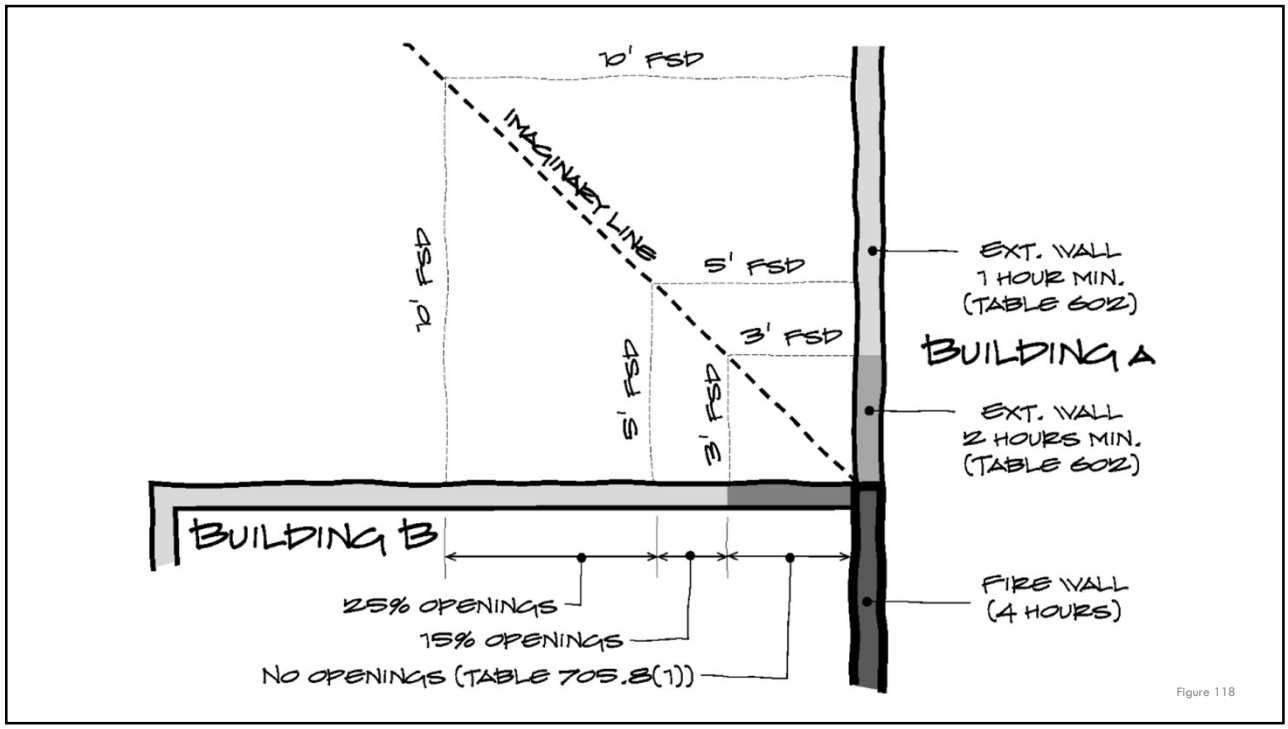


Fire Wall

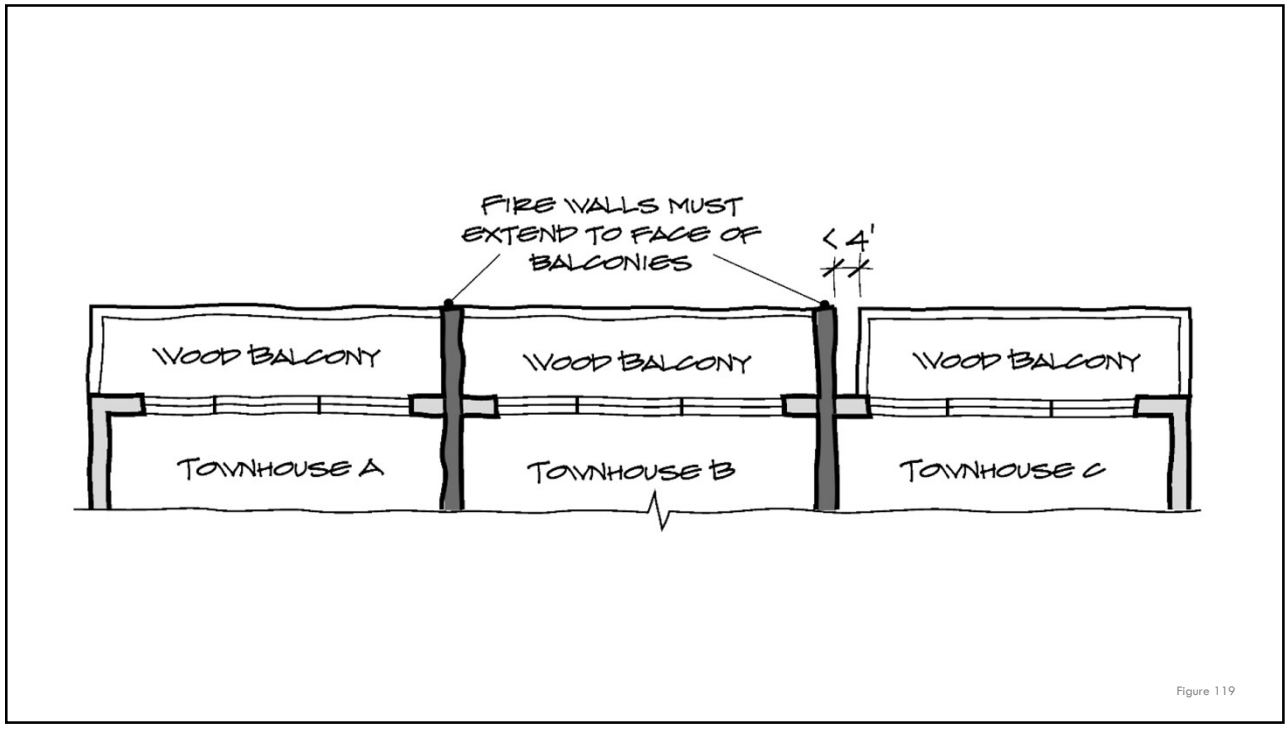
A fire wall is an assembly (primarily vertical) extending continuously from the foundation to or through the roof with limited protected openings, constructed of **noncombustible** materials, and providing a fire-resistance rating of at least **4 hours**.

Fire walls are never required by the code but provide certain benefits where installed.

31


10' FSD
IMAGINARY LINE
10' FSD
5' FSD
3' FSD
5' FSD
3' FSD
EXT. WALL
1 HOUR MIN.
(TABLE 602)
BUILDING A
EXT. WALL
2 HOURS MIN.
(TABLE 602)
BUILDING B
FIRE WALL
(4 HOURS)
25% OPENINGS
15% OPENINGS
NO OPENINGS (TABLE 705.8(1))
Figure 118

32


FIRE WALLS MUST
EXTEND TO FACE OF
BALCONIES
< 4'
WOOD BALCONY
WOOD BALCONY
WOOD BALCONY
TOWNHOUSE A
TOWNHOUSE B
TOWNHOUSE C
Figure 119

33

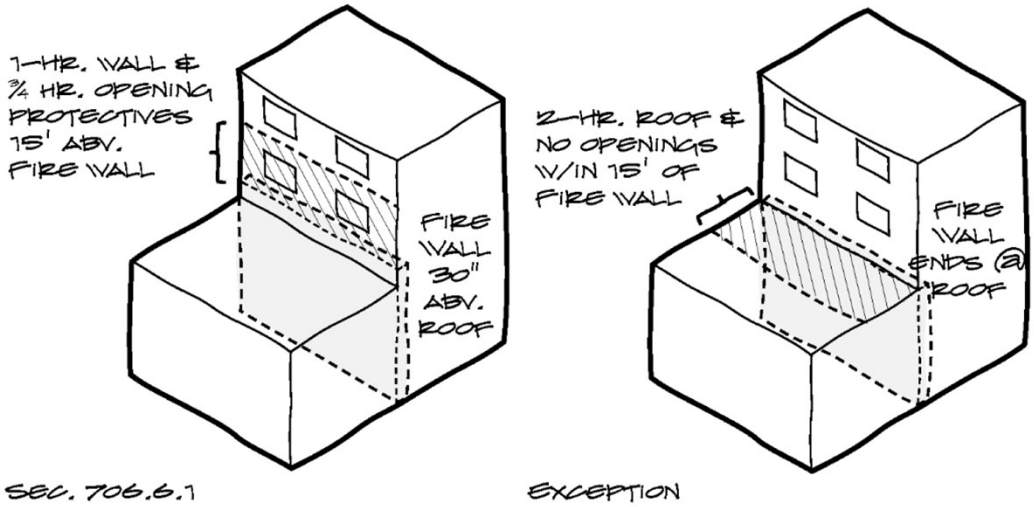
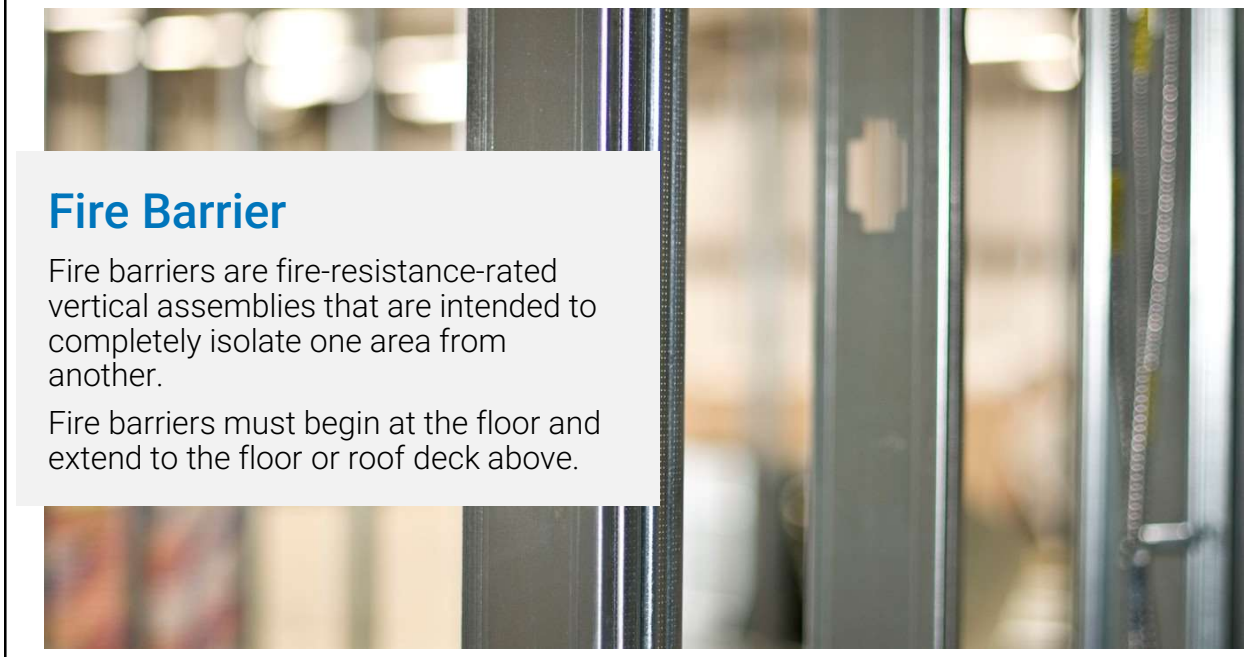


Figure 120

34



Fire Barrier

Fire barriers are fire-resistance-rated vertical assemblies that are intended to completely isolate one area from another.

Fire barriers must begin at the floor and extend to the floor or roof deck above.

35

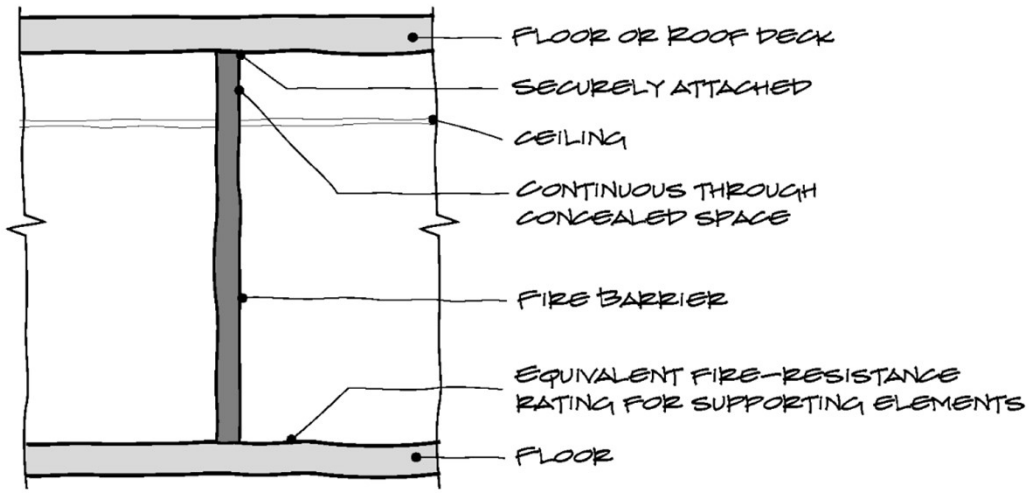


Figure 121

36

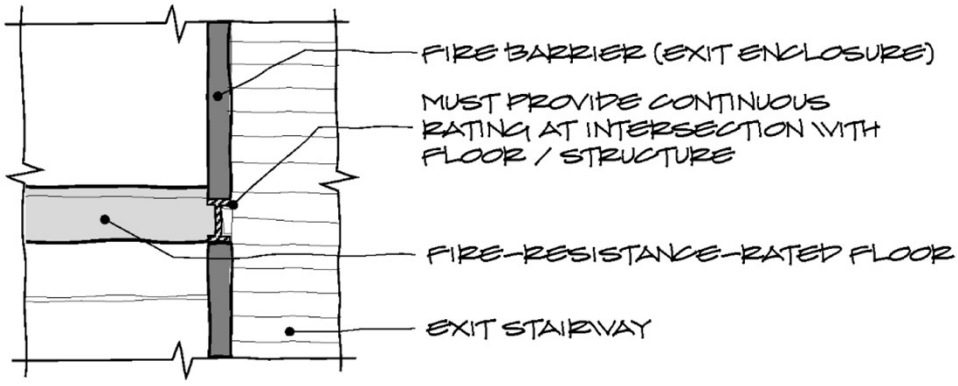


Figure 121

37

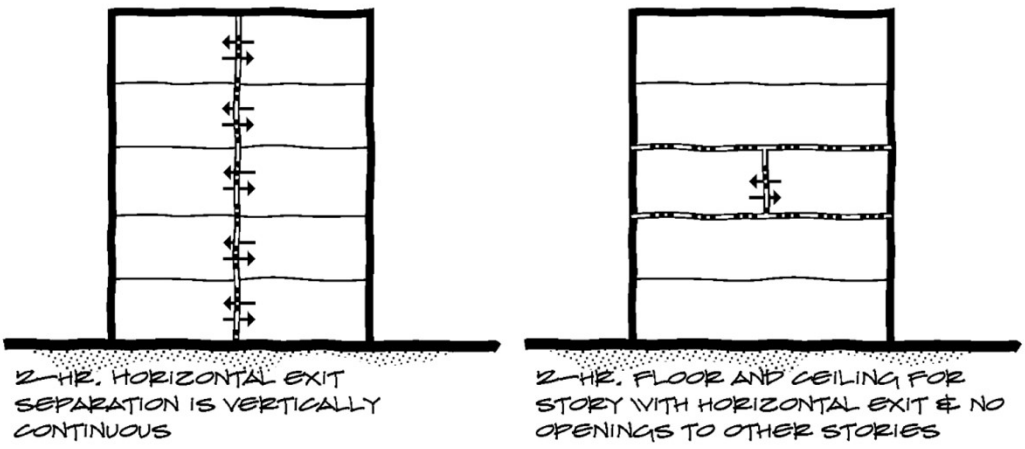


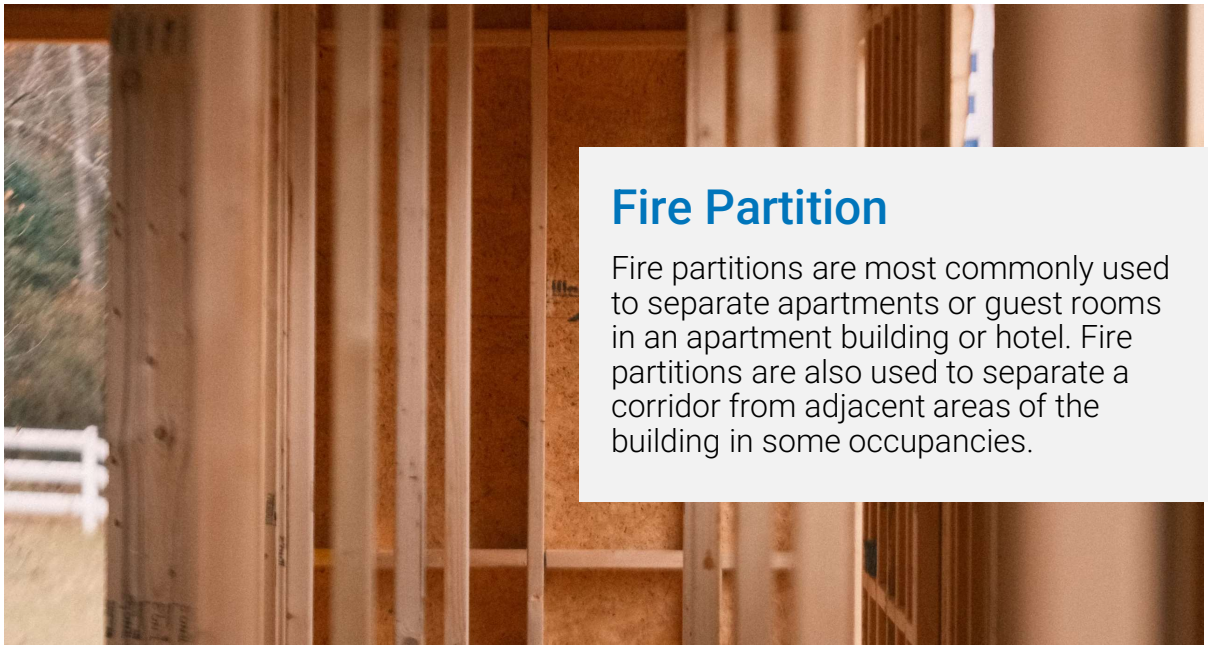
Figure 122

38

Some requirements for fire barriers:

- Exit enclosure and horizontal exits
- Incidental use separation
- Mixed occupancy separation
- Fire area separation
- Atrium separation from adjacent spaces
- Control area separation

39



Fire Partition

Fire partitions are most commonly used to separate apartments or guest rooms in an apartment building or hotel. Fire partitions are also used to separate a corridor from adjacent areas of the building in some occupancies.

40

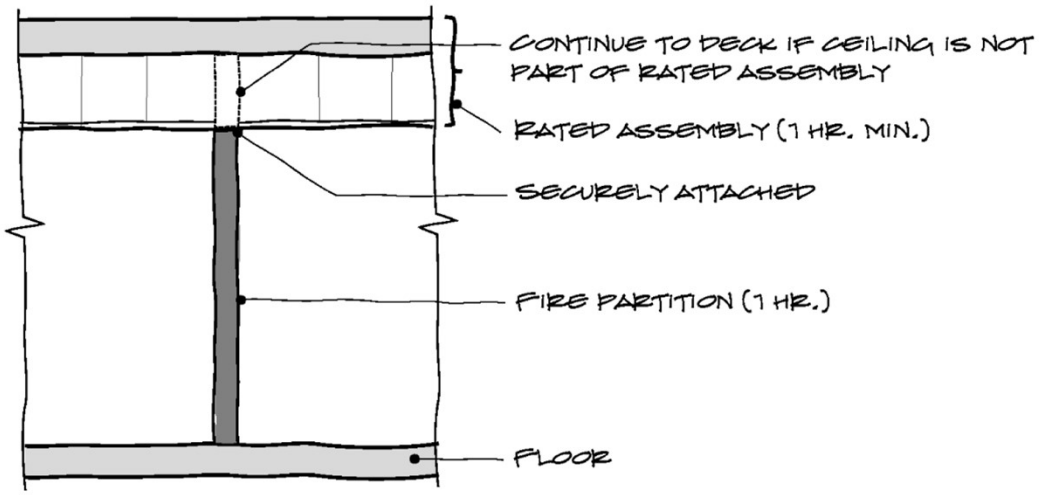


Figure 1.25

41

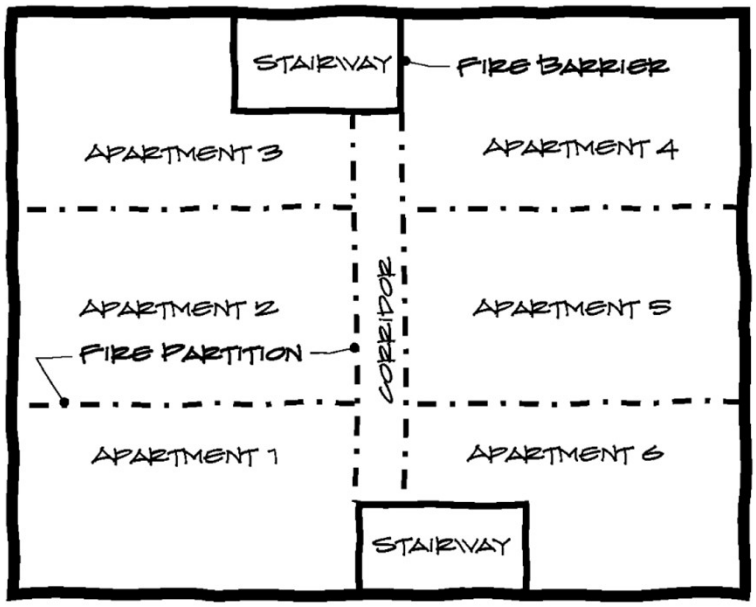


Figure 126

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Structural Members and Bearing Walls

44

Where the **primary structural frame** or **bearing walls** of a structure are required to have a fire-resistance rating by Table 601, or structural members are **supporting a horizontal assembly** that is required to have a fire-resistance rating as a mixed occupancy or fire area separation, then they must comply with the fire-resistance rating requirements of Section 704.

45

Seven Steps to Check Structural Members

1. Check column protection.
2. Check protection of primary structural frame other than columns.
3. Check protection of trusses.
4. Check embedments and enclosures.
5. Check impact protection.
6. Check exterior structural members.
7. Check bottom flange protection.

46

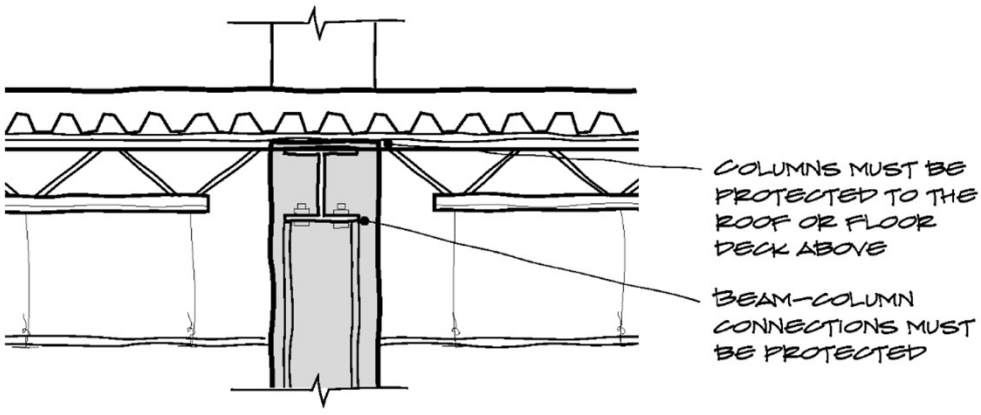
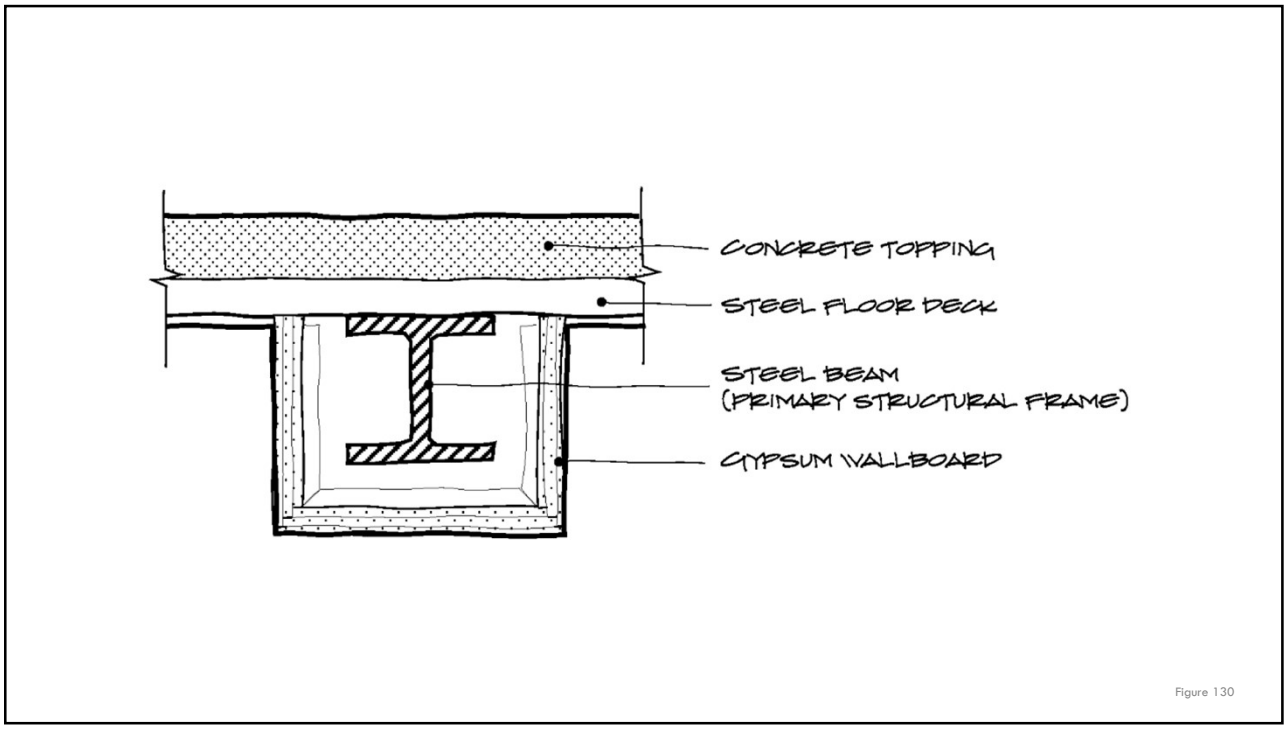


Figure 1.29

47


CONCRETE TOPPING
STEEL FLOOR DECK
STEEL BEAM
(PRIMARY STRUCTURAL FRAME)
GYPSUM WALLBOARD
Figure 130

48


Vertical Openings and Shaft Enclosures

49

The code limits vertical openings between stories to control the spread of smoke and fire. This often requires enclosure of vertical openings and shafts.

The code recognizes several different types of vertical shafts, some of which are allowed to remain open.

50

Seven Steps to Check Vertical Openings and Shaft Enclosures

1. Check allowable method for protection of vertical openings.
2. Check fire-resistance rating of shaft enclosures.
3. Check continuity of shaft enclosures.
4. Check openings, opening protectives, penetrations, and joints.
5. Check whether shaft is enclosed at top and bottom.
6. Check for waste and linen chutes and incinerator rooms.
7. Check for elevators, dumbwaiters, and other hoistways.

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Basement, Floor, and Roof Construction

53

Four Steps to Check Basement Construction

1. Check undivided floor area.
2. Check columns and bearing walls.
3. Check multiple basements.
4. Check floor construction.

54

Three Steps to Check Floor Construction

1. Check the fire-resistance rating for floors and supporting construction.
2. Check the use of combustible materials (Type I or II construction).
3. Check intersections with exterior walls.

55

Three Steps to Check Roof Construction

1. Check the fire-resistance rating of roofs and supporting construction.
2. Check continuity of the roof assembly.
3. Check the use of combustible materials in roofs of Type I or II construction.

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Opening and Penetration Protection

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Interior Finishes

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Definitions

- INTERIOR FINISH. Interior finish includes *interior wall and ceiling finish* and *interior floor finish*.
- INTERIOR FLOOR FINISH. The exposed floor surfaces of buildings including coverings applied over a finished floor or *stair*, including risers.
- INTERIOR FLOOR-WALL BASE. *Interior floor finish trim* used to provide a functional or decorative border at the intersection of walls and floors.

60

Definitions (continued)

- INTERIOR WALL AND CEILING FINISH. The exposed *interior surfaces* of buildings, including but not limited to: fixed or movable walls and partitions; toilet room privacy partitions; columns; ceilings; and interior wainscoting, paneling or other finish applied structurally or for decoration, acoustical correction, surface insulation, structural fire resistance or similar purposes, but not including *trim*.
- TRIM. Picture molds, chair rails, baseboards, *handrails*, door and window frames and similar decorative or protective materials used in fixed applications.

61

Interior Wall and Ceiling Finishes

- Most interior wall and ceiling finish materials must be classified (based on flame spread and smoke development) as either Class A, Class B, or Class C based on testing.
- The code also allows wall coverings to be tested to NFPA 286, which is deemed equivalent to a Class A rating.
- Interior finishes must be as specified in Table 803.13.
- (This requirement does not apply to material with a thickness less than 0.036 inches—excluding paint and wallpaper)

62

TABLE 803.13
INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY[k]

GROUP	SPRINKLERED[l]			NONSPRINKLERED		
	Interior exit stairways and ramps and exit passageways[a]	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces[c]	Interior exit stairways and ramps and exit passageways[a]	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces[c]
A-1 & A-2	A	B	C	A	A	B[e]
A-3, A-4, A-5	A	B	C	A	A	C
B, E, M, R-1	A	C[m]	C	A	B	C
R-4	B	C	C	A	B	B
F	A	C	C	A	C	C
H	A	B	C[g]	A	A	B
I-1	A	C	C	A	B	B
I-2	A	B	B[h, i]	A	A	A
I-3	A	A[j]	C	A	A	B
I-4	A	B	B[h, i]	A	A	B
R-2	A	C	C	A	B	C
R-3, R-5	C	C	C	C	C	C
S	A	C	C	A	B	C
U	No restrictions			No restrictions		

63

TABLE 803.13
INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY[k]

GROUP	SPRINKLERED[j]		
	Interior exit stairways and ramps and exit passageways[a]	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces[c]
A-1 & A-2	A	B	C
A-3, A-4, A-5	A	B	C
B, E, M, R-1	A	C[m]	C
R-4	B	C	C
F	A	C	C
H	A	B	C[g]
I-1	A	C	C
I-2	A	B	B[h,i]
I-3	A	A[j]	C
I-4	A	B	B[h,i]
R-2	A	C	C
R-3, R-5	C	C	C
S	A	C	C
U	No restrictions		

Sprinklered

Library (Group A-3)

Reading room

Corridor

Exit stairs

64

Interior Wall and Ceiling Finishes (continued)

- Textile and expanded vinyl wall coverings and ceiling coverings have additional requirements
- High-density polyethylene (HDPE) and polypropylene (PP) wall coverings must be tested under special standard
- Additional testing requirements apply to:
  - Site-fabricated stretch systems
  - Laminated finishes over wood/combustible substrates
  - Site-applied wood facings and veneers
- Additional rules apply to finishes on fire-resistance rated assemblies.

65

Interior Floor Finishes

- Traditional floor finish and floor covering materials that are not comprised of fibers, such as wood, vinyl, linoleum or terrazzo, and resilient floor covering, are not subject to any special fire performance requirements.
- Fibrous floor finishes in exits and exit discharge vestibules/lobbies must be Class I.
- Floor finishes in other areas must be Class I, Class II or meet the CPSC “pill test” per Sec. 804.4.

66

Decorative Materials and Trim

- Combustible trim (including foam plastic) may not exceed 10 percent of the specific wall or ceiling area to which it is attached.
  - The surface area of combustible handrails and freestanding guardrails is not included in calculating the 10 percent limit.
- Material, other than foam plastic used as interior trim must have a minimum Class C flame rating when tested in accordance with ASTM E84 or UL 723.
- Foam plastic trim has limited dimensions and density, if met, no thermal barrier is required and smoke-developed index is not limited.

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Decorative Materials and Trim

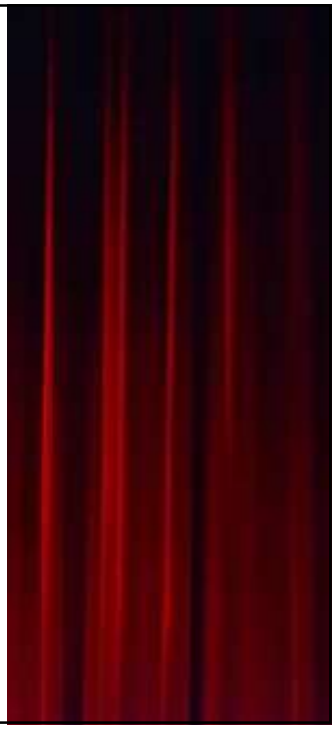
- Where interior floor-wall base does not comply with the requirements for wall trim:
- Interior floor-wall base that is 6 inches or less in height must be tested in accordance with requirements for floor finishes and must be at least Class II.
- Where a Class I floor finish is required, the floor-wall base must be Class I.
- For example, this might include a detail where the floor covering material is used as the floor-wall base.

68

Decorative Materials and Trim (continued)

Decorative Materials

- In Group A, B, E, I, M and R-1 occupancies and in Group R-2 dormitories, curtains, draperies, fabric hangings, and similar combustible decorative materials suspended from walls or ceilings must meet the flame propagation performance criteria of NFPA 701, Test 1 or Test 2, or exhibit a maximum heat release rate of 100 kW when tested per NFPA 289 with a 20 kW ignition source.



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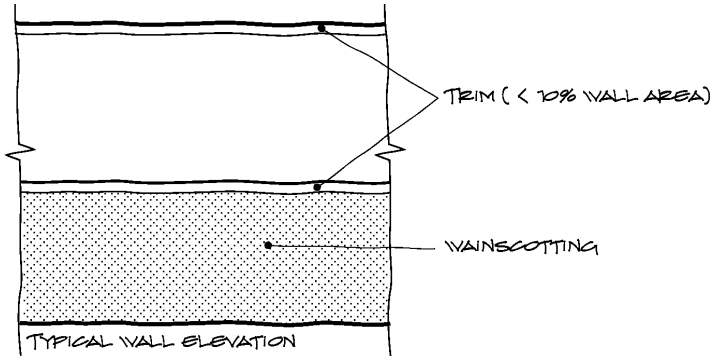
Decorative Materials and Trim (continued)



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Audience Q&A Session

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Fire Protection and Life Safety Systems Overview

- Automatic Sprinkler and Fire-Extinguishing Systems
- Standpipes
- Fire Alarm and Detection
- Carbon Monoxide Detection
- Portable Fire Extinguishers

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Automatic Sprinkler and Fire-Extinguishing Systems

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Automatic Sprinkler Systems

- 3 sprinkler installation standards
  - NFPA 13
  - NFPA 13R (Low-rise Residential)
  - NFPA 13D (Groups R-4, R-5 only)
- A building is not fully sprinklered if a portion uses an alternative automatic extinguishing system (chemical, etc.)
- Sprinkler system requires separate permit from Chicago Fire Department, Fire Prevention Bureau

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Automatic Sprinkler Systems

Sprinkler system triggers:

- Based on occupancy classification of building or fire area
- Specific building areas/hazards (underground parking)
- Buildings over 70 feet in height
- Incidental uses
- Additional requirements for fire suppression systems

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Fire Areas

A fire area separation is not the same as a mixed-occupancy separation. The required fire-resistance rating for fire area separations is in Table 707.3.10:

TABLE 707.3.10
FIRE-RESISTANCE RATING REQUIREMENTS FOR FIRE BARRIERS 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, U	2

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Automatic Sprinkler Systems (p. II-111)

Occupancy-based Automatic Sprinkler System Requirements

Occupancy	Fire Area (ft^2)	Occupant Load (persons)	Stories Above / Below Grade
A-1, A-3, A-4 [a, e]	> 12,000	300	—
A-2 [a, e]	> 12,000	300 / 100 [j]	—
A-3 [d, e] (exhibition area)	> 5,000	—	—
A-5 [a, b, c]	> 1,000	—	—
B [f] (ambulatory care)	—	—	1 / 1 [g]
B (telephone exchange)	Note h	—	—

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Automatic Sprinkler Systems

Occupancy-based Automatic Sprinkler System Requirements			
Occupancy	**Fire Area (ft^2)**	**Occupant Load (persons)**	**Stories Above / Below Grade**
E-1 [d, i]	> 7,200	—	—
E-2	Note h	—	—
F-1 [k] (general)	> 12,000	—	3 / NA
F-1 [k] (upholstery, woodworking)	> 2,500	—	—
F (electricity generation)	Note h	—	—
H	Note h	—	—

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Automatic Sprinkler Systems

Occupancy-based Automatic Sprinkler System Requirements			
Occupancy	**Fire Area (ft^2)**	**Occupant Load (persons)**	**Stories Above / Below Grade**
I	Note h	—	—
M [k] (general)	> 12,000	—	3 / 1
M [k] (upholstered furniture)	> 5,000	—	—
R-1, R-2, R-3, R-4	Note h	—	—

- Never required for R-5
- Limited exception for R-2

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903.2.8, Exception 2

Buildings of Group R-2 occupancy, other than *congregate living facilities*, with not more than four *stories above grade plane* and containing not more than ten *dwelling units* where each *fire area* contains not more than two *dwelling units* and all required vertical *exits* are interior *exit stairways*.

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Automatic Sprinkler Systems

Occupancy-based Automatic Sprinkler System Requirements

Occupancy	Fire Area (ft^2)	Occupant Load (persons)	Stories Above / Below Grade
S-1 [k, m] (general)	> 12,000	—	3 / NA
S-1 [k] (commercial vehicles)	> 5,000	—	3 / NA
S-1 [k] (upholstered furniture)	> 5,000	—	3 / NA
S-1 [k, l] (repair garage)	> 12,000	—	2 / 1
S-2 (general)	> 12,000	—	1
S-2 [n] (parking garage)	> 12,000	—	NA / 1

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Automatic Sprinkler Systems

- Specific hazards:
  - Stories without openings / basements
  - Rubbish and linen chutes
  - Shops and storerooms
  - Telecommunication equipment areas > 150 ft²
- Incidental uses (Table 509)
- Additional required suppression systems (Table 903.2.11.8)

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Automatic Fire Extinguishing Systems

Required for specific hazards, such as commercial kitchen hoods.

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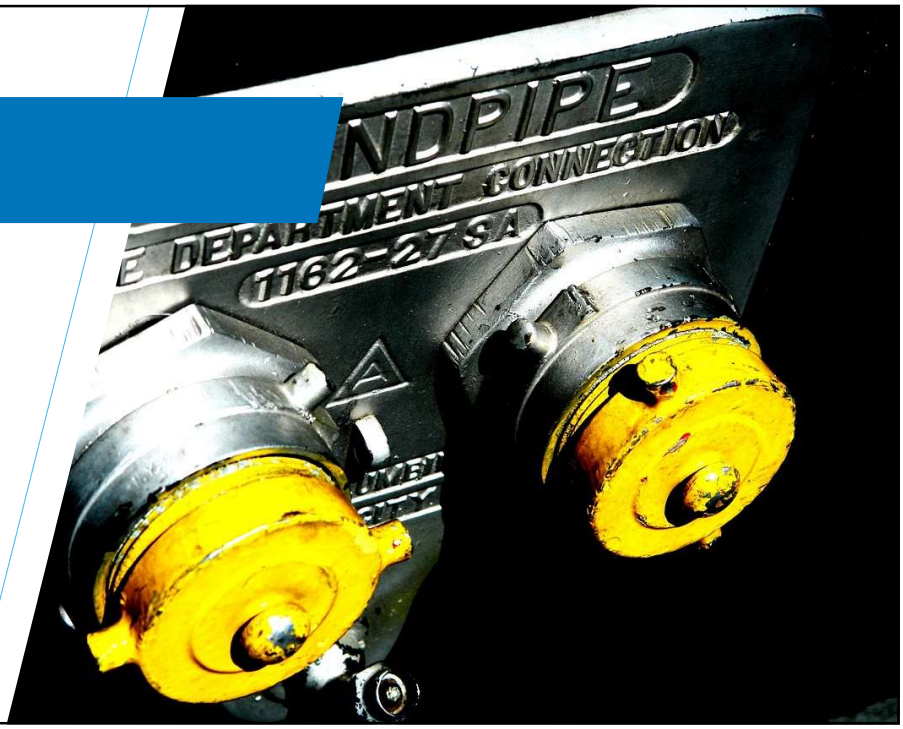
Standpipes



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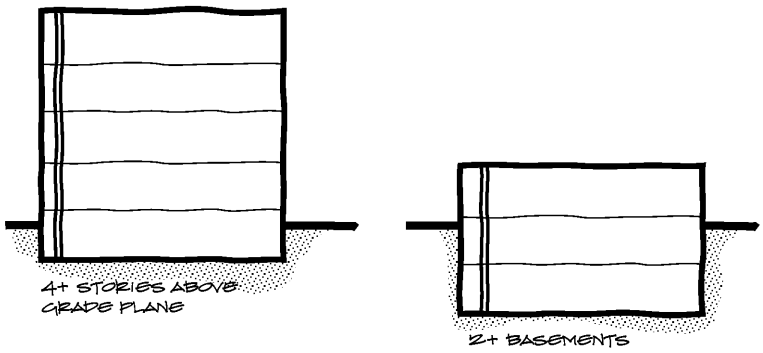
Standpipe Systems

- Required in buildings with 4 or more stories above grade or 2 or more basements
  - For Groups R-2, R-3, R-4 and R-5 not required if 4 or fewer stories above grade



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Standpipe Systems

Other standpipe triggers:

- Group A occupancies with OL > 1,000
- Stages > 1,000 ft²
- Underground buildings (Sec. 405)
- Helistop or heliport
- Vegetative or landscaped roof; occupiable rooftop

- In buildings where standpipes are required, ensure adequate space is provided at stair landings and other required locations

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Fire Alarm and Detection Systems

Item 1

Item 2

Item 3

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Fire Alarm and Detection Systems

- **Manual –** Relies on manual fire alarm boxes or pull stations to activate a notification sequence.
- **Automatic –** Relies on input from devices that detect smoke or heat without occupant interaction or my activate based on waterflow.
- **Presignal-type –** Does not automatically initiate occupant notification throughout the building; notifies trained personnel at constantly-attended location. Required in high-rise buildings by the Chicago Fire Department.

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Fire Alarm and Detection Systems

- Manual fire alarm system requirements summarized in Table on p. II-130 of *Manual*.
- Where code allows elimination of pull stations throughout building (usually due to sprinklers), pull stations must still be installed at each exit on the level of exit discharge.

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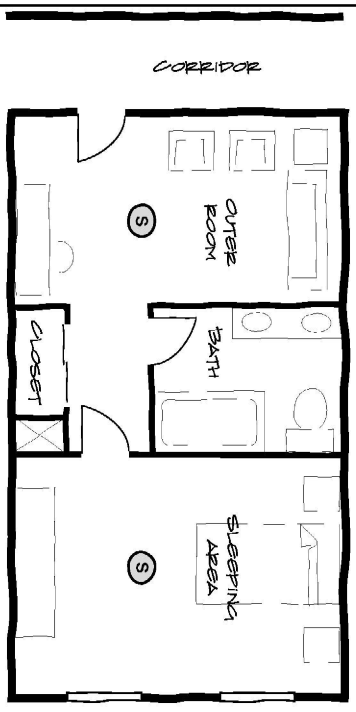
Single- or Multiple-station Smoke Alarms

Group R-1

- In sleeping areas.
- In every room in the path of the means of egress from sleeping area to door leading from sleeping unit.
- In each story within the sleeping unit, including basements.
- At the uppermost ceiling of each interior exit stairway.



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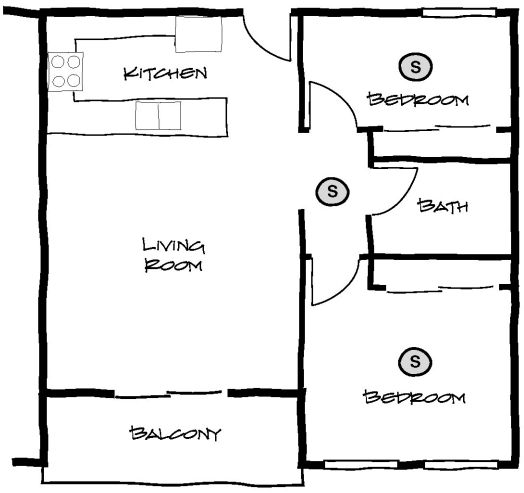
Single- or Multiple-station Smoke Alarms

Groups R-2, R-3, R-4 and R-5

- On ceiling or wall outside of and within 15 feet of each room used for sleeping.
- In each room used for sleeping.
- In each story within a dwelling unit, including basements but not including crawl spaces and uninhabitable attics.
- At the uppermost ceiling of each interior exit stairway.



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Single- or Multiple-station Smoke Alarms

- Where more than one smoke alarm is required to be installed within an individual dwelling unit or sleeping unit in Group R or I-1 occupancies, the smoke alarms must be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit.
  - Physical interconnection of smoke alarms is not required where listed wireless alarms are installed and all alarms sound upon activation of one alarm.
- Limits on placement of certain types of smoke alarms near cooking appliances, bathrooms.

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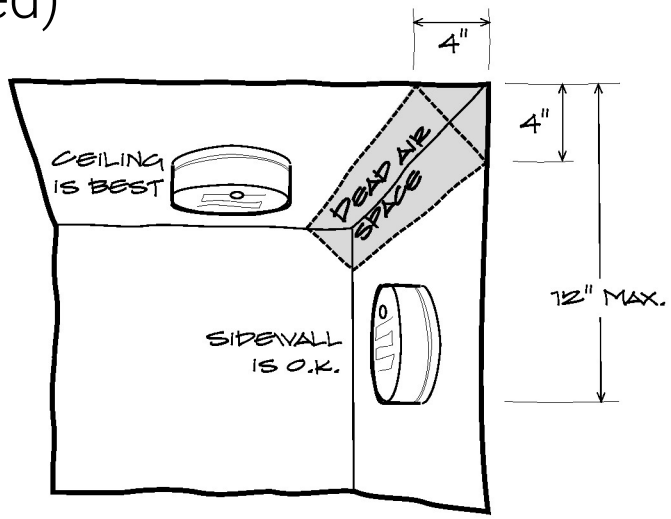
Single- or Multiple-station Smoke Alarms (continued)



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907.2.10.8 Heat alarms and heat detectors.

A heat detector or heat alarm shall be installed in a *private garage* that is attached to or directly below a *dwelling unit* or *sleeping unit* and shall comply with the following:

1. The heat alarm or heat detector shall be rated for the ambient environment.
2. The heat alarm or heat detector shall either be interconnected with the smoke alarms within the attached *dwelling unit* or *sleeping unit* or the heat detector shall be connected to an audible occupant notification device located within the *dwelling unit* or *sleeping unit* and within 20 feet of the door nearest to the *private garage* and additional audible occupant notification devices, as necessary, so that occupant notification is clearly audible in all sleeping rooms over background noise levels with all intervening doors closed. Audible occupant notification is not required within the *private garage*.
3. Heat alarms and heat detectors shall be installed in accordance with the manufacturer's instructions.

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Carbon Monoxide Detection

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Carbon Monoxide Detection

- Required in Groups E, I-1, I-2, I-4, and R
- Only where hazard exists:
  - Fuel-burning appliances
  - Fuel-burning fireplace
  - Attached private garage
- May be combined with smoke alarms
- May be part of building alarm system

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Portable Fire Extinguishers

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Portable Fire Extinguishers

- Fire extinguishers are required in most occupancies.
- Make allowances for fire extinguisher placement:
  - Surface mounted could create obstruction
  - Recessed cabinets must maintain fire-resistance rating of wall construction
- Locations must be conspicuous and unobstructed.
- For most commonly-required type, maximum travel distance is 75 ft.

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