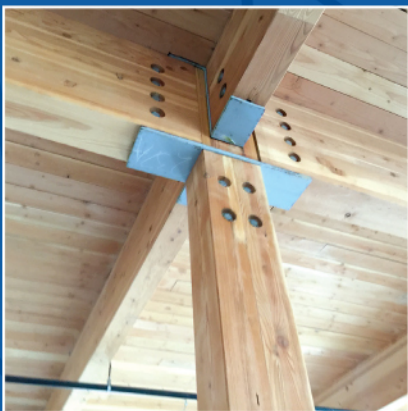

2018 Code Conforming Wood Design



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The American Wood Council (AWC) is the voice of North American traditional and engineered wood products. AWC develops state-of-the-art engineering data, technology, and standards on structural wood products for use by design professionals, building officials, and wood products manufacturers to assure the safe and efficient design and use of wood structural components. AWC also provides technical, legal, and economic information on wood design, green building, and manufacturing environmental regulations advocating for balanced government policies that sustain the wood products industry.

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2018 Code Conforming Wood Design

Introduction

Wood construction offers distinct design options typically not found in a single structural material. It is inexpensive, readily available, easy to work with, strong and adaptable. The economic, environmental and energy efficiency advantages account for more buildings being constructed of wood than any other structural material.

The intent of this book is to summarize the allowable wood use in buildings in accordance with the International Code Council (ICC) 2018 *International Building Code*® (IBC®). Emphasis will be placed on the design flexibilities permitted for wood in commercial construction. This is not meant to be a replacement for the IBC and does not encompass all of the design options in the IBC. The IBC, along with any local amendments, should always be consulted for applicable specific requirements related to designs and site conditions.

Table of Contents

1. General Information
2. Type of Construction
3. Allowable Heights and Areas for Type V, IV and III Construction
4. Establishing Fire Resistance
5. Wood Use in “Noncombustible” Construction
6. Wood Features
7. Structural Considerations
8. Precautions during Construction
9. Resources
10. Building Area Tables

1. General Information

Use and Occupancy Classification

Building code requirements are dependent on the appropriate classification of the building or structure for its design purpose or current occupancy. Eight occupancy classifications are discussed in this book:

- Group A, Assembly
- Group B, Business
- Group E, Educational
- Group F, Factory/Industrial
- Group I, Institutional
- Group M, Mercantile
- Group R, Residential
- Group S, Storage

The occupancies are described below, but when a structure is proposed for a purpose that is not specifically listed, it should be classified in the group that the occupancy most nearly resembles in accordance with Section 302.1. The authority having jurisdiction, the building official, has the ultimate responsibility for rendering interpretations of the code, including designation of the type of occupancy.

Group H (Hazardous) and Group U (Utility and Miscellaneous) occupancies also may be of wood construction but are beyond the scope of this book.

Assembly Occupancies

The IBC lists Assembly (Group A) occupancies in Section 303. Group A occupancies are divided into five subcategories. Group A-1 includes fixed seating occupancies for viewing performing arts, television studios with audience seating, and motion pictures. Group A-2 includes buildings in which food and drink consumption occurs (e.g., restaurants, banquet halls, casinos, bars and nightclubs); Group A-3 includes places of religious worship, waiting areas in terminals, recreation, amusement and other assembly uses not included in the other groups; Group A-4 includes indoor viewing of sporting events and activities with spectator seating (e.g., arenas, skating rinks, swimming pools and tennis courts); and Group A-5 includes outdoor grandstands, stadiums and amusement park structures.



Figure 1: Auditorium

Business Occupancies

Section 304 describes Business (Group B) occupancies. Group B uses are for office, professional, or service-type transactions, including the storage of records. It is a broad use group that often is chosen when a use does not fit another use group description. Group B includes airport traffic control towers, ambulatory care facilities, animal hospitals, kennels and pounds, banks, barber and beauty shops, car washes, civic administration, outpatient clinics, dry cleaning and laundry (pick-up and delivery stations and self-service), educational occupancies (above the 12th grade), electronic data processing, testing and research laboratories, food processing establishments not associated with restaurants and dining facilities not more than 2,500 square feet in area, motor vehicle showrooms, post offices, print shops, professional service offices, radio and television stations, telephone exchanges and training and skill development facilities not located in a school.



Figure 2: Office Building

Educational Occupancies

The IBC lists Educational (Group E) occupancies in Section 305. Group E includes any buildings or portions of a structure used to educate six or more people through the 12th grade. Buildings or portions of a structure used for supervision, personal care or education of more than five children, at least 2½ years old, for fewer than 24 hours are also Group E structures.



Figure 3: Elementary School

Factory/Industrial Occupancies

Section 306 defines Factory/Industrial (Group F) occupancies. Group F is subdivided into two occupancy groups: Group F-1 and Group F-2. Group F-1, moderate hazard industrial, includes buildings or portions of buildings used for the manufacturing of materials that cannot be classified as Group F-2, low hazard industrial. Group F-1 includes the manufacturing of aircraft, appliances, motor vehicles, boats, recreational vehicles, business machines, photo equipment, construction and agricultural machinery, engines, metals, woodworking and millwork, and food processing establishments



Figure 4: Factory

and commercial kitchens not associated with restaurants and dining facilities and more than 2,500 square feet in area. Group F-1 also includes textile production—canvas, clothing, carpet, hemp, jute and paper—and laundries, printing and publishing, soaps and plastic products, beverages having over 16-percent alcohol content, optical goods, wood working and wood distillation.

Group F-2, low hazard industrial occupancies, are buildings and facilities used for beverage production (up to and including 16-percent alcohol), brick, ceramics, glass, gypsum, ice, metal fabrication and assembly and foundries.

Institutional Occupancies

The IBC lists Institutional (Group I) occupancies in Section 308. Group I includes four subcategories: Group I-1 includes residential and custodial care for more than 16 people receiving care (24-hour care); Group I-2 includes hospitals, child care facilities (24-hour care), nursing homes and detoxification facilities for more than five people receiving care; Group I-3 includes facilities with five or more people under restraint or security (e.g., jails, detention centers and prisons); and Group I-4 includes day care facilities for more than five adults or children receiving care (less than 24-hour care).

Group I-1 through I-3 occupancies are further broken into conditions based upon the occupants' ability to respond to an emergency.



Figure 5: Nursing Home

Mercantile Occupancies

Section 309 describes Mercantile (Group M) occupancies. Group M includes department stores, drugstores, greenhouses with display and sale of plants having public access, markets, motor fuel-dispensing facilities, retail or wholesale stores and salesrooms. Essentially any place involving display and sale of merchandise is classified as a Group M occupancy.



Figure 6: Retail Store

Residential Occupancies

The IBC lists Residential (Group R) occupancies in Section 310. Group R contains four subcategories. Group R-1 includes hotels, motels and boarding houses; Group R-2 includes apartments, dormitories, live/work units, timeshare properties and nontransient hotels, motels and boarding houses. Group R-3 includes single- and two-family dwellings, adult and child day care facilities with less than six occupants receiving care and congregate living facilities—transient (10 or fewer occupants) and nontransient (16 or fewer occupants) and lodging houses (five or fewer guest rooms and 10 or fewer occupants) are classified as Group R-3 or are allowed to be constructed in accordance with the IRC. Group R-4 includes residential care and assisted living facilities for 6 to 16 clients who reside for 24 or more hours. Group R-4 occupancies are further broken into two conditions: Condition 1 where all occupants are capable of responding to an emergency without assistance and Condition 2 where limited assistance may be necessary for any single occupant.



Figure 7: Apartments

Storage Occupancies

Section 311 covers Storage (Group S) occupancies. Group S includes subcategories Group S-1, moderate hazard storage, and Group S-2, low hazard storage. Group S-1 contains buildings occupied for storage uses that are not classified as Group S-2, including aircraft hangars, storage of clothing, cloth, fiber, books, paper, wood, fur, furniture, mattresses, tires, tobacco products, sugar, soap and glue. Group S-1 also includes indoor storage of boats and motor vehicle repair garages that comply with the maximum allowable quantities of hazardous materials.



Figure 8: Parking Garage

Group S-2 includes buildings used for storage of noncombustible materials such as beverages up to 16-percent alcohol content, cement, chalk, batteries, electric coils and motors, glass, stoves, washers and dryers, metal furniture, metals; and food products in noncombustible containers or fresh fruit in nonplastic containers and frozen foods. Open and enclosed parking garages are also Group S-2 occupancies.

Referenced Code and Standards

The IBC is developed by the International Code Council. Industry and professional standards are referenced in the IBC to clarify specific code requirements. Chapter 35 of the IBC provides a list of the standards referenced, the agency that writes the standard, the identification and title of the standard, and its effective date.

Standards represent consensus on how a material, product or assembly is to be designed, manufactured, tested or installed so it achieves a specified level of performance. Several key standards relating to design of wood structures are utilized by the IBC. Specifically, the 2018 IBC references the American Wood Council (AWC) 2018 *National Design Specification® (NDS-18®) for Wood Construction*, the AWC SDPWS-15, 2018 *Special Design Provisions for Wind and Seismic*, and the 2018 *Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings*. The NDS details structural and fire design methods for the use of lumber, timber, prefabricated wood I-joists, structural composite lumber, wood structural panels and cross-laminated timber, using either Allowable Stress Design (ASD) or Load and Resistance Factor Design (LRFD). The SDPWS addresses materials, design and construction of wood members, fasteners and assemblies used to resist wind and seismic forces. The WFCM includes design and construction provisions for connections, wall systems, floor systems, and roof systems. A range of structural elements is also covered, including sawn lumber, structural glued laminated timber, wood structural sheathing, I-joists, and trusses.

Section 9 of this book, Resources, provides information on how to obtain these standards and other related materials.



Figure 9: NDS, SDPWS and WFCM

2. Type of Construction

Chapter 6 of the IBC defines types of construction, with wood frame construction typically found in Type V, IV and III. Additionally, the IBC has specific applications that permit the use of wood in construction in Type I and II. These circumstances will be addressed in Sections 5 and 6 of this book.

Type V Construction

Type V construction permits the use of wood or other approved materials for structural elements, including structural frame members, bearing walls, floor and roof construction, as well as nonbearing elements such as exterior walls and interior partitions. Type V construction is further defined as Type VA (all interior and exterior load-bearing walls, floors, roofs and all structural members are designed or protected to provide a minimum 1-hour fire-resistance rating) and Type VB (no fire-resistance rating is required).



Figure 10: Type V Construction

Type IV Construction

Type IV construction (Heavy Timber, HT) has exterior walls made of noncombustible materials, fire-retardant-treated wood (FRTW), or cross-laminated timber (CLT) protected in accordance with Section 602.4.2. Interior building elements must be of solid or laminated wood without concealed spaces (for partitions, see below). Columns supporting roof and ceiling loads must be a minimum nominal dimension of 6 inches by 8 inches and 8 inches by 8 inches if supporting floor loads. Floor beams and girders must be a minimum nominal dimension of 6 inches by 10 inches, and roof beams and girders must be a minimum nominal dimension of 4 inches by 6 inches. Flooring must be a minimum nominal 3-inch thickness covered with 1-inch nominal dimension tongue-and-groove flooring or 4-inch-thick cross-laminated timber (CLT). Roof decking must be a minimum nominal 2-inch thickness, 1¹/₈-inch-thick wood structural panels, or 3-inch-thick CLT. Partitions must be 1-hour fire-resistance-rated construction or a minimum two layers of 1-inch nominal board or laminated construction 4 inches thick.



Figure 11: Type IV Construction

Type III Construction

Type III construction requires exterior walls to be noncombustible material or FRTW having a minimum 2-hour fire-resistance rating. All of the other building elements are permitted to be wood or other approved materials. Type IIIA construction needs to provide a minimum 1-hour fire-resistance rating for all building elements other than nonbearing walls, and Type IIIB construction does not require any fire-resistance rating other than the exterior load-bearing wall.



Figure 12: Type III Construction

Type I and II Construction

Type I and II construction requires building elements to be of noncombustible materials. Sections 5 and 6 of this book outline circumstances where wood is permitted in Type I and II buildings.

3. Allowable Heights and Areas for Type V, IV and III Construction

When the first edition (2000) of the IBC was published, wood buildings were allowed to have areas and heights commensurate with the largest buildings permitted for each construction type under at least one of the regional legacy codes. Since then, allowable building sizes have not changed significantly, although the number of buildings that qualify for unlimited area under the special provisions of Section 507 has expanded. In addition, special allowances for various building features, such as sprinklers or the use of fire-retardant-treated wood (FRTW), continue to be added. As a result, size thresholds for wood structures have more often been determined by structural considerations than by code limitations. But this is changing.

The 2015 IBC was the first edition to recognize new mass timber products such as CLT and other advanced engineered wood products. Because of the structural capabilities of mass timber, wood design is better able to take advantage of the generous building sizes permitted by the IBC. Greater building heights, commercial loads, and long clear spans are now more feasible, allowing the full environmental, economic, and aesthetic benefits of designing in wood to be available for more buildings.

Accordingly, ICC appointed an Ad Hoc Committee on Tall Wood Buildings in 2015 to explore the science of mass timber buildings and make appropriate recommendations for the code. The committee's recommendations were approved in the 2018 code change cycle, and therefore the 2021 edition of the IBC will contain new Type IV mass timber construction types with new provisions allowing substantially increased building height and size for Type IV mass timber buildings.

In the 2018 IBC, general building height and area allowances are given in Chapter 5 of the IBC. Limitations are shown in IBC Tables 504.3, 504.4 and 506.2 for height, number of stories, and per story area, respectively. Excerpts of the tables are shown in Figure 14. These values are unmodified by the frontage increase, as explained in this section.



Figure 13: Type I Construction

	Occupancy Classification		Type of Construction					
			Type III		Type IV	Type V		
			A	B	HT	A	B	
TABLE 504.3: Allowable Building Height (Ft above Grade)	A, B, E, F, M, S, U	NS	65	55	65	50	40	
		S	85	75	85	70	60	
	I-1 Condition 1, I-3	NS	65	55	65	50	40	
		S	85	75	85	70	60	
	I-1 Condition 2, I-2	NS	65	55	65	50	40	
		S						
	I-4	NS	65	55	65	50	40	
		S	85	75	85	70	60	
	R	NS	65	55	65	50	40	
		S13R	60	60	60	60	60	
S		85	75	85	70	60		
TABLE 504.4: Allowable Number of Stories above Grade	A-1, A-2, A-3, A-4	NS	3	2	3	2	1	
		S	4	3	4	3	2	
	B	NS	5	3	5	3	2	
		S	6	4	6	4	3	
	E	NS	3	2	3	1	1	
		S	4	3	4	2	2	
	M	NS	4	2	4	3	1	
		S	5	3	5	4	2	
	S-2	NS	4	3	4	4	2	
		S	5	4	5	5	3	
	R-1	NS	4	4	4	3	2	
		S13R				4	3	
		S	5	5	5	4	3	
	R-2	NS	4	4	4	3	2	
		S13R				4	3	
		S	5	5	5	4	3	
	TABLE 506.2: Allowable Area Factor	A-2, A-3	NS	14,000	9,500	15,000	11,500	6,000
			S1	56,000	38,000	60,000	46,000	24,000
SM			42,000	28,500	45,000	34,500	18,000	
B		NS	28,500	19,000	36,000	18,000	9,000	
		S1	114,000	76,000	144,000	72,000	36,000	
		SM	85,500	57,000	108,000	54,000	27,000	
E		NS	23,500	14,500	25,500	18,500	9,500	
		S1	94,000	58,000	102,000	74,000	38,000	
		SM	70,500	43,500	76,500	55,500	28,500	
M		NS	18,500	12,500	20,500	14,000	9,000	
		S1	74,000	50,000	82,000	56,000	36,000	
		SM	55,500	37,500	61,500	42,000	27,000	
S-2		NS	39,000	26,000	38,500	21,000	13,500	
		S1	156,000	104,000	154,000	84,000	54,000	
		SM	117,000	78,000	115,500	63,000	40,500	
R-1, R-2		NS	24,000	16,000	20,500	12,000	7,000	
		S13R						
		S1	96,000	64,000	82,000	48,000	28,000	
	SM	72,000	48,000	61,500	36,000	21,000		

NS - nonsprinklered

S - sprinklered (NFPA 13 System)

S13R - sprinklered NFPA 13R requirements (NFPA 13R System)

S1 - single-story sprinklered building (NFPA 13 System)

SM - multistory sprinklered building (NFPA 13 System)

Figure 14: Table 504.3, 504.4 and 506.2 Excerpts

The maximum height and area of a structure is dependent on the occupancy classification and the presence of an automatic sprinkler system, as tabulated in Tables 504.3, 504.4, and 506.2. Additional increases may be granted depending on the building location on the lot or using some of the design options recognized in Chapter 5. Upper limits for the size of certain occupancies without sprinklers are located in Chapter 9. These increases and limits are discussed in detail in this section.

Allowable Building Area

Equation 5-1 establishes the maximum allowable floor area for a single-occupancy building with no more than one story above grade plane. Equation 5-2 establishes the maximum allowable floor area of a single-occupancy building with more than one story above grade plane, and simply includes the additional factor, S_a , as defined below.

$$A_a = A_t + (NS \times I_f) \quad \text{(Equation 5-1)}$$

$$A_a = [A_t + (NS \times I_f)] \times S_a \quad \text{(Equation 5-2)}$$

where:

A_a = Allowable building area (square feet).

A_t = Tabular allowable area factor (NS, S1, S13R or SM value, as applicable) in accordance with Table 506.2 (square feet).

NS = Tabular allowable area factor in accordance with Table 506.2 for a nonsprinklered building (regardless of whether the building is sprinklered).

I_f = Area factor increase due to frontage (percent) as calculated in accordance with Section 506.3.

S_a = Actual number of building stories above grade plane, not to exceed three. For buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2, use the actual number of building stories above grade plane, not to exceed four.

Allowable Increases for Frontage

Buildings adjacent to open space adjoining a public way with the exterior wall a minimum of 20 feet from the lot line, or the far edge of the public way for more than 25 percent of the building perimeter, may increase the allowable floor area from Table 506.2 using Equations 5-1 and 5-2. The area factor increase based on frontage is calculated using Equation 5-5.

$$I_f = [F / P - 0.25] W / 30 \quad \text{(Equation 5-5)}$$

where:

I_f = Area factor increase due to frontage.

F = Building perimeter that fronts on a public way or open space having 20 feet open minimum width (feet).

P = Perimeter of entire building (feet).

W = Width of public way or open space (feet) in accordance with Section 506.3.2.

A weighted average frontage width (W) is used when W varies along the perimeter. W is the open space width plus the width of the public way, if applicable, and widths greater than 30 feet will only receive credit for a value of 30 feet in accordance with Section 506.3.2. The maximum increase that can be obtained for frontage would occur when 100 percent of the perimeter has frontage of 30 feet or more and would result in a 75-percent floor area increase.

Weighted Average

Section 506.3.2 allows the use of a weighted average to calculate the frontage width around a building. Figure 15 illustrates the use of the weighted average equation.

Note that this equation is only used for open space widths greater than or equal to 20 feet. Open space widths greater than 30 feet are reduced to 30 feet before calculating a weighted average.

$$\text{Weighted average } W = (L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 \dots) / F \quad \text{(Equation 5-4)}$$

where:

L_n = Length of a portion of the exterior perimeter wall (feet).

w_n = Width (≥ 20 feet) of open space associated with that portion of the exterior perimeter wall (feet).

F = Building perimeter that fronts on a public way or open space having a width of 20 feet or more (feet).

Length of Walls:

L_1, L_2, L_3 and $L_4 = 200$ ft

Frontage Width:

$w_1 = 22$ ft $w_3 = 55$ ft

$w_2 = 45$ ft $w_4 = 50$ ft

$F = 200 \times 4 = 800$ ft

For $w_2, w_3,$ and $w_4,$ use the maximum 30-foot width in the weighted average equation.

$$W = \frac{(L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 + L_4 \times w_4)}{F} \quad \text{(Equation 5-4)}$$

$$W = \frac{(200 \times 22 + 200 \times 30 + 200 \times 30 + 200 \times 30)}{800} = 28 \text{ ft}$$

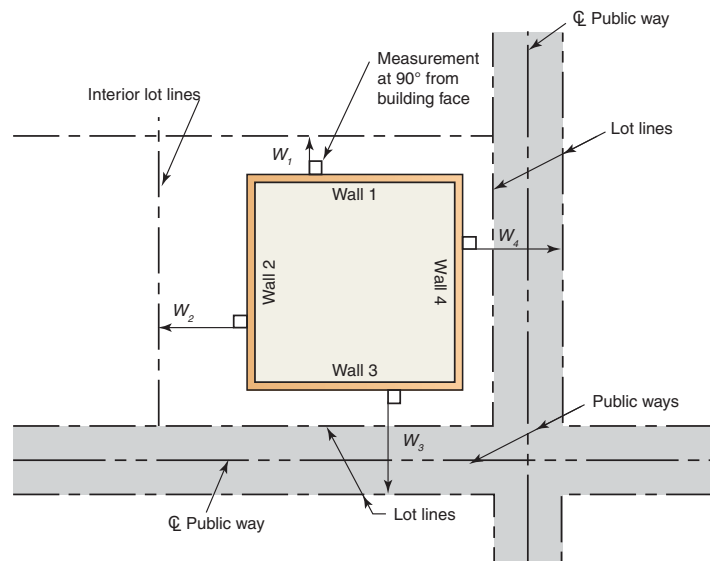


Figure 15: Open Space Width

Frontage Increase Calculation:

The frontage calculation determines the additional allowable increase in area due to open space around the building. Figure 16 illustrates the frontage increase concept for a nonsprinklered two-story restaurant of Type IIIA construction.

Given:

- Two-story restaurant
- Type IIIA construction
- Street width of 22 feet

Determine:

- Maximum allowable building area

Solution:

Length of Walls:

$$L_1 = 120 \text{ ft} \quad L_3 = 120 \text{ ft}$$

$$L_2 = 180 \text{ ft} \quad L_4 = 180 \text{ ft}$$

Frontage Width:

(Note: Public way width is 22 ft)

$$w_1 = 15 \text{ ft} \quad w_3 = 10 + 22 = 32 \text{ ft}$$

$$w_2 = 25 \text{ ft} \quad w_4 = 30 + 22 = 52 \text{ ft}$$

For w_y , the open space width is less than 20 feet; this side of the building

is not included in the frontage calculations. For w_3 and w_4 , use $w = 30$ feet (maximum) in the weighted average in accordance with Section 506.3.2.

Frontage Length:

$$F = L_2 + L_3 + L_4 = 180 + 120 + 180 = 480 \text{ ft}$$

$$W = \frac{(L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 + L_4 \times w_4)}{F} \quad \text{(Equation 5-4)}$$

$$W = \frac{(0 + 180 \times 25 + 120 \times 30 + 180 \times 30)}{480} = 28 \text{ ft}$$

$$A_t = NS = 14,000 \text{ sq ft}$$

$$I_f = (F/P - 0.25) \times W/30 \quad \text{(Equation 5-5)}$$

$$I_f = [(480 / 600) - 0.25] \times 28 / 30 = 0.51$$

$$S_o = 2 \text{ stories}$$

$$A_o = [A_t + (NS \times I_f)] \times S_o \quad \text{(Equation 5-2)}$$

$A_o = [14,000 + (14,000 \times 0.51)] \times 2 = 42,280$ square feet maximum building area; the maximum allowable area per floor is 21,140 square feet.

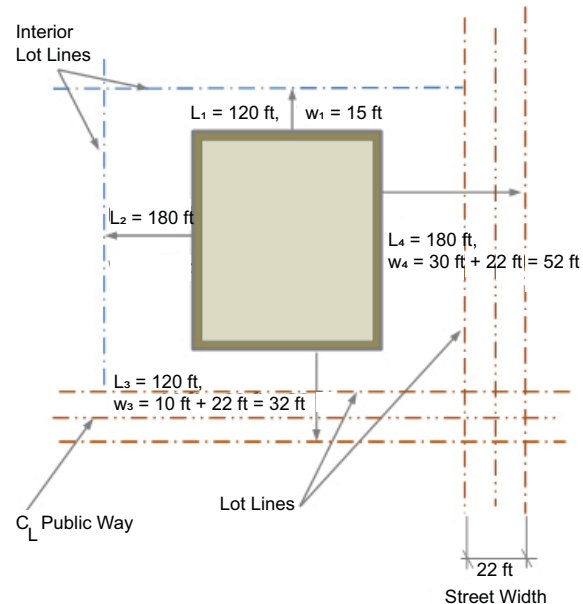


Figure 16: Frontage Increase Calculation

No individual story is permitted to exceed the allowable area as determined by Equation 5-2 using the value of $S_a = 1$. Assuming a smooth rectangular building, both individual story areas (21,600 ft²) as well as the total building area (43,200 ft²) exceed those permitted for a sprinklered building (21,140 ft² and 42,280 ft², respectively). This example assumed a nonsprinklered building, but it is worth noting that a Group A-2 above the level of exit discharge, or having a fire area exceeding 5,000 sq. ft., or having an occupant load of 100 or more, requires sprinklers in accordance with Section 903.2.1.2, as explained in the next section.

The actual areas of the first and second story are larger than the allowed maximum area per story. Possible solutions for this issue include: changing the construction type, subdividing the area with fire walls, moving the building on the lot, providing a sprinkler system, or reducing the building area.

For a building otherwise qualifying as an unlimited area building in accordance with Section 507 that does not have the required 60 feet of fire separation at all perimeter locations but has at least 30 feet of separation all around, the value of $W/30$ can be taken up to 2, in accordance with the exception in Section 506.3.2. The result would be nearly a 150-percent floor area increase. In this case, the value W is not limited to 30 feet, but 60 feet.

Allowable Increases for Automatic Sprinkler Systems

When a building is equipped throughout with an NFPA 13-compliant automatic sprinkler system, the allowable floor area per story is permitted to be increased by 300 percent for a one-story building and 200 percent for a multistory building, as Table 506.2 shows.

In addition to the area increase, Section 504 also permits the building heights to be increased by 20 feet and the number of stories above grade plane to be increased by one story, as shown in Tables 504.3 and 504.4, respectively. This applies to all occupancies addressed in this book, except Group I-2 and Group I-1 Condition 2 occupancies, which are not allowed the increase of a story when an automatic sprinkler system is installed.

For Group R buildings, a similar height increase (but no area increase) is given for the use of NFPA 13R-compliant systems: up to 60 feet and four stories in accordance with Section 504.3.

Figure 17 illustrates the combined effect of frontage and automatic sprinkler systems on the allowable area calculation.

Given: Single-story Type VB grade school

Provided with an NFPA 13-compliant automatic sprinkler system throughout and located on lot as shown.

Determine: Maximum allowable building area

Solution:

$$NS = 9,500$$

Frontage Increase

(Table 506.2)
(Section 506.3)

$$I_f = (F/P - 0.25) \times W/30$$

(Equation 5-5)

$$I_f = [(350 / 700) - 0.25] \times 30 / 30 = 0.25 \text{ (where } W > 30, \text{ use } 30)$$

Note: The weighted average calculation was not needed in this example.

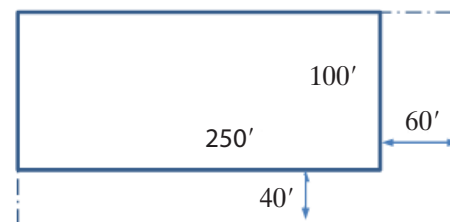


Figure 17: Allowable Building Area Calculation

$A_t = 38,000$ (due to the sprinkler increase)	(Table 506.2)
Total Allowable area	(Section 506.2.1)
$A_a = A_t + (NS \times I_f)$	(Equation 5-1)
$A_a = 38,000 + (9,500 \times 0.25) = 40,375$ square feet maximum allowable building area	
Actual area = $250 \times 100 = 25,000$ square feet	✓ OK

Area Limits for Nonsprinklered Buildings in Chapter 9

Many occupancies have floor area limits allowed by Chapter 5 that are greater than fire areas permitted in Chapter 9 for nonsprinklered buildings. The same thresholds apply to all construction types, not just wood. The allowable area per story can exceed allowable fire areas and a sprinkler system may be required.

If sprinklers are provided, allowable area increases for both sprinklers and open frontage, if applicable, may be taken. Alternatively, fire areas may be kept below sprinkler thresholds by compartmentalizing floor areas with fire-resistance-rated construction in accordance with the definition of “Fire Area” and the requirements of Chapter 7. For several occupancies covered in this book, the requirement for sprinklers can also be triggered by specific use, height above grade or occupant load.

Sprinklers offer a substantial increase to life safety, which is well documented and merits the consideration of designers for that reason alone. But their advantages can also be economic. The code offers considerable trade-offs for providing sprinklers, including:

- Reductions in corridor ratings and corridor opening protection,
- Flexibility in means of egress (travel distance to exits, number and separation of exits, common path of travel),
- Reductions in dwelling unit separations,
- Alternative to emergency escape openings,
- Alternative to certain fire and smoke damper requirements, and
- Interior finish flexibility.

For these reasons, the addition of sprinklers should always be considered in the overall cost analysis for any project.

Maximum Building Area Tables

The tables at the end of this book illustrate the allowable area and height increases permitted for individual occupancies.

- Tables 1, 3, 5, 7, 9, 12 and 17 list nonsprinklered maximum building area per story for each occupancy.
- Tables 2, 4, 6, 8, 11, 13, 16 and 18 list NFPA 13-compliant sprinklered maximum building area per story for each occupancy.
- Tables 10 and 15 list NFPA 13R-compliant sprinklered maximum building area per story for Group I and R occupancies.
- Table 14 lists NFPA 13D-compliant sprinklered maximum building area per story for Group R occupancies.

Total Building Area Limit

Single Occupancy

Ignoring any frontage increases, a single occupancy building with three or more stories above grade has a total building area of the allowable building area per story found in Table 506.2 multiplied by three in accordance with Section 506.2.3. Therefore, buildings with four or more stories of the same floor area will have smaller maximum areas per floor than a three-story building of the same type of construction and occupancy. For two-story buildings, the total building area is the maximum allowable building area per story found in Table 506.2 multiplied by two. The maximum area of any story above grade cannot exceed the allowable area (A_o) as determined by Equation 5-2 using the value of $S_o = 1$. A single basement is not included in the total allowable building area in accordance with Section 506.1.3.

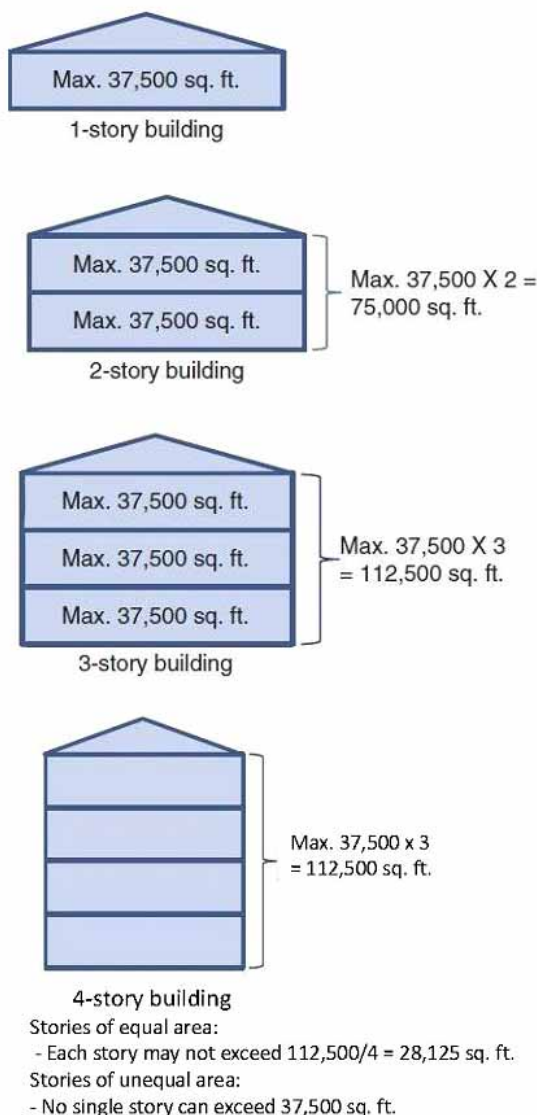


Figure 18: Maximum Building Area

The actual building area for all stories added together must not exceed the total allowable building area.

1-Story Building

Total Allowable Building Area

$$A_o = A_t + (NS \times I_f)$$

2-Story Building

Total Allowable Building Area

$$A_o = [A_t + (NS \times I_f)] \times S_o$$

where $S_o = 2$

3 and 3+ Story Building

Total Allowable Building Area

$$A_o = [A_t + (NS \times I_f)] \times S_o$$

where $S_o = 3$

where:

A_o = allowable building area

A_t = tabular allowable area

S_o = Actual number of building stories above grade plane, not to exceed three

The maximum allowable building area for residential buildings provided throughout with an NFPA 13R-compliant automatic sprinkler system is determined by multiplying the allowable building area per story (A_t), as determined in Table 506.2, by the number of stories above grade plane in accordance with Section 506.2.3 up to four stories in accordance with the scope of the NFPA 13R standard.

Note that use of NFPA 13R means there is no automatic sprinkler area increase as shown in

Table 506.2. A building area increase can only be applied due to the frontage calculations. The building height increase for Group R structures still applies in accordance with Table 504.3.

Mixed Occupancy

Mixed occupancy buildings are permitted a total allowable building area calculated in accordance with Section 508. But a single-story basement does not need to be included in the total allowable building area when the basement does not exceed the area permitted for a single story (see Section 506.1.3).

More than one occupancy in a single building can be accommodated by using the allowable area of the most restrictive occupancy (referred to as “nonseparated occupancies” in accordance with Section 508.3). Alternatively, the occupancies can be regulated as “separated occupancies” (Section 508.4) to allow somewhat larger floor areas. This methodology will often mandate separation of the occupancies by fire barriers or horizontal assemblies, or both, in accordance with Table 508.4. The code also accommodates limited area spaces that are accessory to the function of the main occupancy if the restrictions of Section 508.2 are followed. See Sections 506.2.2 and 506.2.4 for additional limits for single- and multistory mixed occupancy buildings. Note that “incidental uses” (as opposed to accessory uses) are covered in Section 509 of the code and always require separation in accordance with Table 509.

Unlimited Area Buildings

Buildings of certain uses that meet frontage requirements are permitted to be unlimited in area, as explained in the following sections.

One-Story Buildings—Sprinklered

The following unlimited area buildings with a single story above grade plane are permitted if the building is equipped throughout with an NFPA 13-compliant automatic sprinkler system and surrounded on all sides by public ways or yards not less than 60 feet wide. The open frontage can be reduced in some circumstances (Section 507.2.1).

Unlimited area Group B, F, M and S buildings of any construction type are permitted with no special restrictions in Section 507.4.

Unlimited area Group A-4 buildings of Type IIIA, IIIB and IV construction are permitted by Section 507.4. For indoor activities such as tennis, swimming, skating and equestrian venues, the sprinkler system is not required in participant areas if exit doors lead directly outside from participant areas; a fire alarm system with manual fire alarm boxes is installed as required by Section 907; and storage rooms, press boxes, concession booths or other ancillary spaces to the sport activity are provided with sprinklers.

Unlimited area Group E buildings are permitted by Section 507.11 when of Type IIIA or IV construction and each classroom has two means of egress, with one means of egress a direct exit to the outside of the building complying with Section 1022.

Unlimited area Group A-3 buildings of Type III or IV construction, used as a place of religious worship, community hall, dance hall, exhibition hall, gymnasium, lecture hall, indoor swimming pool or tennis court, are permitted by Section 507.7 provided that the building does not have a stage other than a platform, the assembly floor is located within 21 inches of street or grade level and all exits are provided with ramps to the street or grade level.

Group A-1 and A-2 occupancies of Type III or IV construction are permitted by Section 507.4.1 in mixed occupancy buildings containing Group B, F, M or S occupancies of unlimited area pro-

vided that the occupancies are separated as required in Section 508.4.4 with no reduction allowed in the fire-resistance rating of the separation based on the installation of an automatic sprinkler system, each A-1 or A-2 portion of the building does not exceed the maximum allowable area for such occupancy in accordance with Section 503.1, and all exit doors from Group A-1 and A-2 occupancies must discharge directly to the exterior of the building.

One-Story Buildings—Nonsprinklered

Nonsprinklered unlimited area Group F-2 or S-2 buildings, of any construction type, with a single story are permitted by Section 507.3 provided they are surrounded on all sides by public ways or yards not less than 60 feet wide.

Two-Story Buildings—Sprinklered

Unlimited area Group B, F, M or S buildings up to two stories above grade plane of any construction type are permitted by Section 507.5 provided they are equipped throughout with an NFPA 13-compliant automatic sprinkler system and are surrounded on all sides by public ways or yards not less than 60 feet wide.

Section 507.2.1 allows up to 75 percent of the perimeter open space to be less than 60 feet in width for unlimited area one- and two-story Group B, F, M and S buildings. There must be at least 40 feet provided and the exterior wall and all openings on those portions require 3-hour minimum fire-resistance and fire protection ratings.

Allowable Increases with Fire Walls

A fire wall is a fire-resistance-rated wall with protected openings that restricts the spread of fire and extends continuously from the foundation to or through the roof and has sufficient structural stability under fire conditions to allow the collapse of construction on either side without collapse of the fire wall. Fire walls built in compliance with Section 706 create separate buildings for the purpose of area limitations and other code-required features. Fire walls separating Group A, B, E, I, R-1 and R-2 occupancies require a 3-hour minimum fire-resistance rating that can be reduced to a 2-hour minimum for Type V construction. Fire walls separating Group F-1, S-1 and M occupancies require a 3-hour minimum fire-resistance rating with no reduction allowance while Group F-2, S-2, R-3 and R-4 occupancies require only a 2-hour minimum fire-resistance rating. Each portion of a building separated by a fire wall is evaluated individually for allowable heights and areas based on the type of construction.

Fire walls in Type V construction may be wood frame; in other construction types they must be of noncombustible materials in accordance with Section 706.3.

Special Provisions for Stacked Buildings

Under specific circumstances, buildings of different types of construction are allowed to be built on top of each other and are commonly referred to as stacked or pedestal buildings. They are only permitted when following the provisions of Section 510. Section 510.2 requires a 3-hour minimum fire-resistance-rated horizontal assembly between the lower and upper buildings including any vertical offsets which are a part of the horizontal assembly and structure supporting such offsets. The lower building must be Type IA construction and sprinklered in accordance with NFPA 13. The upper building's type of construction and building height in stories are determined as if it did not have a building below, thus permitting all types of construction above the

Type IA pedestal. The total height in feet, however, is still limited and measured from grade plane in accordance with Section 510.2, Item 6. Group B, M, R and S occupancies (including Group S-2 open and enclosed parking garages) are permitted in the upper building, subject to the building height and area limitations discussed previously. Multiple Group A occupancies, each with an occupant load of less than 300, are also permitted. The lower building is permitted to be any occupancy except Group H.

Type IIIA construction in Groups R-1 and R-2 may be increased above the general limitations of Sections 503 and 504 to six stories and 75 feet where the first floor assembly has a fire-resistance rating of not less than 3 hours and the floor area is subdivided by 2-hour fire-resistance-rated fire walls into areas of not more than 3,000 square feet as provided by Section 510.5.

For Group R occupancies, the number of stories of a building with a single-story Group S-2 parking garage of Type I construction or open parking garage of Type IV construction, with grade entrance, are permitted by Section 510.4 to be measured from the floor above such a parking area. The floor assembly between the parking garage and the Group R above must be the type of construction required for the parking garage, must provide a fire-resistance rating in accordance with Table 508.4 and must comply with the requirements for horizontal assemblies in accordance with Section 711.

Section 510.7 contains another alternative with conditions independent of Section 510.2. The upper building height and area are limited as previously discussed and the open parking garage is regulated in Section 406.5 and is permitted to be Type IV construction. The height of the upper building is measured from the grade plane and includes the open parking garage level. See the other conditions listed in Section 510.7 regarding separate means of egress and other protected features if this alternative is used.

Lastly, Group S-2 open parking garages above a Group B or M occupancy are allowed in accordance with Section 510.8.

Multiple upper buildings may be positioned on a single parking structure complying with Sections 510.2, 510.3 or 510.8 and be treated as separate buildings in accordance with Section 510.9.

See the special provisions for the protection of attics in wood frame special occupancy stacked buildings in Section 903.3.1.2.3. Section 903.3.1.2.3 has specific application to construction designed in accordance with Sections 510.2 and 510.4, based on the height of the roof above the lowest level of required fire department vehicle access.

4. Establishing Fire Resistance

Table 601 establishes the required fire resistance of building elements (primarily the structural frame, walls, floors and roofs) due to the construction type of the building (e.g., Type IIIA, Type IIIB, Type IV, etc.). Required ratings are given in hours. The exception is Type IV, where the wood structural elements are assumed to have inherent fire resistance due to their required minimum dimensions (no fire-resistance rating is required except for exterior walls).



Figure 19: Pedestal Building

Fire resistance describes the rate at which a building material degrades due to a fire. Resistance is based on how fast a material will burn, how rapidly the strength of the member or assembly is affected by the fire and whether the member or assembly can maintain its design strength. Fire resistance of wood members and assemblies may be established by testing in accordance with Section 703.2 or by any one of six means listed in Section 703.3. The most common methods are indicated below.

Tested Assemblies

Tested assemblies include wood assemblies that have been tested to the ASTM E119 or UL 263 standard. Using one of these standards, an assembly is typically assigned a 1- or 2-hour fire rating depending on its performance in the fire test(s). Designers choose listed assemblies from various fire-resistance publications or directories, such as the UL *Fire Resistance Directory* or the Gypsum Association *Fire Resistance Design Manual*

Prescriptive Assemblies

The fire resistance of certain wood assemblies is prescribed in Section 721 based on testing using ASTM E119 or UL 263. Section 703.3 permits the use of other sources, as well. Often used is the AWC publication AWC DCA 3, *Fire-Rated Wood Floor and Wall Assemblies*, which is available for free to download at

www.awc.org/codes-standards/publications/dca3.

Calculated Fire Resistance

The fire resistance of exposed wood members may be calculated using the provisions of Chapter 16 of the *National Design Specification*® (NDS®) (see Section 722.1).

AWC's Technical Report No. 10 (TR10), *Calculating the Fire Resistance of Exposed Wood Members*, contains full details of the NDS method as well as design examples, and it is available for free to download at

www.awc.org/codes-standards/publications/tr10.

The fire resistance of wood frame assemblies also may be calculated using the provisions of Section 722.6, which is based on the known fire resistance of many tested assemblies. This method is limited to fire-resistance ratings of no more than 1-hour. The information in AWC DCA 4, *Component Additive Method (CAM) for Calculating and Demonstrating Assembly Fire Endurance*, was the basis for these code provisions. It is available for free to download at

www.awc.org/codes-standards/publications/dca4.

5. Wood Use in “Noncombustible” Construction

Type I and II construction typically require the use of noncombustible materials. Section 603 specifies 26 applications where combustible materials are permitted without reclassifying the building to a different type of construction. For example, fire-retardant-treated wood walls and roof construction are permitted under certain conditions. Wood blocking is permitted for handrails, millwork, cabinets and window and door frames. Furring or nailing strips used in connection with “set-out” construction are also permitted. Show windows, wooden bulkheads below

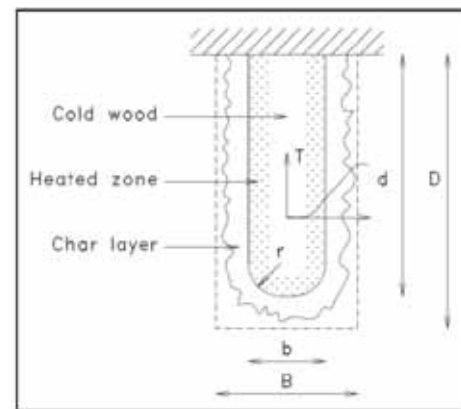


Figure 20: Heavy Timber Member Exposed to Fire

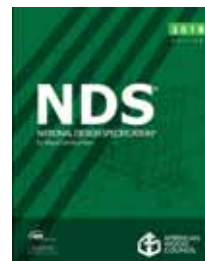


Figure 21: NDS

the window and nailing and furring strips are also permitted to be wood if the window is not more than 15 feet above grade.

Fire-Retardant-Treated Wood

There are many applications for fire-retardant-treated wood (FRTW) in Type I and II construction. FRTW is permitted in nonbearing partitions where the fire-resistance rating does not exceed 2 hours, and it may be used in nonbearing exterior walls that do not require a fire-resistance rating. Roof construction, including structural framework, permits FRTW, except for Type IA construction of three stories or more where the lowest roof member is less than 20 feet measured vertically from the upper floor.

As mentioned above, FRTW may also be used in exterior walls of Type III and IV construction, which are required to be noncombustible by definition. Because of this, certain code provisions that assume noncombustible exterior walls have become difficult to interpret. But usually a practical solution to these code questions can be achieved by working closely with the code official. For instance, the addition of solid FRTW wood blocking of a certain thickness in floor cavities that intersect with the exterior wall in Type III construction is an appropriate precaution to maintain the fire resistance and material integrity of the exterior wall.

Heavy Timber Members

Heavy timber (HT) construction is permitted in roof construction as an alternative to 1-hour or less fire-resistance-rated noncombustible construction. This would allow HT use in all roof construction except Type IA. HT columns and arches are permitted on the exterior of walls if the fire separation distance is 20 feet or more.



Figure 22: Heavy Timber Construction

6. Wood Features

Wood may be used as an architectural or structural component of a building. It is renewable and biodegradable, using less energy to manufacture than steel, concrete, aluminum or plastic. Wood use in foundations, doors, windows, exterior and interior finishes, trim and roofing contributes to the aesthetics of the building in an economical and efficient manner.

Wood Foundations

Wood foundations for buildings are permitted when designed and installed in accordance with the AF&PA/AWC *Permanent Wood Foundation Design Specification* (PWF). Insulated wood foundation systems conserve energy and easily accommodate installation of wiring, plumbing, ductwork and interior finishes. Savings in labor, time and material costs may be achieved when such systems are used.



Figure 23: PWF

Wood Walls and Partitions

Wood stud framing is permitted for all load-bearing and nonload-bearing interior walls and partitions in Type III and V construction. Type IV construction permits wood stud-framed partitions of 1-hour fire-resistance-rated construction (Section 2304.11.2.2) or solid wood formed by at least two layers of 1-inch matched boards or 4-inch-thick laminated construction. In Type I and II construction, partitions dividing single tenant offices or retail and not creating corridors serv-

ing 30 or more occupants are permitted to be FRTW, 1-hour fire-resistance-rated construction or of wood panels or similar light construction up to 6 feet in height (Section 603.1, Item 11).

Wood Interior Finish

In general, wood materials may be used as interior finish in almost all occupancies. Table 803.13 places minimum performance classifications on finish materials based on their location in the building. The material performance classification is determined by testing in accordance with the ASTM E84 or UL 723 standard and results in a classification as Class A (flame spread index 0–25); Class B (26–75) or Class C (76–200). All classifications must have a smoke-developed index between 0–450 (Section 803.1.2).



Figure 24: Wood Interior Finish
(Photo Courtesy of Barbara J Sales)

Nonsprinklered buildings typically require more restricted flame spread materials than sprinklered buildings. Figure 25 contains two tables outlining the required interior finish minimum classification for exit enclosures and passageways, corridors and enclosed spaces and rooms.

Nonsprinklered Buildings: Minimum Interior Finish Classification by Occupancy ^a			
Location	Minimum Interior Finish Classification		
	A ^b	B	C
Interior exit stairways and ramps and exit passageways ^c	A, B, E, I, M, R-1, R-4	F, S, R-2	R-3
Corridors and enclosures for exit access stairways and ramps	A ^d , I-2, I-3, I-4	B, E, M, S, I-1, R-1, R-2, R-4	F, R-3
Enclosed spaces and rooms		I, A-1 ^e , A-2 ^e , R-4	A-3, A-4, A-5, B, E, F, M, S, R-1, R-2, R-3

- This simplified table is not comprehensive; more exceptions can be found in Table 803.13 footnotes.
- Except in Group I-3, buildings less than three stories above grade plane permit the reduction of the exit enclosure and exit passageway classifications to Class B.
- Exit enclosures and exit passageways are permitted to use Class C wainscoting or paneling in the grade lobby for not more than 1,000 square feet of applied surface when applied to a noncombustible base.
- Lobby areas in corridors may use Class B interior finishes for Group A occupancies.
- Places of assembly with an occupant load of 300 persons or less may use Class C interior finishes

Sprinklered Buildings: Minimum Interior Finish Classification by Occupancy ^{a, b}			
Location	Minimum Interior Finish Classification		
	A	B ^c	C
Interior exit stairways and ramps and exit passageways ^d	I-3	A, B, E, M, R-1, R-4, I-1, I-2, I-4	F, R-2, R-3, S
Corridors and enclosures for exit access stairways and ramps	I-3	A, I-2, I-4	B, E, F, M, R, S, I-1
Enclosed spaces and rooms		I-2, I-4	A, B, E, F, M, R, S, I-1, I-3

- This simplified table is not comprehensive; more exceptions can be found in Table 803.13 footnotes.
- Automatic sprinkler system meeting the requirements of NFPA 13 or NFPA 13R as appropriate.
- Except in Group I-3, buildings less than three stories above grade plane permit the reduction of the exit enclosure and exit passageway classifications to Class C.
- Exit enclosures and exit passageways are permitted to use Class C wainscoting or paneling in the grade lobby for not more than 1,000 square feet of applied surface when applied to a noncombustible base.

Figure 25: Summary of Table 803.13 Interior Wall and Ceiling Finish Requirements by Occupancy

Most wood species qualify as Class C, while some, such as cedar, west coast hemlock, Idaho white pine, redwood, and spruce, can qualify as Class B. Wood boards and panels may meet Class A criteria when pressure treated with a fire-retardant chemical. Flame spread information according to wood species is provided in AWC DCA 1, *Flame Spread Performance of Wood Products*, which is available for free to download at www.awc.org/codes-standards/publications/dca1.

Traditional wood floor covering is exempt from interior floor finish requirements (Section 804.1). Exposed portions of Type IV structural members are also exempt from the interior finish requirements (Sections 803.3).

Wood Interior Trim

Baseboards, chair rails, picture molding, handrails, guards, windows and doors are permitted to be wood or wood-based materials. Trim is required to meet a Class C classification and combustible trim, excluding handrails and guards, cannot exceed 10 percent of the wall or ceiling area to which it is attached (Section 806.7).



Figure 26: Wood Trim

Wood Doors and Windows

Wood doors and windows are often the optimum choice for buildings due to their aesthetics, energy efficiency and functionality. Exterior openings are generally required to be protected as an opening protective assembly when the exterior wall is within given distances of a lot line. Table 602 determines when the exterior walls are required to be fire-resistance rated due to their location on the lot, and Table 705.8 defines the allowable percentages of protected and unprotected openings allowed in those walls.



Figure 27: Wood Windows

Unlimited amounts of unprotected openings are permitted by Table 705.8, provided the exterior walls are 30 feet or more from the lot line, or 20 feet or more if the building is equipped throughout with an automatic sprinkler system. No unprotected openings are permitted in the exterior wall within 5 feet of the lot line for nonsprinklered buildings or in any building if the wall is closer than 3 feet from the lot line.

Bay and oriel windows must conform to the type of construction required for the building; however, FRTW is permitted for these windows in buildings not more than three stories above grade plane and of Type I, II, III and IV construction (Section 705.2.4).

Interior wood door assemblies are required to be fire-protection rated when the wall assembly they are in requires a fire-resistance rating and opening protection, such as door assemblies in exit enclosures or exit access corridor walls. The minimum required fire-protection rating of the fire door assembly is given in Table 716.1(2) and ranges from 20 minutes to 3 hours based on the required fire-resistance rating and type of wall assembly.

Wood Siding

Wood siding products come in a variety of sizes, shapes and textures, ranging from wood shingles and shakes to boards and wood structural panels. Each material brings different characteristics in look and performance. The IBC addresses the minimum expectations of these products in Chapter 14 as exterior wall components and Chapter 23 as a wood building material.

Wood shingles as a weather covering are required to be a minimum $\frac{3}{8}$ -inch thick and wood siding without sheathing is required to be $\frac{1}{2}$ -inch thick. According to Table 1404.2, wood siding less than $\frac{1}{2}$ -inch thick requires bracing for support in accordance with Section 2304.6.



Figure 28: Wood Siding

Wood Veneer

Wood veneer is permitted on buildings of Type I, II, III or IV construction and allowed up to 40 feet above grade, 60 feet if FRTW is used provided the veneer is 1-inch nominal thickness, $\frac{7}{16}$ -inch exterior hardboard siding or $\frac{3}{8}$ -inch exterior-type wood structural panels or particleboard. Open or spaced veneers without concealed spaces are not permitted to project more than 24 inches from the building wall (Section 1405.5).



Figure 29: Wood Veneer
(Photo Courtesy of Jeremy Bittermann)

Wood Balconies, Open Exterior Exit Stairs and Ramps

Exterior balconies may be of Type IV construction or of wood construction that provides a fire-resistance rating equal to the floor rating required by Table 601. The aggregate length of the balcony is limited to 50 percent of the building perimeter on each floor. Type I or II structures not more than three stories above grade plane are permitted to have FRTW in the balcony as long as the balcony is not a required exit. Type III, IV and V buildings may have Type V construction of the balcony without requiring a fire-resistance rating if the balcony is sprinkler protected. Where sprinkler protection is extended to the balcony, the length limitation of the balcony is eliminated (Section 705.2.3.1).



Figure 30: Wood Balcony

Open exterior exit stairs and ramps may be constructed of wood when the building is of Type IV and V construction (Sections 1011.7 and 1012.7). The IBC limits their use to buildings that do not exceed six stories above grade and do not have occupied floor levels located more than 75 feet above the lowest level of vehicular access by the fire department (Section 1027.2).

Wood Roof Coverings

Roof assemblies and coverings are divided into classifications in accordance with testing by the ASTM E108 or UL 790 standard. FRTW roof coverings are tested in accordance with the ASTM D2898 standard. Table 1505.1 requires a minimum Class B roof covering for all types of construction except Type IIB, IIIB and VB. These construction types are permitted a minimum of Class C materials, and if the buildings are not more than two stories above grade plane and have no more than 6,000 square feet of roof area and 10-foot minimum frontage width on all sides of the roof, they are permitted to use No. 1 cedar or redwood shakes and No. 1 shingles (Table 1505.1).



Figure 31: Wood Shakes

Fire-retardant-treated wood shingles and shakes can qualify for Class A, B or C classification. Wood shingles and wood shake installation requirements are located in Sections 1507.8 and 1507.9, respectively, with a comparison of the materials in Table 1507.8.

Wood Projection Limitations

Regardless of the material used or the construction type, Section 705.2 places limits on the proximity of projections to the line used to calculate fire separation distance (typically the lot line). According to Table 705.2, in no case may a projection come within 24 inches of a lot line. When the fire separation distance from the exterior wall is 5 feet or greater, projections cannot come within 40 inches of the lot line; when the fire separation distance is 2 feet or less, projections are prohibited altogether.

In Type III, IV, and V construction, projections of any material are permitted subject to the limitation of Section 705.2.3. That section says that combustible projections located within 5 feet of the lot line (or other line used to determine the fire separation distance) must be one of the following:

- Minimum 1-hour fire-resistance-rated construction;
- Type IV construction; or
- FRTW.

Note that the exception in Section 705.2.3 allows projections in Group R-3 and U occupancies to be of typical Type VB construction (protection in the form of rated construction, Type IV construction, or FRTW is not required) when the fire separation distance is greater than or equal to 5 feet.

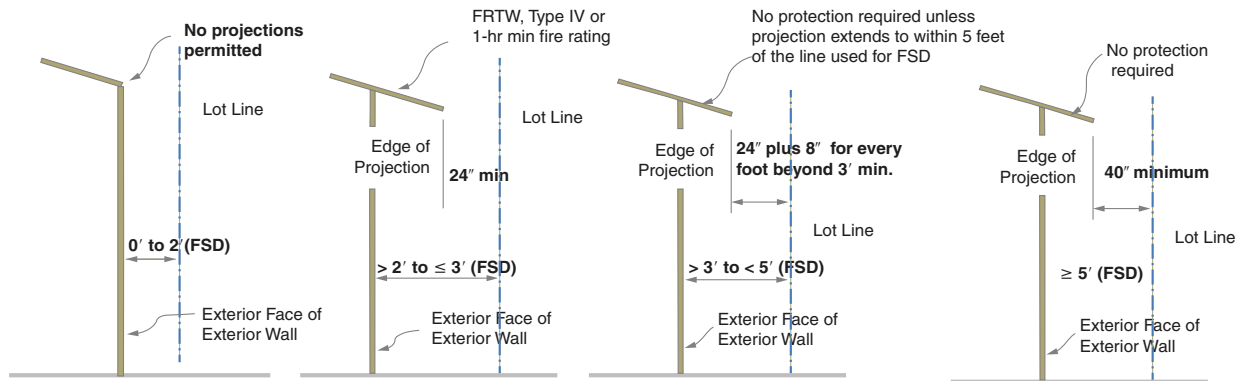


Figure 32: Wood Projection Limitations for Other Than Groups R-3 and U

Wood Rooftop Structures

Wood penthouses are limited by the construction classification permitted for the building and for purposes of height and area are considered a portion of the story below the penthouse as long as they comply with Section 1510. FRTW is permitted for use on buildings of Type I construction two stories or less above grade plane and in Type II construction when the exterior of the penthouse is 5 feet or more from lot lines in accordance with Section 1510.2.4. A 1-hour fire-resistance rating is required when the exterior wall of the penthouse is less than 20 feet from the lot line.

Type III, IV and VA construction permit the penthouse to be Type IV construction or FRTW if 20 feet or more from the lot line.

Wood penthouses used to enclose tanks or elevators must not exceed 28 feet in height above the roof. If enclosing other uses, the penthouse height is limited to 18 feet maximum (Section 1510.2.1).

Wood unroofed mechanical equipment screens, fences or enclosures limited to 4 feet in height are permitted (Section 1510.6.2).

Wood towers, spires, domes and cupolas are permitted on buildings of Type III, IV and V provided that they do not exceed 85 feet in height above grade plane or 200 square feet in area. The IBC places further limitations on these structures in Section 1510.5.

Wood in Locations Subject to Decay or Termites

Wood that is located where it will be exposed to weather, moisture or termites is required to be naturally durable wood species or preservative-treated wood using water-borne preservatives, in accordance with AWPA U1. Naturally durable decay-resistant wood species are heartwoods of redwood, cedar, black locust and black walnut. Naturally durable termite-resistant wood species are heartwood of redwood, Alaska yellow-cedar, eastern red cedar and heartwood and sapwood of all western red cedars (Sections 202 and 2304.12).

7. Structural Considerations

The primary focus of Chapter 23 of the IBC is structural considerations for the design of buildings and structures that use wood and wood-based products in their framing and fabrication. Covered are the materials, design, construction and quality of wood members and their fasteners. Alternative methods and materials can be used where engineering analysis and testing justify their use; however, the general requirements of Section 2304 apply to all elements of wood frame construction.

Compliance Paths

The IBC permits five paths to design wood structural elements, and compliance with one or more is required (Section 2301.2):

- Allowable Stress Design (ASD)
- Load and Resistance Factor Design (LRFD)
- Conventional Light-Frame Construction
- AWC Wood Frame Construction Manual (WFCM)
- ICC 400 for Log Structures



Figure 33: WFCM

The first two methods are engineered design. Allowable stress design (ASD) prescribes the use of load combinations specified in Chapter 16 as well as the general requirements in Section 2304, the lateral force-resistant requirements in Section 2305, and the ASD requirements of Section 2306. Load and resistance factor design (LRFD), permitted by Section 2307, also requires the use of the load combinations in Chapter 16, the general requirements in Section 2304, and the lateral force-resistant requirements in Section 2305.

The descriptive and prescriptive provisions of the conventional light-frame construction in Section 2308 use typical configurations and methods that do not require calculation of loads or analysis by a design professional. The use of these provisions is limited to buildings of relatively small volume that do not incorporate unusual configurations, elements, or loading.

The AWC *Wood Frame Construction Manual for One- and Two-Family Dwellings* (AWC WFCM) and ICC 400, *Standard on the Design and Construction of Log Structures*, are also permitted as design and construction alternatives for buildings within their scopes.

Standards and Quality

Section 2303 references manufacturing standards, necessary specification criteria and use and application provisions for wood and wood products. The materials that have production and quality control standards include structural sawn lumber; end-jointed lumber; prefabricated wood I-joists; structural glued-laminated timber (defined in IBC Chapter 2); structural glued cross-laminated timber (defined in IBC Chapter 2); wood structural panels (defined in IBC Chapter 2); fiberboard sheathing (when used structurally); hardboard siding (when used structurally); particleboard; preservative-treated and fire-retardant-treated wood (defined in IBC Chapter 2 under “Treated wood”); structural log members; structural composite lumber; round timber poles and piles; engineered wood rim board (defined in IBC Chapter 2); wood trusses; joist hangers; nails; and staples.

All lumber used to support loads in a building or structure is required to be properly identified with a grade mark of a lumber inspection agency complying with DOC PS 20, the American Softwood Lumber Standard (see www.alsc.org for a list of grading agencies and representative grade stamps). A certificate of inspection is an acceptable alternative to a grade mark for precut,

remanufactured or rough-sawn lumber and for sizes larger than 3-inch nominal thickness, since industry practice does not individually label such products.

Engineered wood products, preservative-treated wood, and fire-retardant-treated wood are required to meet industry standards specific to their use, as codified within this section.

Framing

The general requirements of Section 2304 govern framing, sheathing, decking and fasteners. It is worth noting that conventional light-frame construction does not require computations to determine the size of members or fasteners; however, ASD and LRFD designs assume actual member sizes rather than nominal sizes. Under the majority of circumstances, the detail and specifications for framing walls, roofs, and floors in accordance with Section 2308 provide the necessary resistance to typical loading conditions. Section 2304.3 specifies that bottom plates are required to have a minimum thickness of a nominal 2-by framing member with a width at least equal to the stud it is supporting in order to ensure loads are fully transferred.

Structural Panels and Sheathing

Wood structural panels are defined in Chapter 2 as being plywood, oriented strand board (OSB), and composite panels. Exterior sheathing is required to be manufactured with exterior glue (Exposure 1 or Exterior) and, when exposed to the weather, to have an exterior exposure durability classification. In enclosed buildings with a mean roof height not greater than 30 feet, wood structural panel sheathing, connections, and framing spacing must meet the wind design requirements of Table 2304.6.1. Tables 2304.8(1) through (5) specify maximum allowable spans, minimum grade requirements, and maximum loads for floor and roof sheathing.

Lumber Decking

Section 2304.9 provides installation and fastening requirements for lumber decking, which is a method of floor construction that employs individual wood members set on edge and connected. Each piece of lumber is required to be square-end trimmed and supported in one of five layup patterns: simple span, two-span continuous, combination simple and two-span continuous, cantilevered pieces intermixed, or controlled random (Section 2304.9.2). Section 2304.9.3 prescribes nailing requirements for mechanically laminated decking to ensure a solid wood floor acting as one element.



Figure 34: Beam-Column Connection

Connectors and Fasteners

Fastening requirements are prescribed in Table 2304.10.1, which provides the minimum number and size of fasteners connecting wood members. Additionally, the ASD and LRFD methods contain design provisions for fasteners, based on design calculations, which must be met in accordance with Section 2304.10. It is therefore common for designed structures to have greater fastening requirements than those prescribed in Table 2304.10.1. Where wall framing members are not continuous from the foundation sill to the roof, sheet metal clamps, ties or clips must also be corrosion resistant (often galvanized steel) if they are subject to moisture. Joist and framing anchors may be used in accordance with the manufacturer's instructions, and other fasteners

such as clips, staples, and glues are permitted when approved by the building official. Such approval should be based on evidence of testing by the manufacturer and installation in accordance with the manufacturer's specifications.

Fasteners in contact with preservative-treated and fire-retardant-treated wood are required to be corrosion resistant (often of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper in accordance with Section 2304.10.5) because chemicals used in the treatments quickly erode untreated steel fasteners.

Lateral Force-Resisting Systems

The general design requirements for lateral force-resisting systems in Section 2305 are applicable to engineered structures (ASD and LRFD). This section applies to structures using wood-framed shear walls or wood-framed diaphragms to resist wind, seismic, or other lateral loads. When individual elements within conventionally constructed structures need to be engineered, these provisions may be able to be applied without engineering the entire structure.

Deflection of wood diaphragms and shear walls fastened with nails is determined in accordance with *AWC Special Design Provisions for Wind and Seismic* (AWC SDPWS). For wood structural diaphragms and shear walls fastened with staples, where the assemblies are uniformly fastened throughout, the IBC permits the calculation of estimates through the use of the equations found in Sections 2305.2 and 2305.3.



Figure 35: SDPWS

Engineered Design—Allowable Stress and Load and Resistance Factor

Sections 2306 and 2307 contain a number of specifications that are intended to be the minimum acceptable methods for constructing wood elements in structures. When designed and built in accordance with the standards listed in these sections, a building or structure is deemed to comply with the code. The most common and applicable practices for ASD are summarized in the standards listed in Section 2306.1, and Section 2307.1 refers the code user to *AWC National Design Specification*® (NDS®) for Wood Construction and AWC SDPWS for alternate design provisions using LRFD.

Conventional Light Frame

The provisions of Section 2308 are prescriptive in nature and can be used to construct certain wood structures in limited application—generally building construction having closely spaced framing (not exceeding 24 inches on center) with studs up to 2 x 6 inches in size and rafters up to 2 x 12 inches in size. Section 2308.2 and its subsections spell out the limitations for the use of conventional construction provisions without design. These include height limits ranging from one story in Seismic Design Categories D and E to three stories in Categories A and B; a maximum floor-to-floor height of 11 feet, 7 inches in all seismic zones; exterior bearing walls and interior bracing walls limited to a stud height of 10 feet; live loads not exceeding 40 psf; ultimate wind speeds (V_{ult}) not exceeding 130 mph; and others (see Section 2308.2 for the full list).

Span Tables

Span tables are provided for girders, floor joists, ceiling joists, and rafters in Tables 2308.4.1.1(1)–(2), 2308.4.2.1(1)–(2), 2308.7.1(1)–(2), and 2308.7.2(1)–(6), respectively. These spans have been updated to reflect the recently revised Southern Pine design values. Spans of only the most common species and grades of wood are shown, and the tables in the *AWC Span Tables for Joists and Rafters* (STJR) should be consulted to determine spans for species and grades not shown. See Section 2308.7.7 for how the use of purlins and struts allows the reduction of rafter spans. An excerpt of Table 2308.4.2.1(1) is shown in Figure 37.



Figure 36: STJR

Joist Spacing (inches)	Species and Grade		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
16	Douglas Fir-Larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-0
	Douglas Fir-Larch	#1	10-11	14-5	18-5	21-4	10-8	13-6	16-5	19-1
	Douglas Fir-Larch	#2	10-9	14-1	17-2	19-11	9-11	12-7	15-5	17-10
	Douglas Fir-Larch	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Hem-Fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-Fir	#1	10-6	13-10	17-8	20-9	10-4	13-1	16-0	18-7
	Hem-Fir	#2	10-0	13-2	16-10	19-8	9-10	12-5	15-2	17-7
	Hem-Fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Southern Pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern Pine	#1	10-9	14-2	18-0	21-4	10-9	13-9	16-1	19-1
	Southern Pine	#2	10-3	13-3	15-8	18-6	9-4	11-10	14-0	16-6
	Southern Pine	#3	7-11	10-10	12-1	14-4	7-1	8-11	10-10	12-10
	Spruce-Pine-Fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-4
	Spruce-Pine-Fir	#1	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-Pine-Fir	#2	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-Pine-Fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6

Figure 37: Excerpt of Table 2308.4.2.1(1) Floor Joist Spans for Common Lumber Species (Residential sleeping areas, live load = 30 psf, L/Δ = 360)

See Sections 2308.4 and 2308.7 for prescriptive framing details for floors and roofs, including required bearing, lateral support, notches and holes, and framing around openings.

Wind Uplift

Section 2308.7.5 requires compliance with both Table 2304.10.1, which is the fastening schedule, and Table 2308.7.5, which specifies the minimum uplift resistance to be provided between the roof framing and wall below in conventional construction. For allowable stress design wind speeds (V_{asd}) of less than 85 mph ties are not required. When ties are required by the table, a tie is required on every rafter or truss to the stud below, assuming the roof framing is spaced 24 inches on center, in accordance with Table 2308.7.5, Footnote b.

Wall Framing

The size, height and spacing of studs are required to be in accordance with Table 2308.5.1. When stud heights exceed 10 feet or the structure is outside the scope of applicability of the conventional construction requirements, studs must be designed in accordance with accepted engineering practice. Studs in nonload-bearing walls and partitions are permitted to be spaced at 24 inches on center.

Section 2308.5 and subsections contain prescriptive framing provisions for walls. Generally, bearing and exterior wall studs are required to be capped with overlapping double top plates, which serves three major functions: the overlapping plates tie the building together, the top plates serve as support beams for joists and rafters, and they serve as chords for floor and roof diaphragms. The single bottom plate serves to anchor the wall to the floor and must have a nominal thickness of not less than 2 inches and a width not less than the width of the wall studs. Openings in exterior bearing walls require headers made of double 2-inch nominal framing lumber.

Wall Bracing

Braced wall panels are portions of walls, as required by Table 2308.6.1, composed of bracing materials and methods specified in Table 2308.6.3(1). Section 2308.6.4 stipulates the minimum panel dimensions for certain bracing methods. A provision exists allowing a minimum 32-inch wall bracing length in lieu of the 48-inch length required elsewhere, or a minimum 16-inch panel length built as a portal, to allow flexibility in constructing braced wall panels adjacent to garage doors and other similar openings (Section 2308.6.5). Cripple walls with studs exceeding 14 inches in height must meet the bracing requirements (Section 2308.6.6).



Figure 38: Wall Bracing

8. Precautions during Construction

Chapter 33 provides minimum safety precautions for fire during construction for all buildings. The chapter includes provisions for fire extinguishers, standpipes, means of egress and sprinkler system commissioning. The *International Fire Code*® (IFC®) also contains detailed requirements for fire precautions during construction that are required to be implemented by Section 3302.3 of the IBC.

Fire Watch

Section 3314 requires a fire watch to be provided during nonworking hours when construction exceeds 40 feet in height above the lowest adjacent grade, where required by the fire code official. The IFC contains additional fire watch provisions (see below).

Fire Extinguishers

During construction one portable fire extinguisher must be placed at each stairway on all floor levels with combustible materials, in each storage or construction shed, and where special hazards exist in accordance with Section 3309.

Maintaining Means of Egress

During construction, when a building height reaches 40 feet above the lowest level of fire department vehicle access, a minimum of one temporary or permanent stairway must be provided. As construction progresses, such stairway shall be extended to within one floor of the highest point of construction having secured decking or flooring in accordance with Section 3310.

Standpipes

In buildings required to have standpipes, a minimum of one must be available during construction for fire department use. The standpipe is installed before the construction is 40 feet above fire department access. The standpipe is placed adjacent to usable stairs and has fire department hose connections. It must be extended during construction to within one floor of the highest point of construction having flooring in accordance with Section 3311. During demolition, a standpipe is maintained in working condition. The standpipe may be demolished floor by floor as demolition proceeds.

Sprinkler System Commissioning

The sprinkler system must be tested and approved before the certificate of occupancy is awarded in accordance with Section 3312.

Additional requirements in the *International Fire Code*

Additional requirements for fire safety during construction required by IBC Section 3302.3 but found in the IFC are as follows:

- Temporary heating equipment must be listed and labeled; installation and maintenance of the equipment must be in accordance with the listing (IFC Section 3303).
- Smoking is prohibited except in approved areas with posted signage (IFC Section 3304.1).
- A fire watch must be maintained with qualified personnel if required by the fire code official (IFC Section 3304.5).
- Welding operations must comply with IFC Chapter 35. Temporary electrical wiring must comply with NFPA 70 (IFC Sections 3304.6 and 3304.7).
- The owner must designate a fire prevention superintendent responsible for the fire prevention program during construction. Requirements for the program are listed in IFC Section 3308.
- An accessible emergency phone must be provided in an approved location at the construction site. The construction site street address and fire department emergency phone number must be posted by the phone (IFC Section 3309).
- Fire-fighting vehicle access must be provided within 100 feet of temporary or permanent fire department connections (IFC Section 3310).
- An approved water supply for fire protection must be available (IFC Section 3312).
- Safeguards during roofing operations must be in accordance with IFC Section 3317.

9. Resources

For additional assistance and information, contact the American Wood Council (AWC) at (202) 463-2766 or info@awc.org. For additional assistance and information from the International Code Council (ICC), see www.iccsafe.org.

American Wood Council Standards

ANSI/AWC NDS®	<i>2018 National Design Specification® (NDS®) for Wood Construction with 2018 Supplement</i>
ANSI/AWC SDPWS	<i>2018 Special Design Provisions for Wind and Seismic</i>
ANSI/AWC WFCM	<i>2018 Wood Frame Construction Manual for One- and Two-Family Dwellings</i>
ANSI/AWC PWF	<i>2015 Permanent Wood Foundation Design Specification</i>
AWC STJR	<i>2015 Span Tables for Joists and Rafters</i>
AWC WCD No. 4	<i>2003 Wood Construction Data—Plank and Beam Framing for Residential Buildings</i>

The above standards published by AWC are referenced in the IBC. These standards and related code publications, design aids, technical reports and guides for wood design and construction can be purchased or downloaded at www.awc.org.

Other Associations Publishing Referenced Standards

Standards from additional organizations are referenced in this publication. The following table lists the standard, its title and the site from which the standard is available.

Standard-Edition	Title	Website
AAMA/WDMA/CSA 101/I.S.2/A440—17	<i>North American Fenestration Standard/ Specifications for Windows, Doors and Skylights</i>	aamanet.org wdma.com
APA PDS—12	<i>Panel Design Specification</i>	apawood.org
ASCE 7—16	<i>Minimum Design Loads and Associated Criteria for Buildings and Other Structures</i>	asce.org
ASTM D2898—10	<i>Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood Fire Testing</i>	astm.org
ASTM E84—16	<i>Test Methods for Surface Burning Characteristics of Building Materials</i>	
ASTM E108—16	<i>Test Methods for Fire Tests of Roof Coverings</i>	
ASTM E119—16	<i>Test Methods for Fire Tests of Building Construction and Materials</i>	
AWPA C1—03	<i>All Timber Products—Preservative Treatment by Pressure Processes</i>	awpa.com
AWPA M4—16	<i>Standard for the Care of Preservative-Treated Wood Products</i>	
AWPA U1—16	<i>USE CATEGORY SYSTEM: User Specification for Treated Wood Except Commodity Specification H</i>	
2018 IBC	<i>2018 International Building Code</i>	iccsafe.org
2018 IRC	<i>2018 International Residential Code</i>	
ICC 400—17	<i>Standard on Design and Construction of Log Structures</i>	
ICC 600—14	<i>Standard for Residential Construction in High-Wind Regions</i>	
NFPA 13—16	<i>Installation of Sprinkler Systems</i>	nfpa.org
NFPA 13D—16	<i>Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes</i>	
NFPA 13R—16	<i>Installation of Sprinkler Systems in Low-Rise Residential Occupancies</i>	
NFPA 70—17	<i>National Electrical Code</i>	
UL 263—11	<i>Standard for Fire Tests of Building Construction and Materials, with revisions through June 2015</i>	ul.com
UL 723—08	<i>Standard for Test for Surface Burning Characteristics of Building Materials, with revisions through August 2013</i>	
UL 790—04	<i>Standard Test Methods for Fire Tests of Roof Coverings with revisions through July 2014</i>	

This publication was developed by the International Code Council in cooperation with the American Wood Council. While every effort was made to ensure accuracy of the information it contains, neither organization assumes responsibility for particular designs or plans prepared from this document.

10. Building Area Tables

These tables are organized by occupancy category. Each category has a nonsprinklered and sprinklered allowable building area table that contains the maximum number of stories and maximum allowable area per floor for Type IIIA and IIIB, IV, VA and VB construction.

Table 1 – Group A Nonsprinklered Buildings – Maximum floor area per story

Group A-1 Nonsprinklered Buildings ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 ^f	0-25	14,000	8,500	15,000	11,500	5,500
	50	17,500	10,620	18,750	14,370	6,870
	100	24,500	14,870	26,250	20,120	9,620
3	0-25	14,000	NP	15,000	NP	NP
	50	17,500	NP	18,750	NP	NP
	100	24,500	NP	26,250	NP	NP
Groups A-2, A-3, A-4 Nonsprinklered Buildings ^{a, b, c, d}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 ^f	0-25	14,000	9,500	15,000	11,500	6,000
	50	17,500	11,870	18,750	14,370	7,500
	100	24,500	16,620	26,250	20,120	10,500
3	0-25	14,000	NP	15,000	NP	NP
	50	17,500	NP	18,750	NP	NP
	100	24,500	NP	26,250	NP	NP
Group A-5 Nonsprinklered Buildings ^{a, e}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
UL	0-25	UL	UL	UL	UL	UL
	50	UL	UL	UL	UL	UL
	100	UL	UL	UL	UL	UL

NP = Not Permitted

UL = Unlimited

- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Sprinklers must be provided for Group A-1, A-3 and A-4 occupancies when the fire area exceeds 12,000 square feet in accordance with Section 903.2.1, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area into fire areas not more than 12,000 square feet can be provided with fire-resistance-rated construction in accordance with Chapter 7.
- Sprinklers must be provided for Group A-2 occupancies when the fire area exceeds 5,000 square feet in accordance with Section 903.2.1.2, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area into fire areas not more than 5,000 square feet can be provided with fire-resistance-rated construction in accordance with Chapter 7.
- Sprinklers must be provided for Group A-5 occupancies when the area exceeds 1,000 square feet in accordance with Section 903.2.1.5.
- Type VB construction does not permit two stories above grade plane.

Table 2 – Group A NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group A-1 Sprinklered Buildings^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	56,000	34,000	60,000	46,000	22,000
	50	59,500	36,120	63,750	48,870	23,370
	100	66,500 ^e	40,370 ^e	71,250 ^e	54,620	26,120
2, 3 ^d	0-25	42,000	25,500	45,000	34,500	16,500
	50	45,500	27,620	48,750	37,370	17,870
	100	52,500	31,870	56,250	43,120	20,620
4	0-25	31,500	NP	33,750	NP	NP
	50	34,120	NP	36,560	NP	NP
	100	39,370	NP	42,180	NP	NP
Group A-2, A-3, A-4 Sprinklered Buildings^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	56,000	38,000	60,000	46,000	24,000
	50	59,500	40,370	63,750	48,870	25,500
	100	66,500 ^{e, f}	45,120 ^{e, f}	71,250 ^{e, f}	54,620	28,500
2, 3 ^d	0-25	42,000	28,500	45,000	34,500	18,000
	50	45,500	30,870	48,750	37,370	19,500
	100	52,500	35,620	56,250	43,120	22,500
4	0-25	31,500	NP	33,750	NP	NP
	50	34,120	NP	36,560	NP	NP
	100	39,370	NP	42,180	NP	NP
Group A-5 Sprinklered Buildings^b						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
UL	0-25	UL	UL	UL	UL	UL
	50	UL	UL	UL	UL	UL
	100	UL	UL	UL	UL	UL

NP = Not Permitted

UL = Unlimited

- The maximum floor area for four stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the four stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Type VB construction does not permit three stories above grade plane.
- Group A-1 and A-2 occupancies may be in unlimited area mixed occupancy buildings when meeting the provisions of Section 507.4.1.
- Group A-4 may be unlimited in area if the frontage width is at least 60 feet and the building is of Type III or IV construction in accordance with Section 507.4.

Table 3 – Group B Nonsprinklered Buildings – Maximum floor area per story^{a, b, c, d}

# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 & 3 ^e	0-25	28,500	19,000	36,000	18,000	9,000
	50	35,620	23,750	45,000	22,500	11,250
	100	49,870	33,250	63,000	31,500	15,750
4	0-25	21,370	NP	27,000	NP	NP
	50	26,710	NP	33,750	NP	NP
	100	37,400	NP	47,250	NP	NP
5	0-25	17,100	NP	21,600	NP	NP
	50	21,370	NP	27,000	NP	NP
	100	29,920	NP	37,800	NP	NP

NP = Not Permitted

- The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Sprinklers must be provided for ambulatory care facilities in accordance with Section 903.2.2.
- Type VB construction does not permit three stories above grade plane.

Table 4 – Group B NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story^{a, b, c}

# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	114,000	76,000	144,000	72,000	36,000
	50	121,120	80,750	153,000	76,500	38,250
	100	135,370	90,250	171,000	85,500	42,750
	100 (60') ^d	UL	UL	UL	UL	UL
2	0-25	85,500	57,000	108,000	54,000	27,000
	50	92,620	61,750	117,000	58,500	29,250
	100	106,870	71,250	135,000	67,500	33,750
	100 (60') ^d	UL	UL	UL	UL	UL
3	0-25	85,500	57,000	108,000	54,000	27,000
	50	92,620	61,750	117,000	58,500	29,250
	100	106,870	71,250	135,000	67,500	33,750
4	0-25	64,120	42,750	81,000	40,500	NP
	50	69,460	46,310	87,750	43,870	NP
	100	80,150	53,430	101,250	50,620	NP
5	0-25	51,300	NP	64,800	NP	NP
	50	55,570	NP	70,200	NP	NP
	100	64,120	NP	81,000	NP	NP
6	0-25	42,750	NP	54,000	NP	NP
	50	46,310	NP	58,500	NP	NP
	100	53,430	NP	67,500	NP	NP

NP = Not Permitted

UL = Unlimited

- The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Sprinklered Group B buildings of one or two stories may be unlimited in area if the frontage width is at least 60 feet in accordance with Sections 507.4 and 507.5.

Table 5 – Group E Nonsprinklered Buildings – Maximum floor area per story^{a, b, c}

# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	23,500	14,500	25,500	18,500	9,500
	50	29,370	18,120	31,870	23,120	11,870
	100	41,120	25,370	44,620	32,370	16,620
2	0-25	23,500	14,500	25,500	NP	NP
	50	29,370	18,120	31,870	NP	NP
	100	41,120	25,370	44,620	NP	NP
3	0-25	23,500	NP	25,500	NP	NP
	50	29,370	NP	31,870	NP	NP
	100	41,120	NP	44,620	NP	NP

NP = Not Permitted

- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Sprinklers must be provided for Group E occupancies when the fire area exceeds 12,000 square feet in accordance with Section 903.2.3, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area into fire areas not more than 12,000 square feet can be provided with fire-resistance-rated construction in accordance with Chapter 7.

Table 6 – Group E NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story^{a, b, c}

# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	94,000	58,000	102,000	74,000	38,000
	50	99,870	61,620	108,370	78,620	40,370
	100	111,620 ^e	68,870	121,120 ^e	87,870	45,120
2, 3 ^d	0-25	70,500	43,500	76,500	55,500	28,500
	50	76,370	47,120	82,870	60,120	30,870
	100	88,120	54,370	95,620	69,370	35,620
4	0-25	52,870	NP	57,370	NP	NP
	50	57,280	NP	62,150	NP	NP
	100	66,090	NP	71,710	NP	NP

NP = Not Permitted

- The maximum floor area for four stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Types VA and VB construction do not permit three stories above grade plane.
- Single-story Group E buildings may be of unlimited area when meeting the requirements of Section 507.11.

Table 7 – Group F Nonsprinklered Buildings – Maximum floor area per story

Group F-1 Nonsprinklered Buildings^{a, b, c, d, e}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2^f	0-25	19,000	12,000	33,500	14,000	8,500
	50	23,750	15,000	41,870	17,500	10,620
	100	33,250	21,000	58,620	24,500	14,870
3	0-25	19,000	NP	33,500	NP	NP
	50	23,750	NP	41,870	NP	NP
	100	33,250	NP	58,620	NP	NP
4	0-25	NP	NP	25,120	NP	NP
	50	NP	NP	31,400	NP	NP
	100	NP	NP	43,960	NP	NP
Group F-2 Nonsprinklered Buildings^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	28,500	18,000	50,500	21,000	13,000
	50	35,620	22,500	63,120	26,250	16,250
	100	49,870	31,500	88,370	36,750	22,750
	100 (60' ^h)	UL	UL	UL	UL	UL
2 & 3^g	0-25	28,500	18,000	50,500	21,000	13,000
	50	35,620	22,500	63,120	26,250	16,250
	100	49,870	31,500	88,370	36,750	22,750
4	0-25	21,370	NP	37,870	NP	NP
	50	26,710	NP	47,340	NP	NP
	100	37,400	NP	66,280	NP	NP
5	0-25	NP	NP	30,300	NP	NP
	50	NP	NP	37,870	NP	NP
	100	NP	NP	53,020	NP	NP

NP = Not Permitted

UL = Unlimited

- The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Sprinklers must be provided in woodworking areas in Group F-1 occupancies when the fire area exceeds 2,500 square feet in accordance with Section 903.2.4.1 and when areas manufacturing upholstered furniture or mattresses exceed 2,500 square feet in accordance with Section 903.2.4.
- Sprinklers must be provided for Group F-1 occupancies when the fire area exceeds 12,000 square feet, or the combined area of all Group F-1 occupancies exceeds 24,000 square feet, in accordance with Section 903.2.4, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area into fire areas not more than 12,000 square feet per compartment and not more than 24,000 square feet total can be provided with fire-resistance-rated construction in accordance with Chapter 7.
- Type VB construction does not permit two stories above grade plane.
- Type VB construction does not permit three stories above grade plane.
- Single-story Group F-2 occupancies may be unlimited in area if the frontage width is at least 60 feet in accordance with Section 507.3.

Table 8 – Group F NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group F-1 Sprinklered Buildings ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	76,000	48,000	134,000	56,000	34,000
	50	80,750	51,000	142,370	59,500	36,120
	100	90,250	57,000	159,120	66,500	40,370
	100(60') ^d	UL	UL	UL	UL	UL
2	0-25	57,000	36,000	100,500	42,000	25,500
	50	61,750	39,000	108,870	45,500	27,620
	100	71,250	45,000	125,620	52,500	31,870
	100(60') ^d	UL	UL	UL	UL	UL
3	0-25	57,000	36,000	100,500	42,000	NP
	50	61,750	39,000	108,870	45,500	NP
	100	71,250	45,000	125,620	52,500	NP
4	0-25	42,750	NP	75,370	NP	NP
	50	46,310	NP	81,650	NP	NP
	100	53,430	NP	94,210	NP	NP
5	0-25	NP	NP	60,300	NP	NP
	50	NP	NP	65,320	NP	NP
	100	NP	NP	75,370	NP	NP

NP = Not Permitted

UL = Unlimited

- The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Sprinklered Group F buildings of one or two stories may be unlimited in area if the frontage width is at least 60 feet in accordance with Sections 507.4 and 507.5.

Table 8 cont. – Group F NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group F-2 Sprinklered Buildings ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	114,000	72,000	202,000	84,000	52,000
	50	121,120	76,500	214,620	89,250	55,250
	100	135,370	85,500	239,870	99,750	61,750
	100(60') ^d	UL	UL	UL	UL	UL
2	0-25	85,500	54,000	151,500	63,000	39,000
	50	92,620	58,500	164,120	68,250	42,250
	100	106,870	67,500	189,370	78,750	48,750
	100(60') ^d	UL	UL	UL	UL	UL
3	0-25	85,500	54,000	151,500	63,000	39,000
	50	92,620	58,500	164,120	68,250	42,250
	100	106,870	67,500	189,370	78,750	48,750
4	0-25	64,120	40,500	113,620	47,250	NP
	50	69,460	43,870	123,090	51,180	NP
	100	80,150	50,620	142,030	59,060	NP
5	0-25	51,300	NP	90,900	NP	NP
	50	55,570	NP	98,470	NP	NP
	100	64,120	NP	113,620	NP	NP
6	0-25	NP	NP	75,750	NP	NP
	50	NP	NP	82,060	NP	NP
	100	NP	NP	94,680	NP	NP

NP = Not Permitted

UL = Unlimited

- The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Sprinklered Group F buildings of one or two stories may be unlimited in area if the frontage width is at least 60 feet in accordance with Sections 507.4 and 507.5.

Group I Sprinklered Buildings

Section 903.2.6 requires all Group I buildings to have automatic sprinkler systems. Therefore, there are no maximum building heights and areas for nonsprinklered Group I buildings, with a single exception: Exception 2 of Section 903.2.6 allows Group I-4 day care facilities on the ground floor (level of exit discharge) to be nonsprinklered when there is an exterior exit door in every room where care is provided.

Additionally, Section 903.2.6 allows Group I-1 Condition 1 buildings to use NFPA 13R-compliant sprinkler systems. In this case, there is no increase in area for having a sprinkler, rather only an increase in area for frontage is allowed. NFPA 13R-compliant maximum floor areas are shown in Table 10.

Table 9 – Group I-4 Nonsprinklered Buildings – Maximum floor area per story

Group I-4 Nonsprinklered Buildings ^{a,b,c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1 & 2 ^d	0-25	23,500	13,000	25,500	18,500	9,000
	50	29,370	16,250	31,870	23,120	11,250
	100	41,120	22,750	44,620	32,370	15,750
3 ^e	0-25	23,500	NP	25,500	NP	NP
	50	29,370	NP	31,870	NP	NP
	100	41,120	NP	44,620	NP	NP

NP = Not Permitted

a. Frontage based on open space widths of 30 feet or more.

b. Interpolation permitted.

c. Section 903.2.6 Exception 2 permits Group I-4 day care facilities to be nonsprinklered when the facility is at the level of exit discharge and has at least one exterior exit door from each room where care is provided.

d. Types VA and VB construction do not permit two stories above grade plane.

e. Maximum floor areas for nonsprinklered buildings above one story apply to existing construction only.

Table 10 – Group I-1 Condition 1, NFPA 13R-Compliant Sprinklered Buildings – Maximum floor area per story

Group I-1 Condition 1 Sprinklered Buildings - NFPA 13R Compliant ^{a, b, c, d}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 & 3 ^e	0-25	16,500	10,000	18,000	10,500	4,500
	50	20,620	12,500	22,500	13,120	5,620
	100	28,870	17,500	31,500	18,370	7,870
4	0-25	16,500	NP	18,000	NP	NP
	50	20,620	NP	22,500	NP	NP
	100	28,870	NP	31,500	NP	NP

NP = Not Permitted

a. NFPA 13R-compliant sprinklered buildings do not receive an increase of area for sprinklers. There is an increase in building area for open frontage, if applicable. The maximum floor area for four stories above grade plane was determined in accordance with Section 506.2.3, taking $S_a = 4$ as permitted for buildings equipped with an NFPA 13R sprinkler system.

b. Frontage based on open space widths of 30 feet or more.

c. Interpolation permitted.

d. Section 903.2.6 permits Group I-1 occupancies to be sprinklered with an NFPA 13R-compliant system. The occupancies do not qualify for area increases due to sprinklers.

e. Type VB construction does not permit three stories above grade plane.

Table 11 – Group I NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group I-1 Condition 1 Sprinklered Buildings^{a, b, c, d}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	66,000	40,000	72,000	42,000	18,000
	50	70,120	42,500	76,500	44,620	19,120
	100	78,370	47,500	85,500	49,870	21,370
2, 3	0-25	49,500	30,000	54,000	31,500	13,500
	50	53,620	32,500	58,500	34,120	14,620
	100	61,870	37,500	67,500	39,370	16,870
4	0-25	37,120	22,500	40,500	23,620	NP
	50	40,210	24,370	43,870	25,590	NP
	100	46,400	28,120	50,620	29,530	NP
5	0-25	29,700	NP	32,400	NP	NP
	50	32,170	NP	35,100	NP	NP
	100	37,120	NP	40,500	NP	NP
Group I-1 Condition 2 Sprinklered Buildings^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	66,000	40,000	72,000	42,000	18,000
	50	70,120	42,500	76,500	44,620	19,120
	100	78,370	47,500	85,500	49,870	21,370
2, 3^e	0-25	49,500	30,000	54,000	31,500	13,500
	50	53,620	32,500	58,500	34,120	14,620
	100	61,870	37,500	67,500	39,370	16,870
4	0-25	37,120	NP	40,500	NP	NP
	50	40,210	NP	43,870	NP	NP
	100	46,400	NP	50,620	NP	NP

NP = Not Permitted

- The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area by the number of stories in accordance with Section 506.2.3. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Section 903.2.6 permits Group I-1 Condition 1 occupancies to be sprinklered with an NFPA 13R system that does not qualify for area increases due to sprinklers. See Table 10 for area limits.
- Type VB construction does not permit three stories above grade plane.

Table 11 cont. – Group I NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group I-2 Sprinklered Buildings^{b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	48,000	NP	48,000	38,000	NP
	50	51,000	NP	51,000	40,370	NP
	100	57,000	NP	57,000	45,120	NP
2^{d, e}	0-25	NP	NP	NP	NP	NP
	50	NP	NP	NP	NP	NP
	100	NP	NP	NP	NP	NP
Group I-3 Sprinklered Buildings^{b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	42,000	30,000	48,000	30,000	20,000
	50	44,620	31,870	51,000	31,870	21,250
	100	49,870	35,620	57,000	35,620	23,750
2	0-25	31,500	22,500	36,000	22,500	15,000
	50	34,120	24,370	39,000	24,370	16,250
	100	39,370	28,120	45,000	28,120	18,750
3	0-25	31,500	NP	36,000	22,500	NP
	50	34,120	NP	39,000	24,370	NP
	100	39,370	NP	45,000	28,120	NP
Group I-4 Sprinklered Buildings^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	94,000	52,000	102,000	74,000	36,000
	50	99,870	55,250	108,370	78,620	38,250
	100	111,620	61,750	121,120	87,870	42,750
2	0-25	70,500	39,000	76,500	55,500	27,000
	50	76,370	42,250	82,870	60,120	29,250
	100	88,120	48,750	95,620	69,370	33,750
3	0-25	70,500	39,000	76,500	NP	NP
	50	76,370	42,250	82,870	NP	NP
	100	88,120	48,750	95,620	NP	NP
4	0-25	52,870	NP	57,370	NP	NP
	50	57,280	NP	62,150	NP	NP
	100	66,090	NP	71,710	NP	NP

NP = Not Permitted

- The maximum floor area for four stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Type VB construction does not permit three stories above grade plane.
- Note that Tables 504.3 and 504.4 do not allow an increase in building height or stories with automatic sprinklers in new or existing Group I-1 Condition 2 and Group I-2 buildings; a building area increase is allowed.

Table 12 – Group M Nonsprinklered Buildings – Maximum floor area per story^{a, b, c, d}

# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 ^e	0-25	18,500	12,500	20,500	14,000	9,000
	50	23,120	15,620	25,620	17,500	11,250
	100	32,370	21,870	35,870	24,500	15,750
3	0-25	18,500	NP	20,500	14,000	NP
	50	23,120	NP	25,620	17,500	NP
	100	32,370	NP	35,870	24,500	NP
4	0-25	13,870	NP	15,370	NP	NP
	50	17,340	NP	19,210	NP	NP
	100	24,280	NP	26,900	NP	NP

NP = Not Permitted

- a. The maximum floor area for four stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- b. Frontage based on open space widths of 30 feet or more.
- c. Interpolation permitted.
- d. Sprinklers must be provided for Group M occupancies when the fire area exceeds 12,000 square feet, or the combined area of all Group M occupancies exceeds 24,000 square feet, in accordance with Section 903.2.7, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area into fire areas not more than 12,000 square feet per compartment and not more than 24,000 square feet total can be provided with fire-resistance-rated construction in accordance with Chapter 7.
- e. Type VB construction does not permit two stories above grade plane.

Table 13 – Group M NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story^{a, b, c}

# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	74,000	50,000	82,000	56,000	36,000
	50	78,620	53,120	87,120	59,500	38,250
	100	87,870	59,370	97,370	66,500	42,750
	100 (60') ^d	UL	UL	UL	UL	UL
2	0-25	55,500	37,500	61,500	42,000	27,000
	50	60,120	40,620	66,620	45,500	29,250
	100	69,370	46,870	76,870	52,500	33,750
	100 (60') ^d	UL	UL	UL	UL	UL
3	0-25	55,500	37,500	61,500	42,000	NP
	50	60,120	40,620	66,620	45,500	NP
	100	69,370	46,870	76,870	52,500	NP
4	0-25	41,620	NP	46,120	31,500	NP
	50	45,090	NP	49,960	34,120	NP
	100	52,030	NP	57,650	39,370	NP
5	0-25	33,300	NP	36,900	NP	NP
	50	36,070	NP	39,970	NP	NP
	100	41,620	NP	46,120	NP	NP

NP = Not Permitted

UL = Unlimited

- a. The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- b. Frontage based on open space widths of 30 feet or more.
- c. Interpolation permitted.
- d. Sprinklered Group M buildings of one or two stories may be unlimited in area if the frontage width is at least 60 feet in accordance with Sections 507.4 and 507.5.

Group R Sprinklered Buildings

Section 903.2.8 requires all Group R buildings to have automatic sprinkler systems; therefore, there are no maximum building heights and areas for nonsprinklered Group R buildings. When using NFPA 13D- or 13R-compliant sprinkler systems, there is no increase in area for having a sprinkler system, rather only an increase in area for frontage is allowed. NFPA 13D- and NFPA 13R-compliant maximum floor area tables are below.

Use of NFPA 13D-compliant sprinkler systems is allowed for one- and two-family dwellings, townhouses, and certain congregate living facilities (Group R-3 and Group R-4 Condition 1) in accordance with Sections 903.2.8 and 903.3.1.3. NFPA 13D-compliant sprinkler systems are also allowed in single-family dwellings with care facilities for five or fewer individuals receiving care.

Table 14 – Group R-3 and R-4 Condition 1, NFPA 13D-Compliant Sprinklered Buildings – Maximum floor area per story

Group R-3 Sprinklered Buildings – NFPA 13D Compliant ^{a, b, c, e}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 & 3	0-100	UL	UL	UL	UL	UL
4	0-100	UL	UL	UL	NP	NP

Group R-4 Condition 1 Sprinklered Buildings – NFPA 13D Compliant ^{a, b, c, e}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 & 3 ^d	0-25	24,000	16,000	20,500	12,000	7,000
	50	30,000	20,000	25,620	15,000	8,750
	100	42,000	28,000	35,870	21,000	12,250
4	0-25	18,000	12,000	15,370	NP	NP
	50	22,500	15,000	19,210	NP	NP
	100	31,500	21,000	26,900	NP	NP

NP = Not Permitted

UL = Unlimited

- The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Type VB construction does not permit three stories above grade plane.
- NFPA 13D-compliant sprinkler systems are allowed in Group R-3 and Group R-4 Condition 1 residences only in accordance with Section 903.3.1.3. Group R-4 Condition 2 buildings require NFPA 13R-compliant sprinkler systems.

Table 15 – Group R, NFPA 13R-Compliant Sprinklered Buildings – Maximum floor area per story

Group R-1, R-2, R-4 Sprinklered Buildings – NFPA 13R Compliant ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 & 3 ^d	0-25	24,000	16,000	20,500	12,000	7,000
	50	30,000	20,000	25,620	15,000	8,750
	100	42,000	28,000	35,870	21,000	12,250
4 ^e	0-25	24,000	16,000	20,500	12,000	NP
	50	30,000	20,000	25,620	15,000	NP
	100	42,000	28,000	35,870	21,000	NP
Group R-3 Sprinklered Buildings- NFPA 13R Compliant ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 & 3	0-25	UL	UL	UL	UL	UL
	50	UL	UL	UL	UL	UL
	100	UL	UL	UL	UL	UL
4 ^d	0-25	UL	UL	UL	UL	UL
	50	UL	UL	UL	UL	UL
	100	UL	UL	UL	UL	UL

NP = Not Permitted

UL = Unlimited

- NFPA 13R-compliant sprinklered buildings do not receive an increase of area for sprinkler. There is an increase in building area for open frontage, if applicable.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- The maximum building height is 60 feet and four stories in accordance with Sections 504 and 903.3.1.2.
- The maximum floor area for four stories above grade plane was determined in accordance with Section 506.2.3, taking $S_o = 4$ as permitted for buildings equipped with an NFPA 13R sprinkler system. The floor area of the four stories is assumed to be equal.

Table 16 – Group R, NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group R-1, R-2, R-4 Sprinklered Buildings ^{a, b, c, d}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	96,000	64,000	82,000	48,000	28,000
	50	102,000	68,000	87,120	51,000	29,750
	100	114,000	76,000	97,370	57,000	33,250
2, 3	0-25	72,000	48,000	61,500	36,000	21,000
	50	78,000	52,000	66,620	39,000	22,750
	100	90,000	60,000	76,870	45,000	26,250
4	0-25	54,000	36,000	46,120	27,000	NP
	50	58,500	39,000	49,960	29,250	NP
	100	67,500	45,000	57,650	33,750	NP
5	0-25	43,200	28,800	36,900	NP	NP
	50	46,800	31,200	39,970	NP	NP
	100	54,000	36,000	46,120	NP	NP
Group R-3 Sprinklered Buildings ^{a, b, c, d}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2, 3 & 4	0-25	UL	UL	UL	UL	UL
	50	UL	UL	UL	UL	UL
	100	UL	UL	UL	UL	UL
5	0-25	UL	UL	UL	NP	NP
	50	UL	UL	UL	NP	NP
	100	UL	UL	UL	NP	NP

NP = Not Permitted

UL = Unlimited

- The maximum floor area for four or more stories above grade plane shown was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage is based on open space widths of 30 feet or more.
- Interpolation permitted.
- Group R occupancies must have a NFPA 13 sprinkler system unless specifically allowed an NFPA 13R or 13D sprinkler system in accordance with Section 903.3.1. If NFPA 13R is used, the building must meet height limits of four stories and 60 feet in accordance with Tables 504.3 and 504.4 and there is no increase in area per floor for sprinklers. Using NFPA 13D, there is no increase in building height or area due to use of the automatic sprinkler system in accordance with Tables 504.3 and 504.4, use the rows for nonsprinklered buildings to determine maximum building area. See Tables 14 and 15 for area increases due to frontage.

Table 17 – Group S Nonsprinklered Buildings – Maximum floor area per story

Group S-1 Nonsprinklered Buildings ^{a, b, c, d, e, f}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1, 2 ^g	0-25	26,000	17,500	25,500	14,000	9,000
	50	32,500	21,870	31,870	17,500	11,250
	100	45,500	30,620	44,620	24,500	15,750
3	0-25	26,000	NP	25,500	14,000	NP
	50	32,500	NP	31,870	17,500	NP
	100	45,500	NP	44,620	24,500	NP
4	0-25	NP	NP	19,120	NP	NP
	50	NP	NP	23,900	NP	NP
	100	NP	NP	33,460	NP	NP

NP = Not Permitted

- a. The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- b. Frontage based on open space widths of 30 feet or more.
- c. Interpolation permitted.
- d. Group S-1 occupancies with storage of commercial motor vehicles must have sprinklers when the fire area exceeds 5,000 square feet in accordance with Section 903.2.10.1. Group S-1 occupancies used to store mattresses or upholstered furniture must be sprinklered when the fire area exceeds 2,500 square feet in accordance with Section 903.2.9. Sprinklers must be provided for Group S-1 occupancies when the fire area exceeds 12,000 square feet per compartment, or the combined area of all Group S-1 occupancies exceeds 24,000 square feet total, in accordance with Section 903.2.9, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area can be provided with fire-resistance-rated construction in accordance with Chapter 7.
- e. Repair garages in Group S-1 occupancies with more than one story, including basements, must have sprinklers when a fire area exceeds 10,000 square feet in accordance with Section 903.2.9.1.
- f. Group S-1 occupancies storing tires must be sprinklered when the fire area exceeds 20,000 cubic feet in accordance with Section 903.2.9.2.
- g. Type VB construction does not permit two stories above grade plane.

Table 17 cont. – Group S Nonsprinklered Buildings – Maximum floor area per story

Group S-2 Nonsprinklered Buildings ^{a, b, c, d}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	39,000	26,000	38,500	21,000	13,500
	50	48,750	32,500	48,120	26,250	16,870
	100	68,250	45,500	67,370	36,750	23,620
	100 (60') ^f	UL	UL	UL	UL	UL
2 & 3 ^e	0-25	39,000	26,000	38,500	21,000	13,500
	50	48,750	32,500	48,120	26,250	16,870
	100	68,250	45,500	67,370	36,750	23,620
4	0-25	29,250	NP	28,870	15,750	NP
	50	36,560	NP	36,090	19,680	NP
	100	51,180	NP	50,530	27,560	NP
5	0-25	NP	NP	23,100	NP	NP
	50	NP	NP	28,870	NP	NP
	100	NP	NP	40,420	NP	NP

NP = Not Permitted

UL = Unlimited

- a. The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- b. Frontage based on open space widths of 30 feet or more.
- c. Interpolation permitted.
- d. Group S-2 occupancies with enclosed parking garages must have sprinklers when the fire area exceeds 12,000 square feet per compartment, in accordance with Section 903.2.10, or by reason of other specific conditions in that section. Buildings with parking garages for commercial motor vehicles must be sprinklered when the fire area exceeds 5,000 square feet.
- e. Type VB construction does not permit three stories above grade plane.
- f. Single-story Group S-2 occupancies may be unlimited in area if the frontage width is at least 60 feet in accordance with Section 507.3.

Table 18 – Group S NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group S-1 Sprinklered Buildings ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	104,000	70,000	102,000	56,000	36,000
	50	110,500	74,370	108,370	59,500	38,250
	100	123,500	83,120	121,120	66,500	42,750
	100(60') ^d	UL	UL	UL	UL	UL
2	0-25	78,000	52,500	76,500	42,000	27,000
	50	84,500	56,870	82,870	45,500	29,250
	100	97,500	65,620	95,620	52,500	33,750
	100(60') ^d	UL	UL	UL	UL	UL
3	0-25	78,000	52,500	76,500	42,000	NP
	50	84,500	56,870	82,870	45,500	NP
	100	97,500	65,620	95,620	52,500	NP
4	0-25	58,500	NP	57,370	31,500	NP
	50	63,370	NP	62,150	34,120	NP
	100	73,120	NP	71,710	39,370	NP
5	0-25	NP	NP	45,900	NP	NP
	50	NP	NP	49,720	NP	NP
	100	NP	NP	57,370	NP	NP

NP = Not Permitted

UL = Unlimited

- The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of the stories is assumed to be equal.
- Frontage based on open space widths of 30 feet or more.
- Interpolation permitted.
- Sprinklered Group S buildings of one or two stories may be unlimited in area if the frontage width is at least 60 feet in accordance with Sections 507.4 and 507.5.

Table 18 cont. – Group S NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story

Group S-2 Sprinklered Buildings ^{a, b, c}						
# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	156,000	104,000	154,000	84,000	54,000
	50	165,750	110,500	163,620	89,250	57,370
	100	185,250	123,500	182,870	99,750	64,120
	100(60') ^d	UL	UL	UL	UL	UL
2	0-25	117,000	78,000	115,500	63,000	40,500
	50	126,750	84,500	125,120	68,250	43,870
	100	146,250	97,500	144,370	78,750	50,620
	100(60') ^d	UL	UL	UL	UL	UL
3	0-25	117,000	78,000	115,500	63,000	40,500
	50	126,750	84,500	125,120	68,250	43,870
	100	146,250	97,500	144,370	78,750	50,620
4	0-25	87,750	58,500	86,620	47,250	NP
	50	95,060	63,370	93,840	51,180	NP
	100	109,680	73,120	108,280	59,060	NP
5	0-25	70,200	NP	69,300	37,800	NP
	50	76,050	NP	75,070	40,950	NP
	100	87,750	NP	86,620	47,250	NP
6	0-25	NP	NP	57,750	NP	NP
	50	NP	NP	62,560	NP	NP
	100	NP	NP	72,180	NP	NP

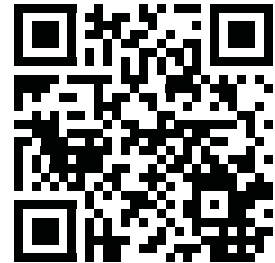
NP = Not Permitted

UL = Unlimited

- a. The maximum floor area for four or more stories above grade plane was determined by dividing the maximum total allowable building area determined in accordance with Section 506.2.3 by the number of stories. The floor area of each of the stories is assumed to be equal.
- b. Frontage based on open space widths of 30 feet or more.
- c. Interpolation permitted.
- d. Sprinklered Group S buildings of one or two stories may be unlimited in area if the frontage width is at least 60 feet in accordance with Sections 507.4 and 507.5.

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