

International Building Code (2018 Edition)
Allowable Building Area Adjustment Equations

The *International Building Code*® (IBC®) allows building sizes to be adjusted for maximum usage based on occupancy, construction type, setbacks (called “frontage”) from adjacent exposures, and built-in fire protection.

IBC Chapter 5 “General Building Heights and Areas” employs five equations the designer and building code official use to determine the eventual maximum allowable area a building can be.

For most of this handout, the subject building will be a Group B (Business) of Type VB construction, non-sprinklered. When we get to mixed-occupancy buildings, we will add a Group S-2 open parking garage of Type IIB construction, also not sprinklered. (See illustration No. 1).

I. TABULAR ALLOWABLE BUILDING AREA

IBC Table 506.2 establishes the allowable area based on occupancy and construction type.

Each occupancy value is further refined when the building is sprinklered.

NS = Not sprinklered.

S1 = One-story above grade building value based on NFPA 13 sprinkler design.

S13R = Group R occupancy building value based on NFPA 13R design.

SM = Two- or more-story above grade building value based on NFPA 13 sprinkler design.

From Table 506.2:

Occupancy	Sprinklers	Construction Type	Area
B	NS	VB	9,000
S-2	NS	IIB	26,000

II. FRONTAGE WIDTH VALUE

To qualify for an area factor increase based on frontage, a building must have at least 25% of its perimeter on a *public way* or open space with a minimum distance (W) of 20 feet measured at right angles to the closest interior lot line, the entire width of a street, alley, or public way, or the exterior face of an adjacent building on the same property.

If the value of the minimum distance (W) is greater than 30 feet, use 30 feet in the formula regardless of the actual distance.

Where the W value varies around the perimeter, use the following Equation 5-4 to find the “weighted” average width.

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

Where:

W = (Width: weighted average) = Calculated width of public way or open space in feet.

L_n = Length of a portion of the exterior wall.

w_n = Width equal to or greater than 20 feet adjacent to that portion of the exterior perimeter wall.

F = Building perimeter that fronts on a public way or open space 20 or more feet wide.

Solution: $W = (L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 + L_4 \times w_4 \dots) / F$

$$W = [(50 \times 22) + (120 \times 30) + 50 \times 30] / F$$

$$W = (1100 + 3600 + 1500) / F$$

$$W = 6200 / F$$

$$F \text{ (open perimeter)} = 220 \text{ ft.}$$

$$W = 6200 / 22 = 28.18$$

∴ Weighted average of open sides equals 28.18 feet.

III. FRONTAGE INCREASE

The basic allowable area may be increased solely if the building has frontage to provide fire access and prevent exposure impingement.

To determine the allowable percentage increase based solely on frontage:

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

Where:

I_f = Area factor increase for frontage.

F = Building perimeter that fronts on a public way or open space 20 or more feet wide.

P = Perimeter of the entire building in feet.

W = Calculated width of public way or open space in feet.

To compute for a solution, we will use the weighted average results obtained from the Equation 5-4.

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Solution:

$$I_f = [F/P - 0.25] W/30$$

$$I_f = [220/340 - 0.25] 28.18/30$$

$$I_f = [0.647 - 0.25] 93.9$$

$$I_f = [0.397] 93.9$$

∴ Increase factor for frontage (I_f) = 37.27%

IV. FRONTAGE AND SPRINKLER INCREASES

A. ONE-STORY SINGLE OCCUPANCY BUILDING

IBC allows area increases when the building is protected by sprinklers *and* meets frontage minimums. If the building contains one occupancy classification and is a single story above grade, the following equation is used to compute area:

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

Where:

A_a = Allowable area in square feet.

A_t = Table 506.2 allowable area factor for sprinklered building

NS = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Area factor increase for frontage.

Solution 1: *Note: For this equation, we will solve using a one-story building without sprinklers. From Table 506.2 the Group B, Type VB non-sprinklered area is 9,000 sq. ft.*

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

$$A_a = 9,000 + (9,000 \times 37.27\%)$$

$$A_a = 9,000 + (3,354)$$

∴ Allowable area for this building is 12,354 sq. ft.

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Solution 2: *Note: For this equation, we will solve using a one-story building protected by a NFPA 13 design sprinkler system. From Table 506.2 the Group B, Type VB sprinklered area is 36,000 sq. ft.*

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

$$A_a = 36,000 + (9,000 \times 37.27\%)$$

$$A_a = 36,000 + (12,354)$$

∴ Allowable area for this building is 48,354 sq. ft.

B. MULTI-STORY SINGLE OCCUPANCY BUILDING

If the building has multiple stories but a single occupancy classification, we use a different equation.

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

Where:

A_a = Allowable area in square feet.

A_t = Table 506.2 allowable area factor for sprinklered building

NS = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Area factor increase for frontage.

S_a = Actual number of stories above grade not to exceed three*

*For Group R buildings protected with a NFPA 13R design, use the actual number stories above grade plane, not to exceed four.

No individual story may exceed the allowable area (A_a) from this equation using the value $S_a = 1$.

Solution (No. 1):

Note: For this equation, we will solve for a two-story building without the sprinkler system.

$$A_a = [A_t + (NS \times I_f)] \times S_a$$

$$A_a = [9,000 + (9,000 \times 37.37\%)] \times 2$$

$$A_a = [9,000 + (12,354)] \times 2$$

$$A_a = [21,354] \times 2$$

∴ Allowable area for this two-story non-sprinklered building is 42,708 sq. ft.

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Solution (No. 2):

Note: For this equation, we will solve for a two-story building with the sprinkler system.

$$A_a = [36,000 + (9,000 \times 37.37\%)] \times 2$$

$$A_a = [36,000 + (12,354)] \times 2$$

$$A_a = [48,354] \times 2$$

∴ Allowable area for this two-story non-sprinklered building is 96,708 sq. ft.

C. MULTI-STORY MIXED-OCCUPANCY BUILDING

Multi-story mixed occupancy buildings can be confusing when computing allowable areas.

Each story of a mixed-occupancy building with more than one story above grade plane must individually comply with the IBC mixed occupancy and use requirements. This means that some buildings must include fire-resistive rated separations between occupancies yet others are permitted to be constructed without them.

For the purpose of this handout, let's assume the proposed building is four stories tall: two levels of open parking garage (Group S-2) with two levels of office space (Group B) above it. This imaginary building will be erected in a cold environment, so the imaginary owner does not want to install fire sprinklers in the open parking garage from fear of freezing.

We will assume the designer has elected to create one-hour fire separations between the two occupancy types. We will also provide “actual” proposed floor areas that are different from the Table 506.2 values for allowable area. We will use the same perimeter value from the illustration. (Note that we are using new proposed floor areas: ignore the 6,000 sq. ft. value in the illustration.)

Now that we know how to compute increases using sprinklers, we will modify our inputs to install sprinkler in the Group B occupancy. To keep it simple, we will assume the building is symmetrical: all floors are the same size.

Occupancy	Sprinklers	Construction Type	Allowable Area	Proposed Area*
B	SM	VB	27,000	24,250
S-2	NS	IIB	13,500	24,250

*Per floor

For buildings with more than three stories above grade plane, the total building area is limited so the aggregate sum of the ratios of the actual area of each story divided by the allowable area of each story does not exceed three. (See IBC 506.2.2.1 for special rules about Group H-2 and H-3 occupancies.)

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The equation to determine the allowable area for each story is familiar: we used it as Equation 5-1. For the multi-story mixed occupancy calculations, it is referred to as Equation 5-3.

$$A_a = [A_t + (NS \times I_f)] \quad \text{Equation 5-3}$$

Where:

A_a = Allowable area in square feet.

A_t = Table 506.2 allowable area factor for sprinklered building

NS = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Area factor increase for frontage.

We will work this equation in steps.

Solution:

Step 1. Determine the allowable area for the first-floor non-sprinklered open parking garage:

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

$$A_a = [26,000 + (26,000 \times 37.27\%)]$$

$$A_a = [26,000 + (9,690)]$$

$$A_a = 35,690 \text{ sq. ft.}$$

∴ Allowable area for this non-sprinklered story 35,690 sq. ft.

Step 2. Since the building is symmetrical, we know the second floor of the non-sprinklered Group S-2 also is 18,531 sq. ft.

Step 3: Floor three is a Group B, VB sprinklered space measuring 24,250.

$$A_a = [27,000 + (9,000 \times 37.27\%)]$$

$$A_a = [27,000 + (12,354)]$$

$$A_a = 39,354 \text{ sq. ft.}$$

Step 4. Since the building is symmetrical, we know the fourth floor of the Group B also is 39,354 sq. ft.

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Step 5: Calculate the sum of the ratios of actual area divided by allowable area:

Floor	Actual	Allowable	Ratio
1	24,250	35,690	0.68
2	24,250	35,690	0.68
3	24,250	39,354	0.62
4	24,250	39,354	0.62
		Sum	2.6

∴ The building passes the sum of the ratio analysis (less than three).

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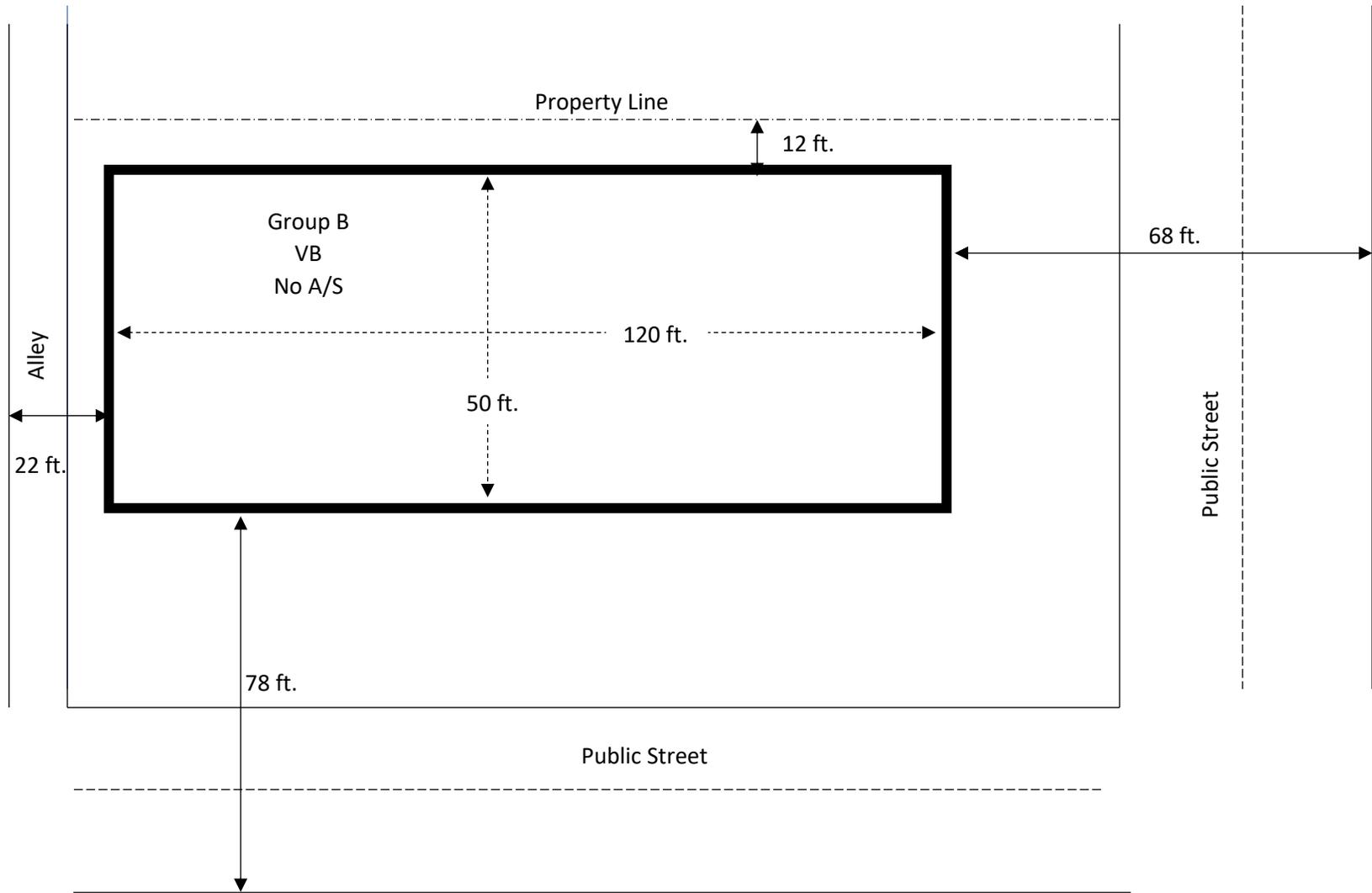


Illustration No. 1

Plan View-Not to Scale