Course Description

• This seminar addresses the key issues of the 2021 International Building Code® (IBC®) Chapter 5 regarding the determination of a building’s allowable height and area.
• The process for correctly evaluating a building for allowable height and area relies on a systematic approach, including the determination of occupancy classification and construction type.

Objectives

Upon completion, participants will be better able to:
1. Describe the purpose for regulating a building's allowable height and area.
2. Identify the relationship of a building’s occupancy classification(s) and type of construction to a building’s allowable height and area.
3. Determine how a building’s actual height, both in stories above grade plane and feet, and floor area are calculated.
4. Determine how a building’s allowable height, both in stories above grade plane and feet, and floor area are determined.
5. Apply the special provisions applicable to mixed occupancies, unlimited area buildings and horizontal building separations.
Course Overview

• Module I – Concept of Allowable Heights and Areas
• Module 2 – Relationship of Building Classification
• Module 3 – Calculation of Actual Building Height and Area
• Module 4 – Special Building Height and Area Provisions
• Module 5 – Determining Maximum Allowable Building Height
• Module 6 – Determining Maximum Allowable Building Area
• Module 7 – Additional Limitations and Allowances

Concept of Allowable Heights and Areas

Module 1

Allowable Height and Area Introduction

• After determining a building’s occupancy and identifying the proposed type of construction, the next step in the classification process is to verify compliance with the height and area limitations.

• Building occupancy, building type of construction and allowable building height and area must simultaneously be considered in order to achieve code compliance.
Allowable Height and Area Introduction

- As the size of the building increases, either in height or area, the number of acceptable construction types is reduced.
- Conversely, where a higher type of construction is provided, the building size may be increased.

Tabular Height and Area Values Tables 504.3, 504.4 and 506.2

- Tables 504.3, 504.4 and 506.2 are the foremost code provisions used in establishing “equivalent risk”—offsetting a building’s inherent fire hazard—represented by group—with materials and construction features.
Tabular Height and Area Tables 504.3, 504.4 and 506.2

- The height and area tables provide insight to the hierarchy of occupancies and construction types.
- Tabular allowable heights and areas vary based on the degree of hazard anticipated.
Allowable Height and Area Modifications to Tables 504.3, 504.4 and 506.2

The tables regulating allowable height and area generally provide for sizeable increases where the building is sprinklered throughout.

• The sprinkler increase to allowable area is one of the most generous benefits for fully sprinklered buildings.

• Sprinkler increases for height in feet and number of stories also provide a significant benefit in the determination allowable construction types.

Allowable Area Modifications to Table 506.2

A more comprehensive review is necessary when the building:

• Has sizable frontage

• Is multistory

• Contains multiple occupancies

• Has one or more fire walls

• Contains one or more mezzanines

• Has an occupied roof

• Is separated by a Sec. 509 horizontal separation

• Complies with Sec. 507 for unlimited area buildings

• Is located on a site with additional buildings
Building Classification

It is critical that a building be classified according to the occupancy group and the anticipated type of construction prior to determining the building’s allowable height and area.

The maximum building size is based on the specific occupancy groups within the building, as well as the materials of construction and the building’s degree of fire resistance.

Occupancy Classification

Section 302.1

Occupancy Groups

- Structures are to be classified into one or more of the occupancy classifications established in the code.
- The 10 general types are subdivided into 26 specific occupancies.

- Where a room or space is to be occupied for different types of uses at different times, all of the requirements applicable to each of the uses must be considered.
- Those buildings that contain two or more distinct occupancy classifications must comply with the provisions of Section 508 for mixed-occupancy buildings.
### Occupancy Classification

**Section 302.1**

<table>
<thead>
<tr>
<th>Types of Use</th>
<th>General Occupancy Group</th>
<th>Occupancy Sub-Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>Group B</td>
<td>None</td>
</tr>
<tr>
<td>Educational</td>
<td>Group E</td>
<td>None</td>
</tr>
<tr>
<td>Factory and Industrial</td>
<td>Group F</td>
<td>F-1, F-2</td>
</tr>
<tr>
<td>High Hazard</td>
<td>Group H</td>
<td>H-1, H-2, H-3, H-4, H-5</td>
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<tr>
<td>Institutional</td>
<td>Group I</td>
<td>I-1, I-2, I-3, I-4</td>
</tr>
<tr>
<td>Mercantile</td>
<td>Group M</td>
<td>None</td>
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<tr>
<td>Residential</td>
<td>Group R</td>
<td>R-1, R-2, R-3, R-4</td>
</tr>
<tr>
<td>Storage</td>
<td>Group S</td>
<td>S-1, S-2</td>
</tr>
<tr>
<td>Utility</td>
<td>Group U</td>
<td>None</td>
</tr>
</tbody>
</table>

### Type of Construction

**Chapter 6**

- Equally as important as occupancy designation, the determination of a building’s type of construction describes its resistance to fire by addressing whether:
  - The materials of construction that make up the building’s key elements are combustible or noncombustible, and
  - These same key elements are protected from fire by a recognized level of fire resistance.

- The relationship of a building’s construction type and its allowable height and area is the most important reason for correctly evaluating the type of construction.

- The permitted building size is directly related to the construction type.
**Type of Construction**

**Section 602.1**

- A building must be classified as a single type of construction only.
- Unlike mixed-occupancy conditions where multiple uses occur, the type of construction must be established based on full compliance with the minimum requirements for the intended construction type.

**Type of Construction**

**Section 602.1**

- The designer selects one of the 12 construction types that will be in conformance with the requirements of the code, based primarily on the building's anticipated height and area.
  - The design decision is based on a variety of factors, but ultimately the construction type chosen must comply with the code.
  - The plan reviewer then verifies that the type of construction chosen by the designer is permitted.

**Materials of Construction**

**Section 602**

<table>
<thead>
<tr>
<th>Type of Construction</th>
<th>Materials of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>I IA IB</td>
<td>Exterior and interior walls, floors, roof and structural elements to be of noncombustible materials.</td>
</tr>
<tr>
<td>II IA IB</td>
<td>Exterior walls to be of noncombustible materials.</td>
</tr>
<tr>
<td>III IA IB IIIA IIIB</td>
<td>Exterior walls to be of noncombustible materials.</td>
</tr>
<tr>
<td>IV IV-A IV-B IV-C</td>
<td>Exterior and interior walls, floors, roof and structural elements to be of mass timber members or noncombustible materials.</td>
</tr>
<tr>
<td>IV-HT</td>
<td>Exterior walls to be of noncombustible materials. Interior element to be of heavy timber members.</td>
</tr>
<tr>
<td>V VA VB</td>
<td>Combustible materials permitted throughout.</td>
</tr>
</tbody>
</table>

See Sections 602 and 603 for allowances, modifications and exceptions.
Fire-Resistance of Construction
Table 601

- Types of building elements regulated for fire-resistance-rated construction, based on Table 601:
  - Structural frame
  - Interior and exterior bearing walls
  - Floor construction
  - Roof construction

- All building elements must meet or exceed the fire-resistance requirements of the table.

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Type of Construction Minimum
Fire-Resistance Ratings
Table 601

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Calculation of Actual Building Height and Area
Module 3

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Actual Building Height and Area

Introduction
• The IBC establishes a specific approach to establishing a building’s actual:
  • Height in feet
  • Height in stories above grade plane
  • Floor area
• This determination may not necessarily be consistent with the height and area established by zoning regulations, real estate terminology, and other uses.

General Building Height Limitations
Section 503
• The height of a building is limited to that established by Tables 504.3 and 504.4.
• Before calculating the maximum allowable height (in both feet and stories above grade plane), it is necessary to determine the actual height of the building.

Building Height (in feet)
Section 202
• Building height (in feet): Defined as the vertical distance from grade plane to the average height of the highest roof surface.

• Average height for a sloping roof is the midway point between the extremes of the sloping roof.

• Grade plane is established by definition as the average of finished ground level adjoining the building.
Building Height
Section 202

• Building height is not measured to the top of a parapet wall.

Grade Plane
Section 202

• Grade plane is relatively simple to calculate if the land adjoining a building is relatively flat.

Grade Plane
Section 202

• In the case of sloping ground, grade is the lowest ground elevation within 6 feet of an exterior wall or, if the lot line is within that 6 feet, the lowest ground elevation between the wall and the lot line.
### Building Height (in stories)

**Table 504.4**

- The allowable height limitations on stories based on Table 504.4 are only applicable to stories considered as “stories above grade plane.”
- Unlike the limitation on height in feet, the limits on allowable stories above grade plane vary significantly based on the occupancy classification of the building.

### Story Above Grade Plane

**Section 202**

**Story Above Grade Plane:** Any story having its finished floor surface entirely above grade plane, or in which the finished surface of the floor next above is:
- More than 6 feet above grade plane, or
- More than 12 feet above the finished ground level at any point.

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General Building Area Limitations  
Section 503

• The area of a building is limited to that established by Table 506.2, along with any permitted increase due to the presence of significant exterior open space at the building’s perimeter.

• Before calculating the maximum allowable area, it is necessary to determine the actual floor area of the building on a story-by-story basis.

Building Area  
Section 202

• For that portion of the building surrounded by exterior walls and/or fire walls, the building area is considered the floor area within such walls.

• For that portion of the building not surrounded by exterior walls, the building area is considered the floor area within the horizontal projection of the roof or floor above.
Special Building Height and Area Provisions
Module 4

Special Provisions
Introduction
• It is important that all special allowances and limitations in the determination of allowable building height and area be reviewed for application.
• Key special provisions include:
  • Special industrial occupancies
  • Buildings on the same lot
  • Basements
  • Mezzanines
  • Occupied roofs

Special Industrial Occupancies
Section 503.1.1
• Buildings containing special industrial processes that require large floor areas and/or unusual heights are exempt from the height and area limitations of Sections 504 and 506.
• The allowance is limited to low-hazard and moderate-hazard occupancies housing manufacturing and energy-producing uses (typically classified as Groups F-1 and F-2).
Special Industrial Occupancies
Section 503.1.1
Some of the uses that qualify for these special allowances include:
• Rolling mills
• Structural metal fabrication shops
• Foundries
• Production and distribution of electric, gas or steam power

Buildings on the Same Lot
Section 503.1.2
If two or more buildings are located on the same lot, they must be:
• Regulated as separate buildings in accordance with Section 705.3, or
• Considered as portions of one building.

Buildings on the Same Lot
Section 705.3
• If viewed as separate buildings, an imaginary line (location determined by the designer) must be assumed between the buildings to determine exterior wall and opening protection.
• This approach is consistent with the regulation of buildings on adjacent lots insofar as fire separation distance is concerned.
Buildings on Same Lot
Section 705.3

Buildings 1 and 2 regulated as two separate and distinct buildings.

Buildings on Same Lot
Example 1

Buildings on Same Lot
Section 503.1.2

- As an alternative, multiple buildings on the same lot are permitted to be considered as portions of single building if the building height in feet, number of stories of each building, and aggregate building area of such buildings is within limits specified in Sections 504 and 506 for a single building.
- Provisions of IBC applicable to aggregate building area and applicable to each building.
Buildings on Same Lot
Section 503.1.2

Buildings 1 and 2 regulated as portions of a single building

Buildings on Same Lot
Example 2

A: separate buildings
- Building 1a
- Building 1b

B: single building
- Height limited in feet and stories above grade plane based upon Type VB construction
- Aggregate allowable area limited to 9,000 sq ft as both buildings regulated as Type VB construction

Basements
Sections 202, 504.3, 504.4, 506.1.3

- In the determination of compliance for allowable building size, basements are not typically included in a building’s actual height and area.
  - Basements are not a factor in building height in feet because the actual height is measured from the grade plane.
  - Basements are not a factor in building height in stories because Table 504.4 regulates the allowable number of stories to only those stories above grade plane.
  - Basements are not a factor in building area provided the total area of such basements does not exceed the area permitted for a one-story above grade plane building.
Mezzanines
Section 505

• A mezzanine is a complying intermediate floor level placed between the floor and ceiling of a story.
• The use of the mezzanine provisions is a design option, because an intermediate floor level can also be considered an additional story.

Mezzanines
Section 505

The use of mezzanine provisions focuses on the fact that:
• Mezzanines do not contribute to the number of stories in the building.
• Mezzanines do not contribute to the building area.

Mezzanines
Section 505

Conditions to qualify as a mezzanine include:
• Aggregate area of mezzanines limited to one-third of floor area of room where located (2 exceptions allow for greater percentages).
• Mezzanines to be open and unobstructed to room where located (5 exceptions allow for partial or full enclosure of mezzanine area).
• Mezzanines contribute to floor area for fire area size determination.
Mezzanine Floor Area
Section 505.2.1

The aggregate floor area of all mezzanines cannot exceed 1/3 of the floor area of that room or space in which they are located.

Mezzanine Floor Area
Section 505.2.1, Exception 2

The aggregate floor area of all mezzanines cannot exceed 1/2 of the floor area of that room or space in which they are located under very specific conditions.

Mezzanine Openness
Section 505.2.3

• A mezzanine is intended to be open and unobstructed to the room in which the mezzanine is located.
  • A variety of exceptions allow for the mezzanine to be enclosed.
Mezzanine Openness
Section 505, Exceptions 1 and 3

Section 505.2.3, Exception 2

Mezzanines
Example 1
Occupied Roofs
Section 503.1.4

• A roof level is permitted to be used as an occupied roof provided the rooftop occupancy is permitted by Table 504.4 to be located on the story immediately below the roof.
• Exceptions permitted for sprinklered buildings with occupant notification extended to roof area, and for Type I or II open parking garages.
• Area of occupied roofs are not to be included in building area, building height or number of stories.

Occupied Roofs
Section 503.1.4

Example:
If building of Type VA construction,
Group B: 4 stories max. (5)
Group A-3: 3 stories max. (3)

Notification appliances shall be provided per Section 907.2

A-3 on roof

B
B
B

Sprinkler system required throughout per Section 903.3.1.1

Except for complying penthouses, enclosures of occupied roof areas limited to 48” above roof surface.
Allowable Building Height

**Introduction**

- Once the actual building height is determined, in both feet and stories above grade plane, it cannot exceed the allowable height as determined by Section 504 based on:
  - Occupancy classification
  - Type of construction
- Where towers, steeples, spires and other rooftop structures are provided, specific provisions are to be applied.

### Height Increase for Sprinklers

**Section 504.1**

- The tabular limits on height in both feet and stories are typically greater where the building is protected by an automatic sprinkler system.
- Tables 504.3 and 504.4 identify the type of sprinkler system required to receive any sprinkler increase.
  - **S** = buildings equipped throughout with an NFPA 13 sprinkler system
  - **S13R** = buildings equipped throughout with an NFPA 13R sprinkler system
  - **S13D** = buildings equipped throughout with an NFPA 13D sprinkler system

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**Allowable Height in Feet**

**Table 504.3**

<table>
<thead>
<tr>
<th>Occupancy Classification</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Type D</th>
<th>Type E</th>
<th>Type F</th>
<th>Type G</th>
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<tbody>
<tr>
<td>S13R</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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(footnotes not shown)
Allowable Height Increase
Example 1

Given: A Type VB building classified as a Group B occupancy.

Determine: The maximum allowable height in feet and stories above grade plane if:
  - the building is not sprinklered, and
  - if the building is sprinklered.

Solution: Taken directly from Tables 504.3 and 504.4
Group R Occupancies
Tables 504.3 and 504.4

• If the building is a Group R occupancy sprinklered with an NFPA 13R system, the height in feet and story above grade plane increases are also applied; however, the building cannot exceed a total of 4 stories above grade plane or 60 feet in height as reflected in the tables.

Group R Occupancies
Example 2

• Given: A Type IIB building classified as a Group R-2 occupancy. The building is sprinklered with an NFPA 13R system.

• Determine: The maximum allowable building height in feet and stories.

• Solution:

<table>
<thead>
<tr>
<th>Group R-2 Type IIB</th>
<th>4 stories</th>
<th>6 stories</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFPA 13R Sprinkler System</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Tables 504.3 and 504.4 permit 75 feet and 5 stories where an NFPA 13 sprinkler system is provided.
Allowable Height Increase
Tables 504.3 and 504.4

- Occupancies where the installation of an automatic sprinkler system does not provide for an increase in allowable height include:
  - Group I-2 occupancies in Type IIB, III, IV and V buildings.
  - Group H-1, H-2, H-3 and H-5 occupancies.
- In these high-hazard occupancies, sprinkler protection is such an integral part of the building’s overall protection package that no additional benefit is granted.

Roof Structures
Section 504.3, Exception

The height limitations for towers, spires, steeples and other roof structures are found in:
- Exception to Section 504.3, which regulates such roof structures in regard to the contribution to the overall height of the building.
- Section 1511 deals more with rooftop structures as independent elements.
Roof Structures Example

Maximum permitted height for noncombustible building:
- 60 feet (Table 504.3)
- + 20 feet (Sec. 504.3, Exc.)
- 80 feet

* No limit if of noncombustible construction

Combustible Steeple:
- Maximum permitted height for combustible building:
  - 60 feet (Table 504.3)
  - + 20 feet (Sec. 504.3, Exc.)
  - 80 feet

Maximum roof height limited by Table 504.3 and the Exception to Section 504.3, if applicable.

Determining Maximum Allowable Building Area

Module 6

Allowable Building Area Section 506

- Building area is limited to that established by Table 506.2, along with any permitted increase due to the presence of significant frontage on open space.
- The table addresses the presence of an automatic sprinkler system, as well as multistory conditions, where applicable.
- The entire building must be analyzed for allowable area compliance, along with the area of each individual story.
Automatic Sprinkler System Increase
Table 506.2

• The presence of a sprinkler system can provide for a significant increase in allowable area in most buildings.
• The allowable area increase reflected in Table 506.2 for the installation of an automatic sprinkler system is only applicable where an NFPA 13 system is provided throughout the building.
• In addition, Table 506.2 does not provide for a sprinkler increase for:
  • Group H-1 occupancies
  • Portions of buildings classified as Group H-2 or H-3

Allowable Area Factors
Table 506.2

Frontage Increase
Section 506.3

• An increase in allowable area is permitted for buildings that have substantial open space adjacent to the exterior walls (to facilitate fire department access). Open space also greatly limits the potential for exterior materials to contribute to a fire within the building.
• To qualify, the yard or public way must have a minimum width of 20 feet. No allowable area increase is given unless at least 25% of the building’s perimeter has complying frontage.
Frontage Increase
Section 506.3.2

• The minimum 20-foot public way or open space adjacent to the building perimeter is to be measured at right angles from the building space to the:
  • Closest interior lot line, or
  • Entire width of a street, alley or public way, or
  • Exterior face of an adjacent building on the same lot.

Frontage Increase
Section 506.3.2

• The frontage increase ($I_f$) is to be based upon two factors as applied in Table 506.3.3:
  • The smallest public way or open space that is 20 feet or greater, and
  • The percentage of building perimeter having a minimum of 20 feet of open space and/or public ways.

Frontage Increase
Example 1

• Given: Yards as shown, and two 60-foot streets.
• Determine: Percentage of frontage increase for allowable area.
• Solution: Smallest open space ≥ 20’:
  40 feet
  Percentage of perimeter ≥ 20’ open: 61% (based on 220/360)

Frontage increase ($I_f$): 0.50 Based on Table 506.3.3
Frontage Increase Example 2

- **Given:** A building fronted by a 60-foot street and three yards, as shown.
- **Determine:** The factor, $W$, to be used in the calculation of $I_f$ (area increase due to frontage).
- **Solution:** Smallest open space > 20': 26 feet
  
  Percentage of perimeter > 20' open: 82% (based on 360/440)

$\text{Frontage increase (I)}: \quad 0.63 \quad \text{Based on Table 506.3.3}$

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Frontage Increase for Section 507 Buildings
Section 506.3.3.1

- Table 506.3.3.1 can be used to determine the frontage increase for unlimited area buildings that would be regulated by Section 507 except for compliance with the open space requirements.

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Frontage Increase Section 506.3.2

- There are situations where it will be advantageous for the designer to not consider all portions of the open space or public way that are 20 feet or more in width.
  
  - It is acceptable to ignore open space where its inclusion in the application of Table 506.3.3 will result in a smaller frontage increase.
Open Space Limits
Section 506.3.1

- Section 506.3.1 mandates that the open space used for a frontage increase must be on the same lot as the building or dedicated for public use.
- This ensures that the space will remain open and available. Fire personnel must also be able to access the open space from a street or fire lane.

Open Space Limits
Section 506.3.1

Three issues to consider when evaluating potential yards for use as open space in the determination of a frontage increase:

- What type of public and common spaces are permitted to be utilized for frontage increases?
- How is the frontage increase calculated for a common yard shared by two buildings on the same lot?
- Does the presence of a fire wall affect the allowable area calculation for a frontage increase?
Open Space Availability
Introduction

- Yards, public ways and other types of open spaces are expected to be open and relatively unobstructed from the ground to the sky.
- The decision as to what types of uses are permitted within the designated open space is left to the building official.
- Parking lots, low level landscaping, light standards and similar features are often permitted to occupy open space.
- Conversely, the storage and/or display of goods and similar uses would typically be prohibited.
- The intent is to provide effective fire department access and maintaining building separation from site hazards.

Open Space Availability
Section 506.3.1

Yards to be accessed by street or fire lane

Yard

Building

Shared yard with recorded covenant

Street

Yard

Public way

Open space available for area increase

May be used when approved by the building official

Open Space Availability
Section 506.3.2

- The entire open space between two buildings on the same lot is available for a potential frontage increase for both buildings.
- For the purpose of determining the width of the yard, no imaginary line between the buildings is assumed.
- The entire width of the yard can be used by both buildings.
Open Space Availability

Example

• **Given:** Buildings 1 and 2, as shown.
• **Determine:** The percentage frontage increase for each building.

![Diagram showing open space availability for Buildings 1 and 2.]

Example

• **Solution:** Because the buildings are located on the same lot, both buildings may use the 30-foot yard that separates them for area increase. Each building may use the total perimeter for area increase, provided access is available in accordance with Section 506.3.1.

Example

• **Solution:** A fire wall separates a single structure into two buildings. In this case, the use of the fire wall prohibits the use of the 50-foot yard for a frontage increase for Building A.
Allowable Area Determination
Section 506.2
• Determination of the allowable area of a building differs depending on the conditions presented:
  • Single-occupancy buildings  Section 506.2.1
  • Mixed-occupancy buildings  Section 506.2.2
• Under both conditions, the allowable area is determined for:
  • Each individual story, and
  • Entire building

Allowable Area Determination
Single-Occupancy, Each Story
Section 506.2.1
• The allowable area of each individual story in a single-occupancy building is determined by the following equation:
  \[ A_a = A_t + (NS \times I_f) \] (Equation 5-1)

\[ A_a = \text{Allowable building area} \]
\[ A_t = \text{Tabular allowable area factor (NS, S1, SM, S13R or S13D value, as applicable) in accordance with Table 506.2} \]
\[ NS = \text{Tabular allowable area factor in accordance with Table 506.2 for nonsprinklered building (regardless of whether building is sprinklered)} \]
\[ I_f = \text{Area factor increase due to frontage in accordance with Section 506.3} \]

Allowable Area Example 1
• Given: A 1-story, Type VA building housing a Group B occupancy.
• Determine: The maximum allowable area if the building is fully sprinklered (include frontage increase).

Example:
• Given:
  - A 1-story, Type VA building housing a Group B occupancy.
  - Determine: The maximum allowable area if the building is fully sprinklered (include frontage increase).
**Allowable Area Example 1**

- **Solution:** \( A_a = A_t + (NS \times f_f) \)

<table>
<thead>
<tr>
<th>Tabular area ((A_t)): 72,000 sf</th>
<th>S1, T506.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontage increase ((NS \times f_f)): 9,000 sf</td>
<td>18,000 x 0.50*</td>
</tr>
<tr>
<td>Total allowable area ((A_a)): 81,000 sf</td>
<td>Additive</td>
</tr>
</tbody>
</table>

*Based on Table 506.3.3, w/50% open ≥ 20’, open space ≥ 30’

The story/building is limited to 81,000 sf.

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**Allowable Area Example 2**

- **Given:** A 2-story, Type VA building housing a Group B occupancy.
- **Determine:** The maximum allowable area if the building is fully sprinklered (include frontage increase).

<table>
<thead>
<tr>
<th>Tabular area ((A_t)): 54,000 sf</th>
<th>SM, T506.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontage increase ((NS \times f_f)): 9,000 sf</td>
<td>18,000 x 0.50*</td>
</tr>
<tr>
<td>Total allowable area per story ((A_t)): 63,000 sf</td>
<td>Additive</td>
</tr>
</tbody>
</table>

*Based on Table 506.3.3, w/50% open ≥ 20’, open space ≥ 30’

Each story is limited to 63,000 sf
Building is limited to 126,000 sf

Based on 63,000 x 2 (stories in building) = 126,000 sf
Allowable Area Determination
Single-Occupancy, ≥ 4 Stories AGP
Section 506.2.1

- The allowable area of a single-occupancy building four or more stories above grade plane is determined by Equation 5-2:

\[ A_a = A_t + (N S \times I_f) \times S_a \] (Equation 5-2)

- Where:
  - \( A_a \) = Allowable building area
  - \( A_t \) = Tabular allowable area factor (NS, SM, S13R or S13D value, as applicable) in accordance with Table 506.2
  - \( N S \) = Tabular allowable area factor in accordance with Table 506.2 for nonsprinklered building (regardless of whether building is sprinklered)
  - \( I_f \) = Area factor increase due to frontage in accordance with Section 506.3
  - \( S_a \) = 3 where the actual number of stories above grade plane exceeds three, or
  - \( S_a \) = 4 where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2 (13R)

**Example 3**

- **Given:** A 4-story, Type VA building housing a Group B occupancy.
- **Determine:** The maximum allowable area if the building is fully sprinklered (include frontage increase).
Allowed Area, > 4 Stories AGP
Example 3

**Solution:** \( A_a = A_t + (NS \times I_f) \times S_a \)

- Tabular area \((A_t)\): 54,000 sf  SM, T506.2
- Frontage increase \((NS \times I_f)\): 9,000 sf  18,000 x 0.50*
- Allowable area \((A_t)\): 63,000 sf  Additive
- Buildings > 4 stories: \( \frac{x}{3} \times S_a \)
- Building allowable area: 189,000 sf  Equation 5-2

*Based on Table 506.3.3, w/50% open > 20', open space > 30'

Total building allowable area limited to 189,000 sf
No single story is permitted to exceed 63,000 sf
If all stories have same floor area, 47,250 sf per story

---

Allowed Area, 13R Building
Example 4

**Given:** A 4-story, Type VA building housing a Group R-2 occupancy.

**Determine:** The maximum allowable area if the building is fully sprinklered with an NFPA 13R system (include frontage increase).

**Solution:** \( A_a = A_t + (NS \times I_f) \times S_a \)

- Tabular area \((A_t)\): 12,000 sf  S13R, T506.2
- Frontage increase \((NS \times I_f)\): 6,000 sf  12,000 x 0.50*
- Allowable area \((A_t)\): 18,000 sf  Additive
- Buildings > 4 stories: \( \frac{x}{4} \times S_a \)
- Building allowable area: 72,000 sf  Equation 5-2

*Based on Table 506.3.3, w/50% open > 20', open space > 30'

Total building allowable area limited to 72,000 sf
No single story is permitted to exceed 18,000 sf
Allowable Area Determination
Mixed-Occupancy, Each Story
Section 506.2.2

• The allowable area of each story of a mixed-occupancy building is based on the applicable provisions of:
  • Section 508.3.2 Nonseparated occupancies
  • Section 508.4.2 Separated occupancies

• Where a mixed-occupancy condition is regulated by the accessory occupancy provisions, Section 508.2.3 permits the allowable area to be based on the main occupancy of the building.

Allowable Area Determination
Four or More Stories
Section 506.2.2

• Total allowable area of a mixed-occupancy building with 4 or more stories above grade plane is determined by:

\[
\frac{a_{\text{story 1}}}{A_{\text{story 1}}} + \frac{a_{\text{story 2}}}{A_{\text{story 2}}} + \frac{a_{\text{story 3}}}{A_{\text{story 3}}} + \frac{a_{\text{story 4}}}{A_{\text{story 4}}} + \ldots \leq 3
\]

Where \(a_{\text{story 1}}, a_{\text{story 2}}, a_{\text{story 3}},\) and \(a_{\text{story 4}}\) represent the actual floor areas of each individual story, and \(A_{\text{story 1}}, A_{\text{story 2}}, A_{\text{story 3}},\) and \(A_{\text{story 4}}\) represent the maximum allowable floor areas.

• For buildings designed as separated occupancies, sum of ratios not to exceed 4 for buildings equipped with NFPA 13R sprinkler system.

Group H-2 or H-3 Mixed Occupancies
Section 506.2.2.1

• For mixed-occupancy building containing Group H-2 or H-3 occupancies, allowable area increase for sprinkler protection applicable only to those portions of building not classified as Group H-2 or H-3.
Unlimited Area Buildings
Section 507

- The provisions of Section 507 allow for buildings with large floor areas to be constructed with no requirement for:
  - Fire-resistance-rated construction, or
  - Fire walls.
- The area limitations of Sections 503 and 506 are not applicable where compliance with Section 507 is achieved.
- Risks have been addressed to the point that the regulation for allowable area is unnecessary.

Unlimited Area Buildings
Section 507

- Concept based on four main criteria:
  - Limited height
  - Moderate-hazard and low-hazard occupancies
  - Significant open frontage
  - Sprinkler protection
- This section provides alternative approach to regulating building size
Unlimited Area Buildings
Section 507
• Although the allowance for unlimited floor area typically permits the building to be of any construction type, the actual type of construction will be important in the application of other code provisions, such as:
  • Accessory occupancies
  • Group H occupancies in unlimited area Group F and S occupancies

Unlimited Area Buildings
Section 507.1.1
• The use of the unlimited area provisions is limited to those occupancies specifically addressed in Section 507, but other occupancies are permitted where in compliance with Section 508.2 (Accessory Occupancies).

One-story Nonsprinklered Buildings Section 507.3
• A one-story building housing a Group F-2 and/or S-2 occupancy is permitted to be unlimited in area if it is completely surrounded by minimum 60-foot public ways and/or yards.
• An automatic sprinkler system is not required in order to obtain unlimited area status because the occupancies involved are not expected to have any significant fire loading.
One- and Two-story Sprinklered Buildings Sections 507.4 and 507.5

• A building of no more than two stories is permitted to be unlimited in area where:
  • The building houses only Group B, F, M, and/or S occupancies.
  • The building is protected with a sprinkler system throughout.
  • Open space and/or public ways at least 60 feet in width adjoin and surround the building.

One-story Group A-4 Occupancies Section 507.4

• Group A-4 occupancies are granted unlimited area in a manner consistent with that for B, F, M and S occupancies with two exceptions:
  • The Group A-4 building can be only one story in height.
  • The building’s construction must be of Type I, II, III or IV.

Group A-1 and A-2 Occupancies Section 507.4.1

• In complying unlimited area buildings housing Group A-4, B, F, M and/or S occupancies, it is permissible to include a limited amount of Group A-1 and A-2 occupancies within the building.
• The type of construction of the building must be Type I, II, III or IV.
Group A-1 and A-2 Occupancies
Section 507.4.1 (continued)

• The Group A-1 and A-2 occupancies shall be separated from other spaces as required by Section 508.4.4 for separated occupancies with no reduced rating allowed for sprinkler protection. This will result in a minimum 2-hour fire-resistance-rated separation.

• The floor area of each Group A-1 and A-2 occupancy cannot exceed the maximum allowable area established in Section 503.1, which includes any applicable frontage increase.

• All required exits from Group A-1 and A-2 occupancies must discharge directly to the exterior of the building.

Group A-3 Buildings
Sections 507.6 and 507.7

The area of a Group A-3 occupancy is permitted to be unlimited under the following conditions:
• Maximum of one story in height.
• Used as a place of religious worship, community hall, dance hall, exhibition hall, gymnasium, lecture hall, indoor swimming pool or tennis court.
• Type II, III or IV construction.
Group A-3 Buildings
Sections 507.6 and 507.7 (continued)

• No stage, but may contain a platform.
• Fully sprinklered.
• Surrounded and adjoined by minimum 60-foot (18,288 mm) yards and/or public ways.
• Assembly floor located within 21 inches (533 mm) of street or grade level with egress provided by ramps rather than stairs, where applicable (only required where building is Type III or IV construction).

Reduced Open Space
Section 507.2.1

• Open space of at least 60 feet (18,288 mm) must be provided around complying unlimited area buildings. The minimum 60-foot width is permitted to be reduced to 40 feet provided:
  • The reduced open space applies to a maximum of 75 percent of the building’s perimeter, and
  • A minimum 3-hour fire-resistance rating is required for any exterior wall facing the reduced open space, and
  • Openings in the exterior wall facing the reduced open space have a minimum fire protection rating of 3 hours.
Reduced Open Space
Section 507.2.1
• The allowance for reducing the required open space from 60 feet to 40 feet is only permitted for the following unlimited area buildings:
  • One-story nonsprinklered Groups F-2 and S-2 (507.3).
  • One-story sprinklered Groups B, F, M, S and A-4 (507.4).
  • Two-story sprinklered Groups B, F, M and S (507.5).
  • One-story sprinklered Group A-3 (507.6 and 507.7).
  • One-story sprinklered motion picture theaters (507.12).

Group H Occupancies
Section 507.8
• Group H-2, H-3 and H-4 occupancies are permitted to be located in unlimited area buildings containing Group F and S occupancies with the following limitations:
  • Compliance with the unlimited area provisions of Sections 507.4 and 507.5 for Group F and S occupancies.
  • Limits on permitted floor area of Group H occupancies based on whether:
    • Located within the building, or
    • Located on building perimeter

• Aggregate floor area of Group H occupancies located at the building’s perimeter limited to 10% of the actual building area or Group H allowable area per Section 506 with any applicable frontage increase.
• Aggregate floor area of Group H occupancies not located on perimeter of building are limited to 25% of Group H area limits as specified in Section 506.
Other Unlimited Area Buildings
Sections 507.9 through 507.13

The following occupancies are also permitted to be unlimited in floor area subject to the specific requirements:

- Mixed-occupancy buildings with Group H-5 (507.9)
- Group H-2 aircraft paint hangars (507.10)
- Group E educational buildings (507.11)
- Group A-1 motion picture theaters (507.12)
- Covered mall buildings and anchor stores (507.13)

Mixed Occupancies
Section 508

Where two or more distinct occupancies are located within a building, the provisions of Section 508 must be applied.

The scope of Section 508 is limited to:

- Occupancy classification.
- Allowable building height.
- Allowable building area.
- Fire protection systems.
- Separation.

Mixed Occupancies
Section 508

- Three design options for compliance in mixed-occupancy buildings are established:
  - Accessory occupancies
  - Nonseparated occupancies
  - Separated occupancies
  - Each design option varies in its approach to allowable building height and area
Accessory Occupancies
Section 508.2

Allowable Area and Allowable Height

• The allowable area of any accessory occupancy is to be based on that of the main occupancy.

• The allowable height and number of stories of the building shall comply with Section 504 for the main occupancy of the building.

Considered as Accessory Occupancy

Group A-3 Conference Room

Group B

Office Building

Maximum floor area of building is based totally on that of the Group B occupancy.

 allowable area in square feet

12,000

97,750

Total allowable area in square feet

Frontage Increase

9,750

2,750

Table 506.2

Frontage increase

Considered as Accessory Occupancy

Group A-3 Conference Room

(or could also be located on the 2nd story and/or 3rd story)

Assume building is fully sprinklered and of Type VB construction.

Accessible Height of Accessory Occupancy
Nonseparated Occupancies
Section 508.3

• Occupancies are not required to be separated if they are in compliance with the provisions of Section 508.3. If the building is designed in part to address the most restrictive and most hazardous conditions that are expected to occur, a fire-resistance-rated separation is not necessary.

• The worst-case application of the type of construction (allowable height and area) and fire protection provisions forms the basis for this option.

Allowable Area and Allowable Height is:

• Based on the most restrictive allowances for the occupancies involved.

• Based on the building’s type of construction, each occupancy is individually evaluated for height and area in accordance with Section 503.1.

Frontage increases to Table 506.2 are permitted for open space and sprinkler protection, where applicable.

The most restrictive height and area allowance of the occupancies under consideration is then applied to the entire building.

Most restrictive type of construction is applied
Nonseparated Occupancies
Section 508.3

Example: Building is to be multistory, fully sprinklered and of Type VB construction. Frontage increase of 30% available. 1st story contains Group M and A-2 occupancies as shown with Group B occupancy above.

<table>
<thead>
<tr>
<th>Group M</th>
<th>Group A-2</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,700</td>
<td>19,800</td>
<td>29,700</td>
</tr>
</tbody>
</table>

Table 508.4 establishes the degree of fire resistance that is mandated.

Separated Occupancies
Section 508.4

• This is the only method that potentially requires a fire-resistance-rated separation between adjacent occupancies.

• Table 508.4 establishes the degree of fire resistance that is mandated.

• Provides a balanced approach in the evaluation of a building’s allowable height and area.
Separated Occupancies
Section 508.4
Allowable area
• The unity formula is used to determine allowable area per story. This provides a weighted average of the allowable areas for the different occupancies located on each story.
• Compliance is achieved where the sum of the ratios of the actual floor area divided by the allowable floor area for each of the occupancies involved does not exceed 1.

Separated Occupancies
Section 508.4
Allowable area
• The formula is:

\[
\frac{a_1}{A_1} + \frac{a_2}{A_2} + \frac{a_3}{A_3} + \ldots \leq 1.0
\]

Where \(a_1, a_2\), and \(a_3\) represent the actual floor areas of the individual occupancies, and \(A_1, A_2\), and \(A_3\) represent the maximum allowable floor areas.

Separated Occupancies
Example
• Given: A one-story, 30,000 square foot, fully-sprinklered building with three occupancy groups, as shown. The building is of Type VB construction and qualifies for a 50% frontage increase.
• Determine: If the building complies with the allowable area limitations based on separated occupancies.
Separated Occupancies

Example

\[
\begin{align*}
\gamma_{A,1} = 24,000 & , \quad \gamma_{A,2} = 4,250 \\
\gamma_{B,1} = 5,000 & , \quad \gamma_{B,2} = 1,500 \\
\gamma_{A,1} & = 3,000 & \text{T506.2 (no sprinkler increase per Sec. 506.2.1)} \\
\gamma_{B,2} & = 1,500 & \text{Frontage} \\
\gamma_{A,1} & = 4,000 & \text{Total Allowable} \\
\gamma_{B,2} & = 4,500 & \text{Total Allowable} \\
\gamma_{A,1} & = 34,000 & \text{T506.2} \\
\gamma_{B,2} & = 4,500 & \text{Frontage} \\
\gamma_{A,1} & = 38,250 & \text{Total Allowable} \\
\gamma_{B,2} & = 40,500 & \text{Total Allowable} \\
0.63 \times 0.12 & = 0.07 < 1.0 & \text{OK}
\end{align*}
\]

Separated Occupancies

Section 508.4

Allowable height

• The maximum allowable height of each occupancy is regulated independently based on the building's type of construction.
• An occupancy cannot be located higher than that permitted by Section 503.1.
Allowable Height and Area Use of Fire Walls

• One or more fire walls complying with Section 706 may be also utilized to gain compliance with height and area limitations, as well as type of construction.

Special Provisions Section 510

• Allows for modifications or exceptions to the general requirements for building areas and heights, taking precedence over any general provisions that may apply.

• Because Section 510 permits, rather than requires, the use of its special conditions, the provisions are optional.
Horizontal Building Separation Allowance
Section 510.2

- The benefit of Section 510.2 is the ability to create two separate buildings, one above the other, for the purpose of applying several specific code provisions independently to each building.

Referred to as "podium" or "pedestal" buildings, they may be viewed as separate buildings above and below the required fire separation for these purposes:

- Determination of allowable area limits.
- Continuity of fire walls.
- Limitation on number of stories.
- Type of construction.

- Vertical enclosures through horizontal assembly to have a minimum fire-resistance rating of 2 hours (see exception for 3-hour/1-hour allowance).
- Building above horizontal assembly limited to Group A with individual occupant loads less than 300, B, M, R and/or S.
- Building below horizontal assembly to be any occupancy other than Group H.
- Maximum building height in feet based on most restrictive height of the upper and lower buildings.
Horizontal Building Separation Allowance
Section 510.2
Requirements to be considered as separate and distinct buildings:

- Lower building of Type IA construction.
- Lower building separated from building above with Type IA horizontal assembly having a minimum fire-resistance rating of 3 hours.

Enclosed Parking Garage Above Open Parking Garage
Section 510.3

- If special provisions are met where a Group S-2 enclosed parking garage is located below a Group S-2 open parking garage, the open parking garage may be classified as a separate and distinct building for type of construction determination.
Parking Beneath Group R
Section 510.4

- Where parking is limited to the first story, the number of stories used in the determination of the minimum type of construction may be measured from the floor above the garage.
- The singular benefit provided by Section 510.4 is the allowance for an additional story above grade plane without requiring a higher type of construction.

Group R-1 and R-2 Buildings of Type IIA and IIIA Construction
Sections 510.5 and 510.6

- The height limitations for Group R-1 and R-2 buildings of Type IIA and IIIA construction are permitted to be increased if special conditions are met.
Buildings of Type IIIA Construction
Section 510.5
For Type IIIA buildings the height limitation may be increased by one story and 10 feet (to 6 stories and 95 feet), where:
• The first floor construction above basement has a minimum fire-resistance rating of 3 hours.
• The floor area is subdivided by a minimum 2-hour fire-resistance-rated fire walls into areas not exceeding 3,000 sf.

Buildings of Type IIA Construction
Section 510.6
For Type IIA buildings the height limitation may be increased to 9 stories and 100 feet (typically 5 stories and 85 feet), where:
• The building is separated by at least 50 feet from any other building on the lot and from lot lines.
• The exits are segregated in an area enclosed by a minimum 2-hour fire-resistance-rated fire wall.
• The first floor construction has a minimum fire-resistance rating of 1½ hours.

Open Parking Garage Beneath Groups A, I, B, M and R
Section 510.7
• Applies to open parking garages only.
• If in compliance, the areas above and below the horizontal separation are permitted to be regulated for allowable height and area as separate buildings.
• Specific fire separation and means of egress requirements have been established to address any reduction in construction type.
Group B or M with an Open Parking Garage Above Section 510.8

- Special provisions address a condition where an open parking garage is located above Group B or M occupancies—representing a desire to have offices and/or retail stores on the lower level(s) of open parking garages.
- The benefit provides for a potential reduction in the building’s type of construction by permitting the evaluation of allowable floor areas independently for the open parking garage and the occupancy.

Group B or M with an Open Parking Garage Above Section 510.8

Multiple Buildings Above Group S-2 Parking Garages Section 510.9

- Where the varying provisions of Section 509 are used to create separate buildings above and below a complying horizontal separation, it is permissible to have multiple buildings above the separation.
- This allowance is limited to those cases where there is a single open or enclosed parking garage below the horizontal separation.
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