

CODE ANALYSIS

Area Calculations and Applications



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California Accessibility

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LEARNING OBJECTIVES

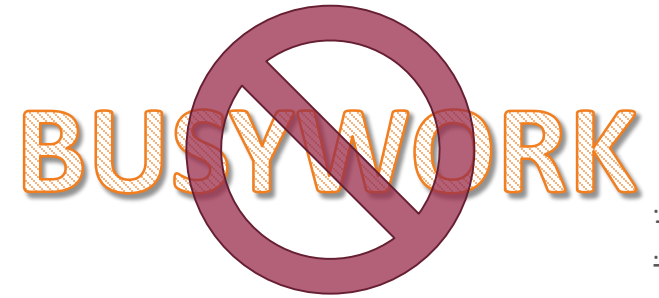
Following this seminar, participants will be able to:

- Explain the types of area calculations used in code analysis and their different applications;
- Understand the ramifications of using the wrong type of area calculation for different parts of code analysis;
- Accurately calculate each type of area used in code analysis; and
- Apply these skills to identify and avoid code analysis problems related to area calculations in current and future projects.

CODE ANALYSIS OVERVIEW

Why do we do code analysis?

PURPOSE OF CODE ANALYSIS



- **Internally verify** the design will not endanger the health, safety, or welfare of building occupants, emergency responders, or the general public (a/k/a “the purpose of building standards codes”).
- **Externally demonstrate** compliance with building standards codes for building officials, who are entrusted with enforcement.
- In addition, provide insights to design team such as:
 - Understanding relationships between essential building data; and
 - Exploring alternative design opportunities.

Example: If fireproofing is known to be required early enough in the design process, then the design can be adjusted to accommodate concealed structural elements, or the budget can be planned around more expensive intumescent fireproofing.

EFFECTIVE USE OF THE BUILDING CODE

EXCERPTED FROM THE 2010 CALIFORNIA BUILDING CODE

-
1. Classify the building for occupancy and construction type.
 - a. Identify the distinct and varied uses of the building (Chapter 3).
 - b. Identify the building's type of construction based on the materials of construction and degree of fire-resistance for the building's major elements (Chapter 6).
 2. Determine if the building is to be fully sprinklered (Chapter 9).
 3. Locate the building on the site.
 - a. Determine the number of buildings on the site (Chapter 5).
 - b. Determine minimum required fire rating of exterior walls (Chapter 6).
 - c. Determine exterior opening protection requirements (Chapter 7).
 - d. Determine frontage increase for allowable area purpose (Chapter 5).
 4. Verify building's construction type by determining the allowable building size (Chapter 5).
 - a. Allowable height in feet and stories.
 - b. Allowable area per floor and as entire building.
 5. Identify extent of any special detailed occupancy requirements (Chapter 4).
 6. Identify and evaluate fire and smoke protective elements (Chapter 7).
 7. Identify additional fire protection systems that may be required (Chapter 9).
 8. Identify and evaluate materials utilized as interior finishes (Chapter 8).
 9. Evaluate means of egress system based on anticipated occupant loads (Chapter 10).
 10. Identify any special use features of the building (Chapter 4).
 11. Determine areas of building and site required to be accessible (Chapter 11A/11B).
 12. Determine extent of other miscellaneous provisions (Chapters 12, 14, 24, 30, 31).

Take-away: Code analysis is NOT a linear process.



COMMON CODE ANALYSIS CONTENTS

- Relevant Code Excerpts
- Type of Construction
- Area Calculations
- Egress Calculations
 - Occupant Load
 - Clear Width
 - Exit/Exit Access Separation
 - Travel Distance
 - *etc.*
- Allowable Height
- Fire Separation Distance
- Mixed Occupancy Separations
- Fire Protection & Suppression
- Locations of Fire Resistive Construction and Protected Openings
- Facility Accessibility



HOW MANY CODE AREA CALCULATIONS SHOULD WE BE DOING?

1. One is good enough! (There's only one building, right?)
2. Two: one for building areas and one plumbing areas.
3. Three: one for building areas, one for plumbing areas, and one for, uh, some other type of area.
4. Is "four" the right answer?
5. Wait, it's not "five" is it?
6. It can't possibly be "six" or more, can it?

CODE ANALYSIS AREA CALCULATIONS

**ZONING
FLOOR
AREA**

Zoning Code /
Planning
Regulations

**ALLOWABLE
BUILDING
AREA**

Building Code
(CBC Chapter 5)

**EGRESS
OCCUPANT
AREA**

Building Code
(CBC Chapter 10)

**FIRE
AREA**

Building Code
(CBC Chapter 9)

**PLUMBING
OCCUPANT
AREA**

Plumbing Code
(CBC Chapter 4)

**GROSS
LEASABLE
AREA**

Building Code
(Chapter 4) —
*only applicable
for covered
mall buildings*

**HAZARDOUS
MATERIALS
CONTROL
AREA**

Building Code
(Chapter 4) —
*only applicable
for “large”
quantity of
hazardous
materials*

**CLIENT-DRIVEN
AREAS (SP,
RENTABLE,
ETC.)**

Defined by client
requirement
and/or third-
party standard
(e.g., BOMA),
not code or
regulation

AREA CALCULATION: ZONING FLOOR AREA

Floor Area

Zoning Code / Planning Regulations (Municipal Code)

ZONING FLOOR AREA


$$A_{\text{zoning}} \div A_{\text{site}} \leq \text{F.A.R.}$$

Purpose

- Basis of F.A.R. intended to limit density of development
- Based on zoning or planning regulations, not a building code
- Methods typically vary by local jurisdiction/municipality
- In California, public agencies are generally exempted from municipal zoning codes and planning regulations

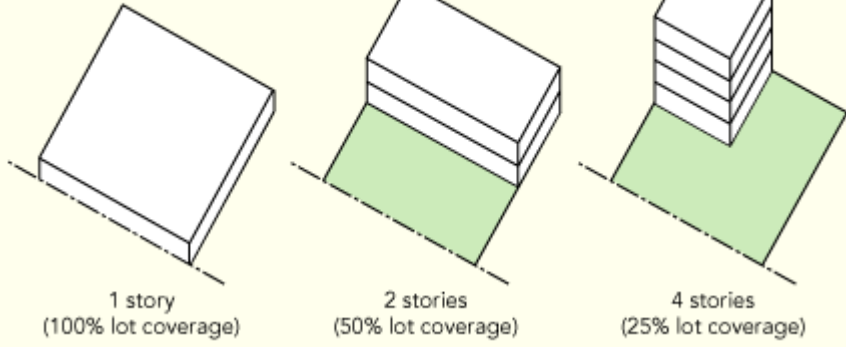


Calculation: Gross SF, per site

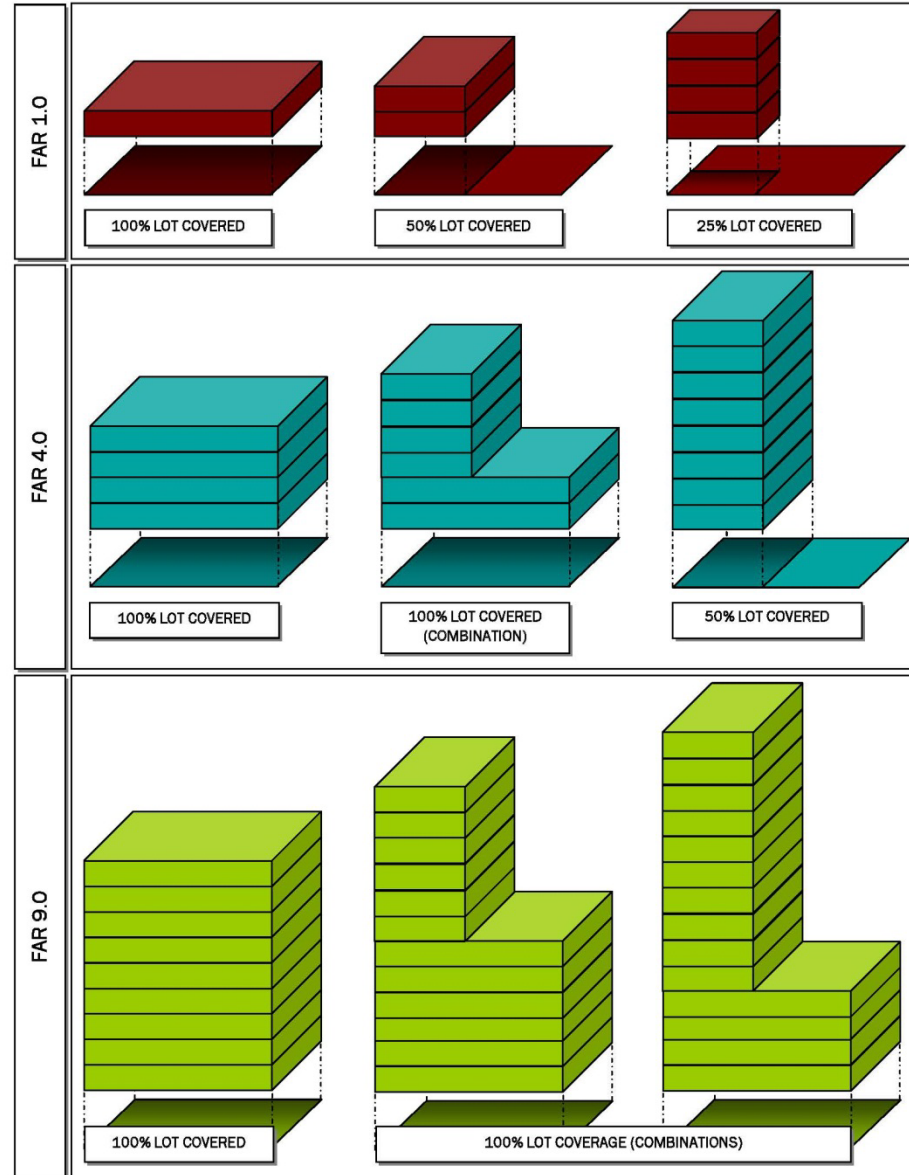
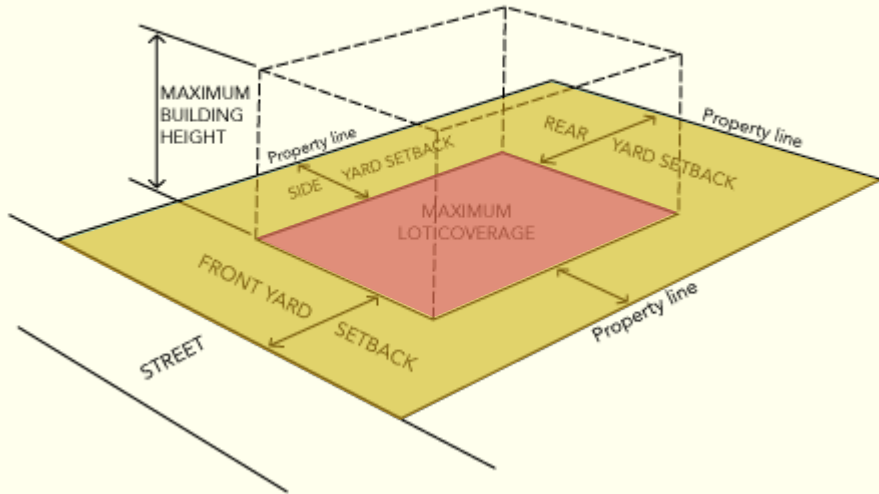
- Usually includes gross area of all built levels, including basement
- Often excludes:
 - Building services spaces (electrical, mechanical, elevator equipment)
 - Vertical circulation spaces (stairs, elevators, escalators)
 - Accessory or required structures
- Often includes:
 - Thickness of exterior walls
 - Exterior covered areas

Floor Area Ratio (FAR)

1:1 Ratio



Building Envelope



FAR based on **total site area** (most non-residential, City of Los Angeles)

FAR based on **buildable area** (most residential, City of Los Angeles)

AREA CALCULATION: ALLOWABLE BUILDING AREA

Building Area

Building Code (Chapter 5)


$$A_{\text{bldg}} \leq A_{\text{allow}}$$

ALLOWABLE BUILDING AREA

Purpose

- Basis of requirements for fire resistive construction and fire suppression systems, and limitations of height and area
- Ensures buildings become progressively “safer” the larger they become
 - *If you don't want to include a particular safety feature, then you must build a smaller building!*

Calculation: Gross SF, per story, per building

- Includes:
 - Interior areas within exterior walls and fire walls
 - Exterior areas under horizontal projection of roof or floor above
- Excludes:
 - *Vent shafts*
 - *Courts*
 - *Mezzanines*
 - *Exterior wall/fire wall thickness*

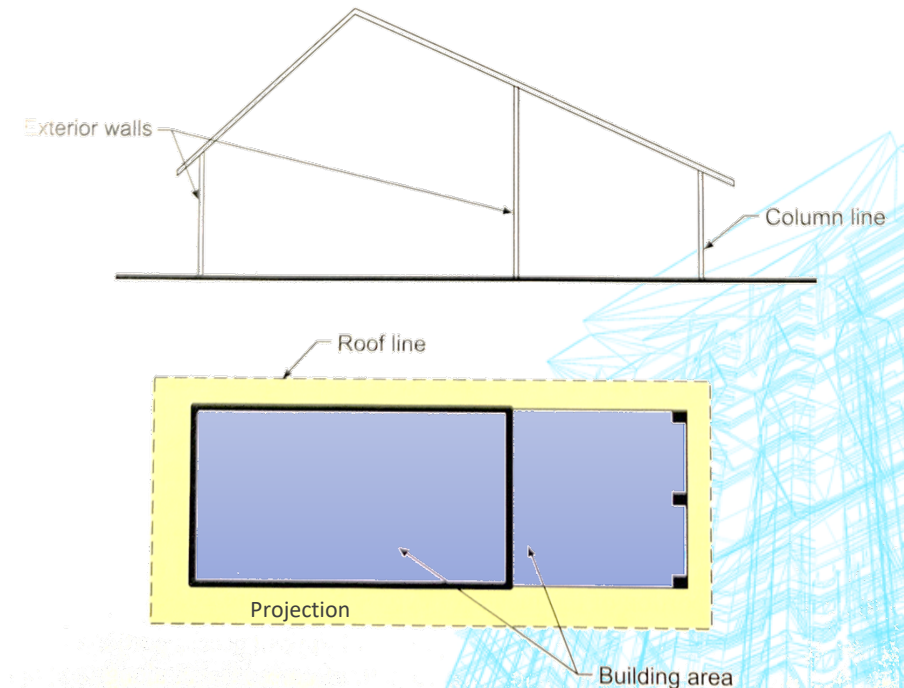


BUILDING AREA. The term *building area* describes that portion of the building's floor area to be utilized in the determination of whether or not a structure complies with the provisions of Chapter 5 for allowable building size. It is not to be confused with the term *floor area*, which is the basis for occupant-load determination in Chapter 10 for means of egress evaluation, nor the term *fire area* as used in the application of automatic sprinkler requirements in Chapter 9.

The definition of building area is the area included within the surrounding exterior walls of the building, and the definition further states that the floor area of a building or portion thereof not provided with surrounding exterior walls shall be the usable area under the horizontal projection of the roof or floor above. The intent of this latter provision is to address where a structure may not have exterior walls or may have one or more sides open without an enclosing exterior wall. Examples would include a canopy covering pump islands at a service station, or the drive-through area of a fast food restaurant. Where a column line establishes the outer perimeter of the usable space under the roof, it is also typically the extent of building area. Beyond the column line, the overhead cover is simply viewed as a projection. See Figure 202-3. If all of the area beneath the roof above can be considered usable space, then the building area is measured to the leading edge of the roof above. See Figure 202-4.

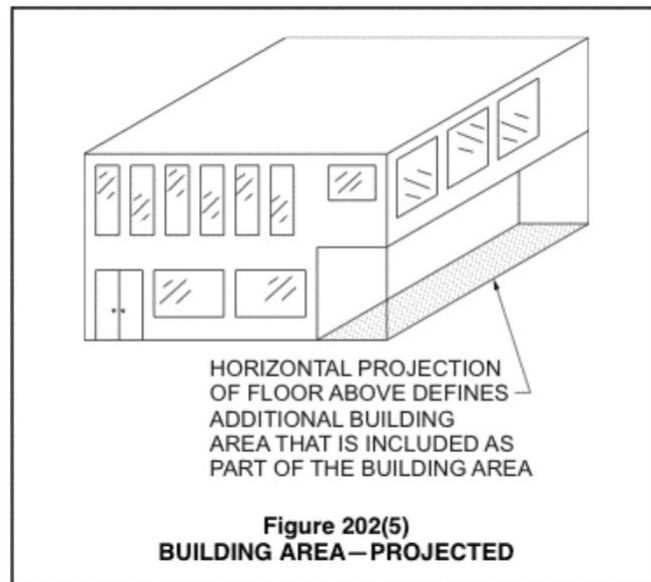
UNOFFICIAL GUIDANCE

An area beneath an overhang becomes usable when it is at least 36" deep.



AREA, BUILDING. The area included within surrounding *exterior walls* (or *exterior walls* and *fire walls*) exclusive of vent *shafts* and *courts*. Areas of the building not provided with surrounding walls shall be included in the building area if such areas are included within the horizontal projection of the roof or floor above.

- ❖ Allowable building areas (as established by the provisions of Chapter 5 and Table 506.2) are a function of the potential fire hazard and the level of fire endurance of the building's structural elements, as defined by the types of construction in Chapter 6. A building area is the "footprint" of the building; that is, the area measured within the perimeter formed by the inside surface of the exterior walls. This excludes spaces that are inside this perimeter and open to the outside atmosphere at the top, such as open shafts and courts (see Section 1206). When a portion of the building has no exterior walls, the area regulated by Chapter 5 is defined by the projection of the roof or floor above [see Commentary Figure 202(5)]. The roof overhang on portions of a building where there are exterior enclosure walls does not add to the building area because the area is defined by exterior walls.



“

As the definition of *building area* states, the measurement of a building's floor area is taken within the *exterior walls* and excludes the area occupied by the *exterior walls*...

Also excluded from the *building area* are *vent shafts* and *courts*. A *court* is defined by the IBC; however, a *vent shaft* is not. *Courts* are spaces surrounded on three or more sides by building walls or other devices and are open to the sky. Similarly, *vent shafts* are considered to be those areas surrounded by building walls and open to the sky for ventilation purposes and are not usually accessible by the occupants, unlike *courts*, which can be occupied.

— *Applying the Building Code: Step-by-Step Guidance for Design and Building Professionals* by Ronald L. Geren, John Wiley & Sons (2016), pp 21-22.

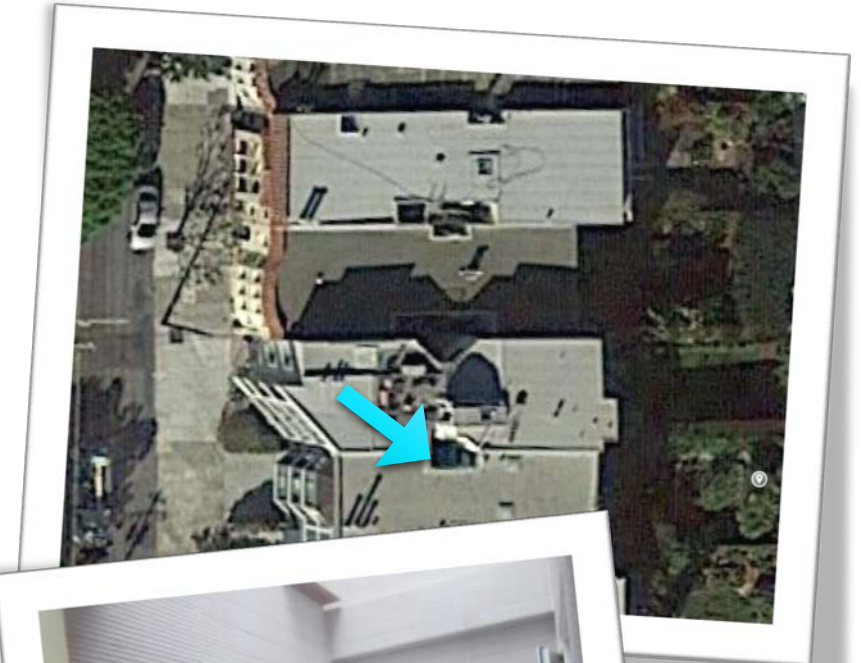
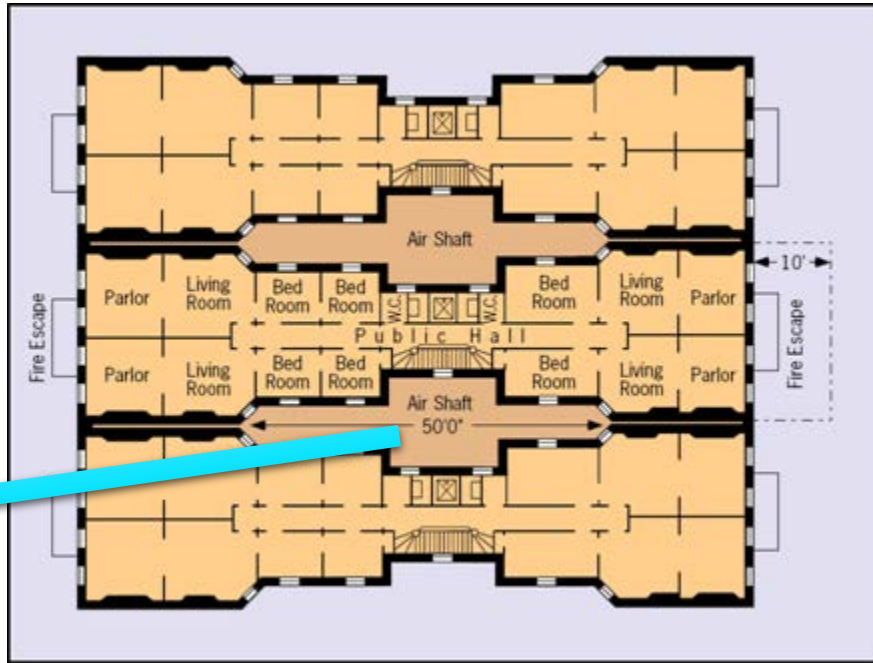
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Unless they are **open to the sky at the top**, all other types of shafts — including mechanical (duct) shafts, elevator hoistways, and stair enclosures — are included for each floor in the calculation of actual building area!

VENT SHAFT

Excerpted from Chapter 25 of *The American Pageant* by Kennedy, Cohen & Bailey (Houghton Mifflin).



Google Maps



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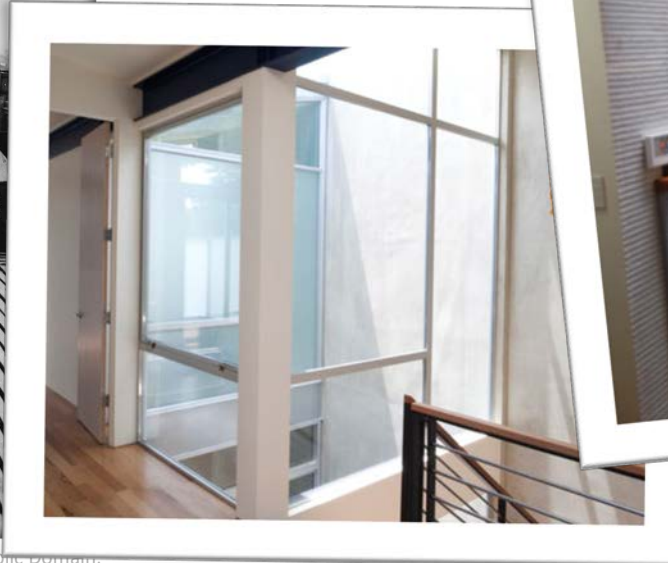
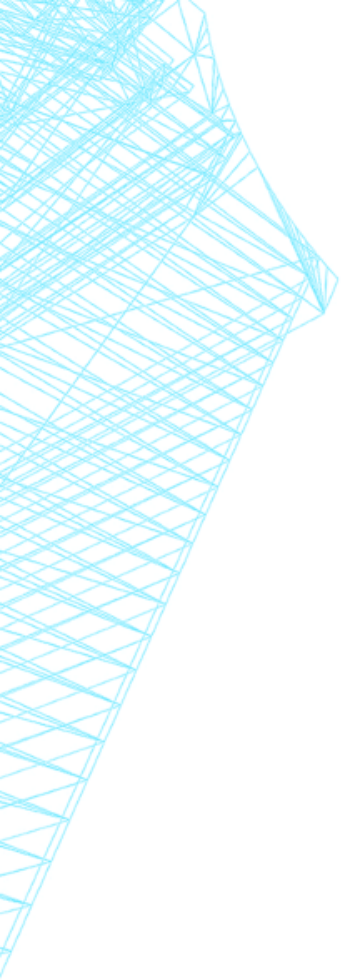


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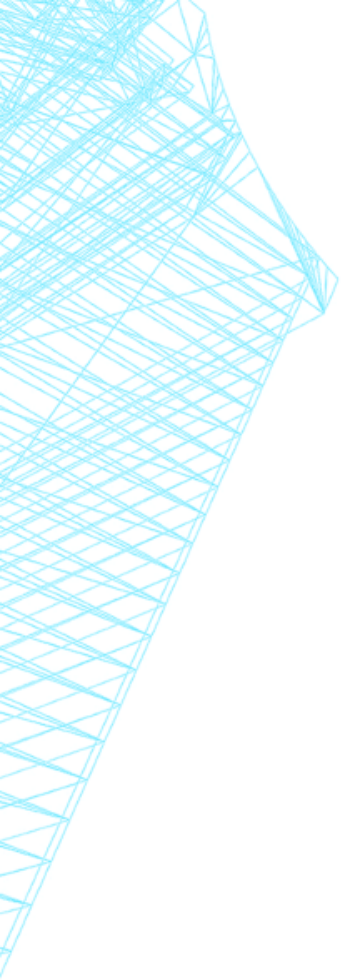


We'll return to allowable building area calculations at the end of this seminar.

AREA CALCULATION: EGRESS OCCUPANT AREA

Floor Area

Building Code (Chapter 10)



EGRESS OCCUPANT AREA

OCCUPANTS
→ EGRESS
COMPONENTS

Purpose

- Determines the maximum number of occupants in a given space (based on the function of that space), on a given floor, and within an overall building
- Determines the minimum width and number of means of egress components, such as doorways and stairs, so that building occupants can safely exit the building in a timely fashion

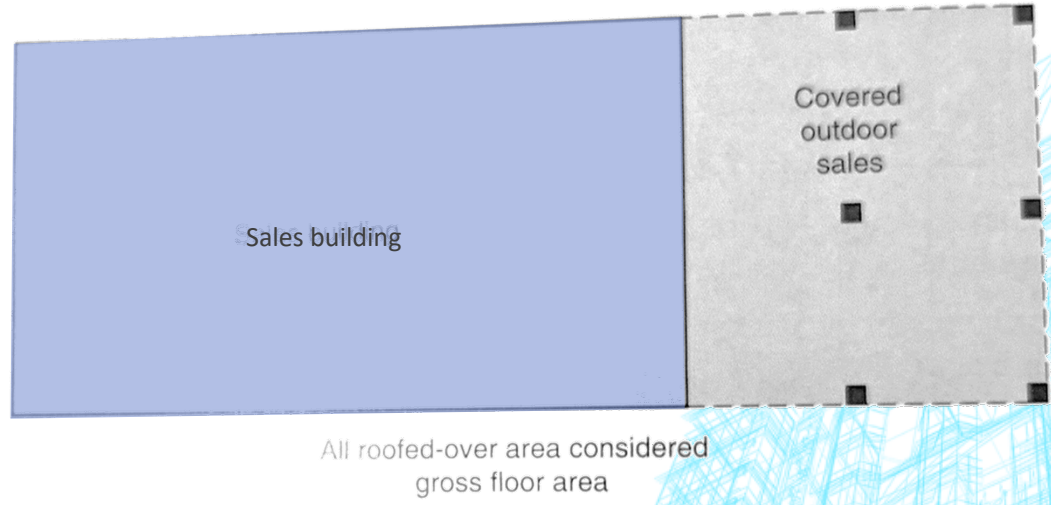
Calculation: Net and Gross SF, per space, per story

- Includes:
 - Interior areas within exterior walls
 - *Usable* exterior areas under horizontal projection of roof or floor above
 - **Mezzanines**
- Excludes:
 - Vent shafts and courts
 - Exterior wall thickness
 - Shafts with no openings (gross SF)
 - Unusable space (net SF)



FLOOR AREA, GROSS. As evidenced in Table 1004.1.2, the determination of the occupant load in the design of the means of egress system for most building uses is typically based on the gross floor area. This term describes the total floor area included within the surrounding exterior walls of a building, and the definition further states that the floor area of the building or portion thereof not provided with surrounding exterior walls shall be the usable area under the horizontal projection of the roof or floor above. The intent of this latter provision is to cover where a structure may not have exterior walls or may have one or more sides open without an enclosing exterior wall. Where buildings are composed of both enclosed and unenclosed areas, the gross floor area is typically determined as illustrated in Figure 202-11.

Projections extending beyond an exterior wall or column line that are not intended to create usable space below are not to be considered in the determination of gross floor area. **Areas often considered accessory-type spaces, such as closets, corridors, elevator shafts, and stairways, must also be considered a part of the gross floor area.**



FLOOR AREA, NET. The net floor area is considered that portion of the gross floor area that is typically occupied. Normally unoccupied accessory areas such as corridors, stairways, closets, toilet rooms, equipment rooms, and similar spaces are not to be included in the calculation of net floor area. In addition, the measurements are based on clear floor space, allowing for the deduction of building construction features such as interior walls and columns, as well as elevator shafts and plumbing chases. The use of net floor area in the calculation of design occupant load is typically permitted only in assembly and educational uses as set forth in Table 1004.1.2. It is important to note that in calculating net floor area, as well as gross floor area, **the floor space occupied by furniture, fixtures, and equipment is not to be excluded in the calculation.** The floor-area-per-occupant factor established in Table 1004.1.2 includes any such anticipated furnishings in the establishment of an appropriate density estimate.

OCCUPIABLE SPACE. A number of provisions in the code apply only to those spaces, rooms, or areas typically occupied during the course of a building's use. This definition clarifies that an occupiable space is intended for human occupancy, and as such is provided with means of egress, as well as light and ventilation facilities. Occasionally, the code refers to the term *normally occupied space*. For example, Section 1022.4 limits openings in interior exit stairways to those necessary for exit access from *normally occupied spaces*.

Although not defined in the code, these spaces are generally occupied for extended periods of time during the building's use. There is an expectation that a fire or other hazardous condition would be quickly identified and addressed, rather than go unnoticed for an extended time. Examples of those spaces that would not be considered *normally occupied* include storage rooms, mechanical equipment rooms, and toilet rooms.

FLOOR AREA, GROSS. The floor area within the inside perimeter of the *exterior walls* of the building under consideration, exclusive of vent *shafts* and *courts*, without deduction for *corridors*, *stairways*, *ramps*, closets, the thickness of interior walls, columns or other features. The floor area of a building, or portion thereof, not provided with surrounding *exterior walls* shall be the usable area under the horizontal projection of the roof or floor above. The gross floor area shall not include *shafts* with no openings or interior *courts*.

❖ Gross floor area is that area measured **within the perimeter formed by the inside surface of the exterior walls**. The area of all occupiable and nonoccupiable spaces, including mechanical and elevator shafts, toilet rooms, closets and mechanical equipment rooms, are included in the gross floor area. This area could also include any covered porches, carports or other exterior space intended to be used as part of the building's occupiable space. Both gross and net floor areas are used for the determination of occupant load in accordance with Table 1004.1.2.

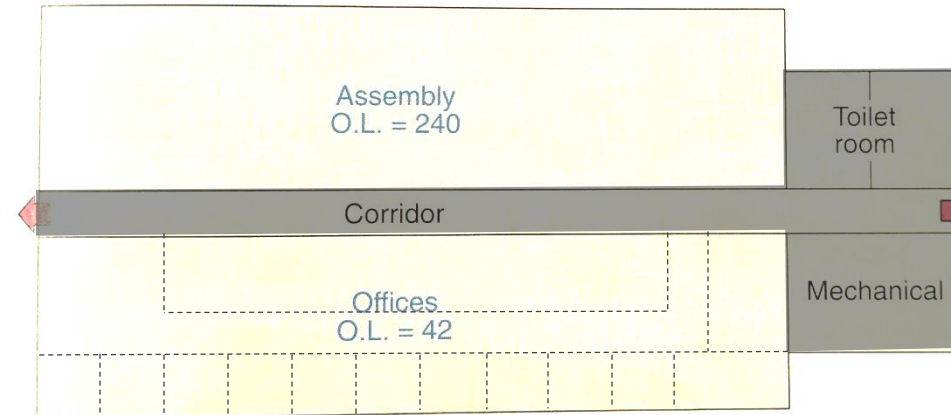
FLOOR AREA, NET. The actual occupied area not including unoccupied accessory areas such as *corridors*, *stairways*, *ramps*, toilet rooms, mechanical rooms and closets.

❖ This area is intended to be **only the room areas that are used for specific occupancy purposes** and does not include circulation areas, such as corridors, ramps or stairways, or service and utility spaces, such as toilet rooms and mechanical and electrical equipment rooms. **Net floor area is typically measured between inside faces of walls within a room.** Floor area, net and gross, is utilized in Table 1004.1.2 to determine occupant load for a space.



GIVEN: A building with assembly area and business areas as shown.

DETERMINE: The design occupant load of the building.



SOLUTION: The occupant load is simply 282, the combination of the assembly and business spaces. **It is not necessary to consider the corridor, toilet rooms, and other small accessory spaces that serve the entire building.** *Note that within the office area itself, such circulation and accessory areas would be included in the calculation.*

UNOFFICIAL GUIDANCE: If the top area was also Offices like the bottom area, then the gross area calculation **would** include the areas of the corridor, toilet room, and mechanical spaces on this floor. The presence of a significant “net OLF” space on a given floor allows the exclusion of “accessory” spaces that serve the entire floor/building.

In specifying how the occupant load is to be determined, the code intends that **it is to be assumed that all portions of a building are fully occupied at the same time**. It may be recognized, however, that in limited instances not all portions of the building are, in fact, fully occupied simultaneously. ... **It is important to note that the code does not provide a method to address such conditions; thus, full occupancy should always be assumed.** Only under rare and unusual circumstances should the building official ever consider reducing the design occupant load because of the nonsimultaneous use concept.

Another type of support area that must be considered in occupant-load calculation includes corridors, closets, toilet rooms, and mechanical rooms. **These uses are typical of most buildings and are to be included by definition in the gross floor area of the building.** A quick review of Table 1004.1.2 will show that most of the uses listed are to be evaluated based on **gross floor area, with no reduction for corridors** and the like. However, a few of the listings indicate the use of the net floor area in the calculation of the occupant load.

NET OLF

An example [of using net floor area] would be the determination of an occupant load in a school building. The building official should calculate the occupant load in such buildings using only the administrative, classroom, and assembly areas. It is generally assumed that when corridors, restrooms, and other miscellaneous spaces are occupied, they are occupied by the same people who are at other times occupying the primary use spaces.

TABLE 1004.1.2
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR ^a
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit Gallery and Museum	30 net
Assembly with fixed seats	See Section 1004.4
Assembly without fixed seats	
Concentrated (chairs only-not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net
Bowling centers, allow 5 persons for each lane including 15 feet of runway, and for additional areas	7 net
Business areas	100 gross
Courtrooms—other than fixed seating areas	40 net
Day care	35 net
Dormitories	50 gross
Educational	
Classroom area	20 net
Shops and other vocational room areas	50 net
Exercise rooms	50 gross
H-5 Fabrication and manufacturing areas	200 gross
Industrial areas	100 gross
Institutional areas	
Inpatient treatment areas	240 gross
Outpatient areas	100 gross
Sleeping areas	120 gross
Kitchens, commercial	200 gross

TABLE 1004.1.2
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR ^a
Library	
Reading rooms	50 net
Stack area	100 gross
Mall buildings—covered and open	See Section 402.8.2
Mercantile	60 gross
Storage, stock, shipping areas	300 gross
Parking garages	200 gross
Residential	200 gross
Skating rinks, swimming pools	
Rink and pool	50 gross
Decks	15 gross
Stages and platforms	15 net
Warehouses	500 gross

For SI: 1 square foot = 0.0929 m².

a. Floor area in square feet per occupant.

❖ Table 1004.1.2 establishes minimum occupant densities based on the function or actual use of the space (not group classification). The table presents the maximum floor area allowance per occupant (i.e., occupant load factor) based on studies and counts of the number of occupants in typical buildings. The use of this table, then, results in the minimum occupant load for which rooms, spaces and the building must be designed. While an assumed normal occupancy may be viewed as somewhat less than that determined by the use of the table factors, such a normal occupant load is not necessarily an appropriate design criterion.

The greatest hazard to the occupants occurs when an unusually large crowd is present. The code does not limit the occupant load density of an area, except as provided for in Section 1004.2, but once the occupant load is established, the means of egress must be designed for at least that capacity. If it is intended that the occupant load will exceed that calculated in accordance with the table, then the occupant load is to be based on the estimated actual number of people, but not to exceed the maximum allowance in accordance with Section 1004.2. Therefore, the occupant load of the office or business areas in a storage warehouse or nightclub is to be determined using the occupant load factor most appropriate to that space—one person for each 100 square feet (9 m²) of gross floor area.

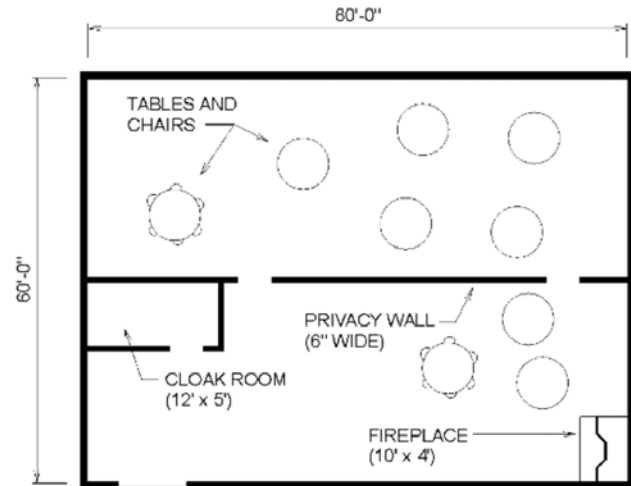
Net OLF is generally limited to assembly and educational spaces.

The use of net and gross floor areas as defined in Chapter 2 is intended to provide a refinement in the occupant load determination. The gross floor area technique applied to a building only allows the deduction of the plan area of the exterior walls, vent shafts and interior courts from the plan area of the building.

The net floor area permits the exclusion of certain spaces that would be included in the gross floor area. The net floor area is intended to apply to the actual occupied floor areas. **The area used for permanent building components, such as shafts, fixed equipment, thicknesses of walls, corridors, stairways, toilet rooms, mechanical rooms and closets, is not included in net floor area.** For example, consider a restaurant dining area with dimensions measured from the inside of the enclosing walls of 80 feet by 60 feet (24 384 mm by 18 288 mm) (see Commentary Figure 1004.1.2). Within the restaurant area is a 6-inch (152 mm) privacy wall running the length of the room [80 feet by 0.5 feet = 40 square feet (3.7 m²)], a fireplace [40 square feet (3.7 m²)] and a cloak room [60 square feet (5.6 m²)]. Each of these areas is deducted from the restaurant area, resulting in a net floor area of 4,660 square feet (433 m²). Since the restaurant intends to have unconcentrated seating that involves loose tables and chairs, the resulting occupant load is 311 persons (4,660 divided by 15). As the definition of "Floor area, net" indicates, certain spaces are to be excluded from the gross floor area to derive the net floor area. The key point in this definition is that the net floor area is to include the actual occupied area and does not include spaces uncharacteristic of that occupancy.

In determining the occupant load of a building with mixed groups, each floor area of a single occupancy must be separately analyzed, such as required by Section 1004.6. The occupant load of the business portion of an office/warehouse building is determined at a rate of one person for each 100 square feet (9 m²) of office space, whereas the occupant load of the warehouse portion is determined at the rate of one person for each 300 square feet (28 m²). There may even be different uses within the same room. For example, a restaurant dining room would have seating but may also have a waiting area with standing room, a take-out window with a queue line or employee areas behind a bar or reception desk.

Intended process starts with *gross floor area* and **subtracts** elements not applicable to *net floor area*.



	80' x 60' = 4,800 SQ.FT.
PRIVACY WALL:	40 SQ.FT.
FIREPLACE:	40 SQ.FT.
CLOAK ROOM:	60 SQ.FT.
TOTAL:	140 SQ.FT.

$$\text{(TOTAL AREA WITHIN WALLS)} - \text{(EXCLUDED ITEMS)} = \text{(NET FLOOR AREA)}$$

$$4,800 \text{ SQ.FT.} - 140 \text{ SQ.FT.} = 4,660 \text{ SQ.FT.}$$

$$\text{(NET FLOOR AREA)} / \text{(TABLE 1004.1.2 VALUE)} = \text{(OCCUPANT LOAD)}$$

$$4,660 \text{ SQ.FT.} / 15 \text{ SQ.FT. PER OCCUPANT} = 311 \text{ OCCUPANTS}$$

Figure 1004.1.2
TYPICAL NET FLOOR AREA OCCUPANT LOAD CALCULATION

If a specific type of facility is not found in the table, the occupancy it most closely resembles should be utilized. For example, a training room in a business office may utilize the 20-square-foot (1.86 m²) net established for educational classroom areas, or a dance or karate studio may use the occupant load for rinks and pools for the studio areas.

Table 1004.1.2 presents a method of determining the absolute base minimum occupant load of a space that the means of egress is to accommodate.

The table occupant loads are based on the stereotypical configuration of spaces. For example, the dorm requirements were written based on dormitories with sleeping rooms with two to four students, a gang bathroom and a meeting/study lounge on each floor. Dormitory buildings that operate like army barracks may have a heavier occupant load, while facilities with groups of rooms with private bathrooms, living and even kitchenette areas may have a lower occupant load. Industrial facilities are based on typical fabricating plants. Warehouses are based on consistent in and out movement of product by employees. Factories with largely mechanized operations or warehouses that contain long-term storage are other examples where discussion with the building official and the application of the exception in Section 1004.1.2 might be considered.

In addition to the table, Section 402 contains the basis for calculating the occupant load of a covered mall building; however, Table 1004.1.2 should be used for determining the occupant load of each anchor store.

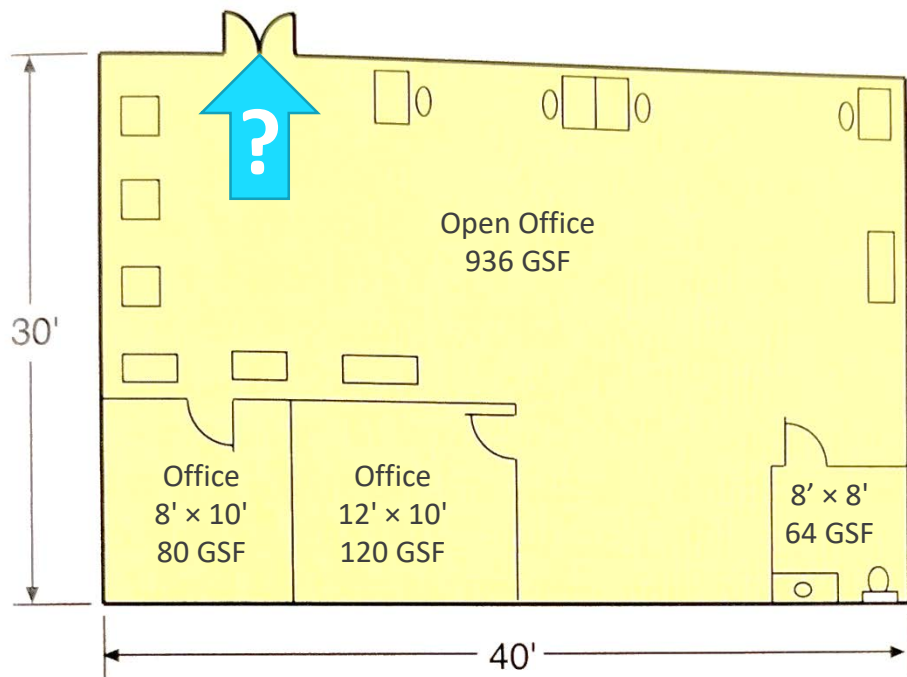
UNOFFICIAL GUIDANCE

It's acceptable to start with *net floor area* if all spaces are net OLF; but where there is a mix of floor area types, it is faster (and easier!) to start with *gross floor area* and subtract net OLF spaces.



GIVEN: Office Suite in Group B Occupancy.

DETERMINE: Occupant load for egress door.



In most areas subject to **gross OLF**, the occupant load of an individual space is only important if it exceeds 49 (which triggers other code provisions).

Business areas	100 gross
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Room/Space	Area	OLF	#Occupants
Open Office	936 GSF	100 GSF	10
Office	80 GSF	100 GSF	1
Office	120 GSF	100 GSF	2
Restroom	64 GSF	100 GSF	1
TOTALS	1200 GSF		14

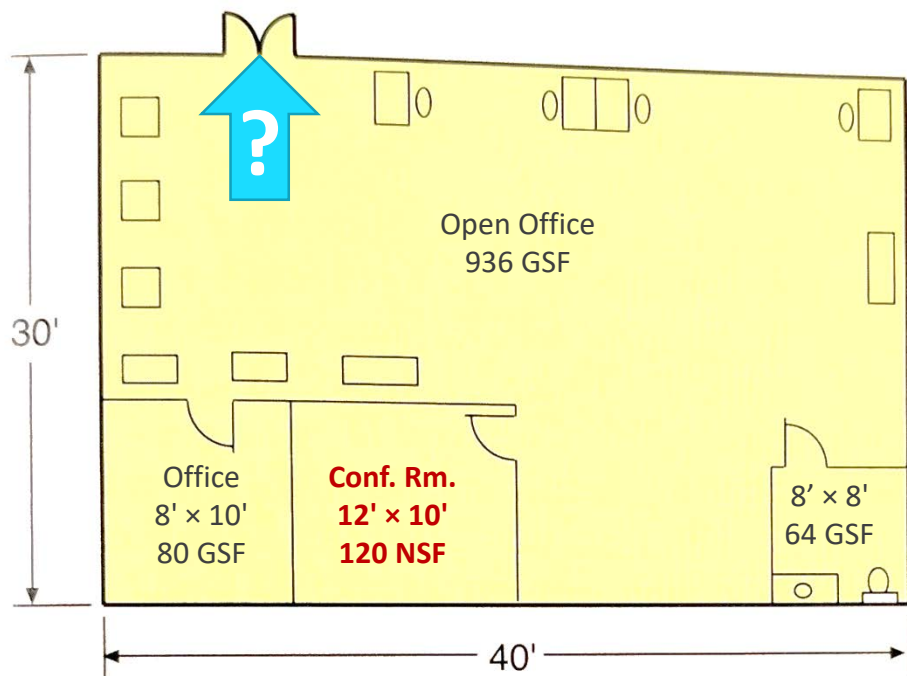
1. $30' \times 40' = 1,200$ GSF
Calculate gross floor area
2. $1,200$ GSF \div 100 GSF (OLF) = **12 OCC**
Divide gross floor area by OLF

Every space subject to **net OLF** must be individually calculated because the area of surrounding walls is not included.



GIVEN: Office Suite in Group B Occupancy with conference room.

DETERMINE: Occupant load for egress door.



Assembly without fixed seats	
Concentrated (chairs only-not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net
Business areas	100 gross

1. $30' \times 40' = 1,200$ GSF (overall)
Calculate gross floor area
2. $12' \times 10' = 120$ NSF (conference room)
Calculate net floor area
3. $1,200$ GSF $-$ 120 NSF = $1,080$ GSF
Subtract net floor area from gross floor area
4. $1,080$ GSF \div 100 GSF (OLF) = 11 OCC
Divide remaining gross floor area by OLF
5. 120 NSF \div 15 NSF (OLF) = 8 OCC
Divide net floor area by OLF
6. 11 OCC + 8 OCC = **19 OCC**
Add occupant counts from gross and net floor areas

AREA CALCULATION: FIRE AREA

Fire Area

Building Code (Chapter 9)

FIRE AREA

Purpose

- Determines the need for fire suppression systems (typically sprinklers)
- Accommodates adequate level of fire safety for larger buildings through **compartmentalization** (passive protection) in lieu of fire suppression systems (active protection)

Follows *floor area* for interior spaces and *building area* for exterior spaces

$$A_{\text{fire}} \leq A_{\text{sprinkler}}$$

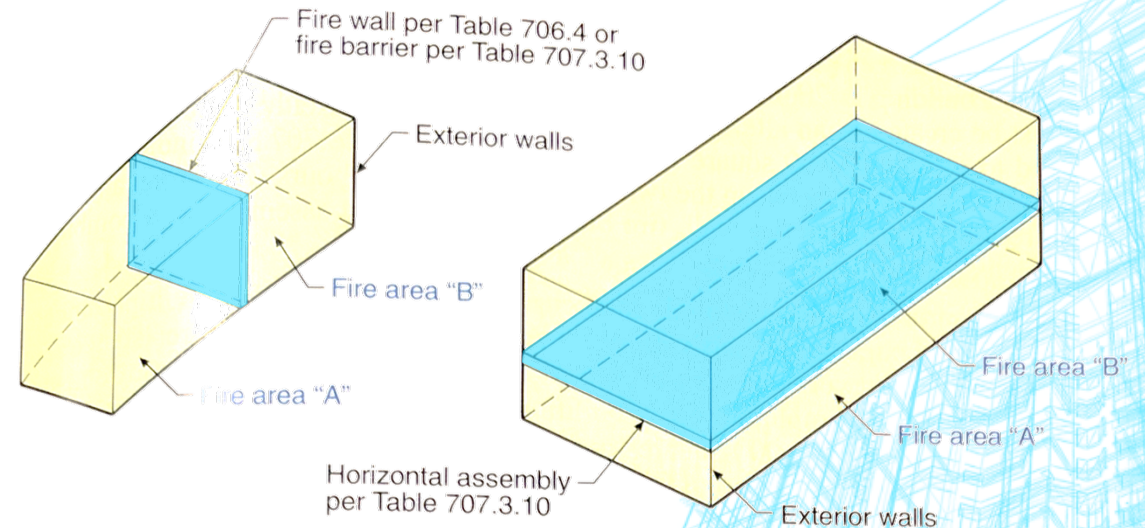
Calculation: Gross SF, per fire area (*multi-story*)

- Includes:
 - Enclosed floor area within exterior walls, fire barriers, and fire walls
 - Unenclosed floor areas under horizontal projection of roof or floor *next* above
 - **Mezzanines**
- Excludes:
 - Enclosing wall thickness
 - Areas open to sky (e.g., vent shafts and courts)

FIRE AREA. Many of the provisions of Section 903 requiring the installation of automatic sprinkler systems utilize the fire area concept. A fire area is considered a compartment that will contain a fire such that the maximum fire size will be limited to the size of the compartment. An in-depth review of fire areas is found in the discussion of Section 901.7.

Fire areas. The fire area concept is based on a time-tested approach to limiting the spread of fire in a building. Through the use of fire-resistive elements, compartments can be created that are intended to contain a fire for a prescribed period of time. The floor area that occurs within each such compartment is considered to be the fire area. By definition, a fire area is the aggregate floor area enclosed and bounded by fire walls, fire barriers, exterior walls, and/or fire-resistance horizontal assemblies of a building. See Figure 901-1.

In addition, any areas beyond the exterior wall that are covered with a floor or roof above, such as a canopy extending from the building, are considered part of the building for fire area purposes. This approach is consistent with the determination of building area in Chapter 2. An example is shown in Application Example 901-1. By isolating a fire condition to a single fire area through the use of fire separation elements, only a portion of the building is considered at risk because of a single fire incident.

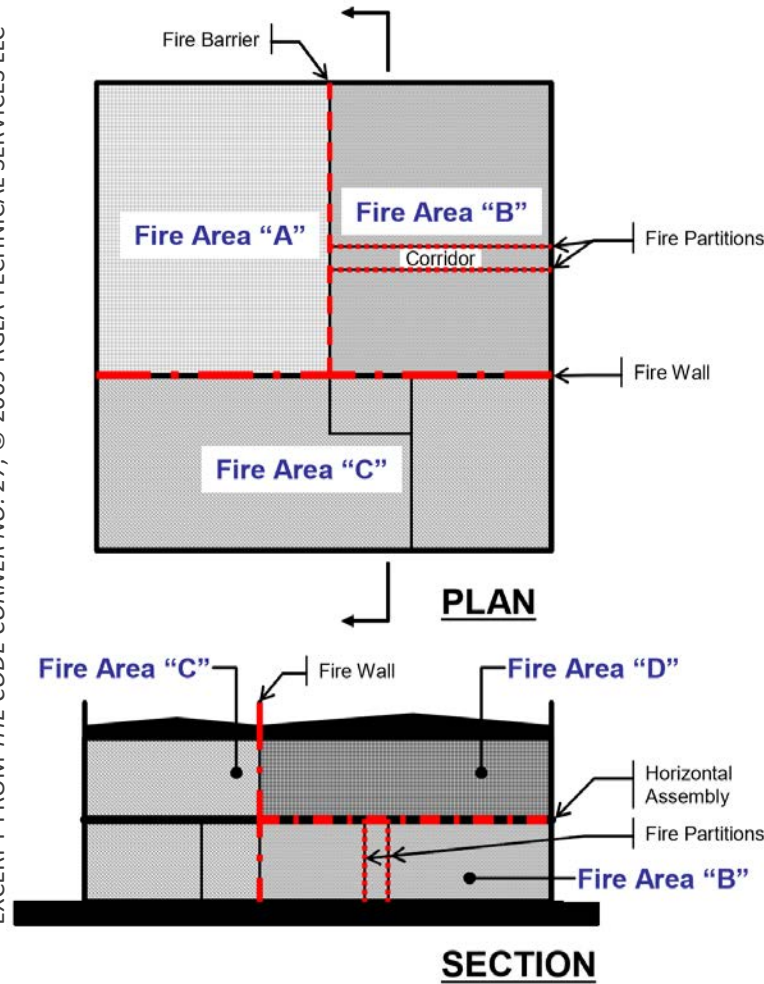


FIRE AREA. The aggregate floor area enclosed and bounded by *fire walls, fire barriers, exterior walls or horizontal assemblies* of a building. Areas of the building not provided with surrounding walls shall be included in the fire area if such areas are included within the horizontal projection of the roof or floor next above.

❖ This term is used to describe a specific and controlled area within a building that may consist of a portion of the floor area within a single story, one entire story or the combined floor area of several stories, depending on how these areas are enclosed and separated from other floor areas. Where a fire barrier with a fire-resistance rating in accordance with Section 707.3.10 divides the floor area of a one-story building, the floor area on each side of the wall would constitute a separate fire area. If a horizontal assembly separating the two stories in a two-story building is fire-resistance rated in accordance with Section 711.2.4, each story would be a separate fire area. **In cases where mezzanines are present, the floor area of the mezzanine is included in the fire area calculations, even though the area of the mezzanine does not contribute to the building area calculations.** See the commentary to Sections 707.3.10 and 711.2.4 for further information.

Note that fire walls are one way of creating fire areas but are typically used to create separate buildings.

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CODE ANALYSIS: Area Calculations and Applications

12/13/2017

Note: Occupancy separations (Chapter 5) are *fire barriers*, but may not be of sufficient hourly rating to qualify as enclosure walls for fire areas (Chapter 7)!

**TABLE 508.4
REQUIRED SEPARATION OF OCCUPANCIES (HOURS)**

OCCUPANCY	A, E		I-4, R-2.1		I-2, I-2.1		I-3		R-1, R-2, R-3, R-3.1, R-4		F-2, S-2 ^b , U		B ^f , F-1 ^{a,f} , M, S-1		L		H-1		H-2		H-3, H-4		H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	2	2	2	NP	2	NP	1	2	N	1	2	2	NP	NP	NP	3	4	2	3	2	NP	
I-4, R-2.1	—	—	1 ^c	NP	2	NP	2	NP	1	NP	1	2	1	2	2	NP	NP	NP	4	NP	4	NP	4	NP
I-2, I-2.1	—	—	—	—	N	NP	2	NP	2	NP	2	NP	2	NP	2	NP	NP	NP	4	NP	4	NP	4	NP
I-3	—	—	—	—	—	—	N	NP	2	NP	2	2	2	2	2	NP	NP	NP	4	NP	4	NP	4	NP
R-1, R-2, R-3, R-3.1, R-4	—	—	—	—	—	—	—	—	N	N	1 ^c	2 ^c	1	2	4	NP	NP	NP	3	NP	2	NP	2	NP
F-2, S-2 ^b , U	—	—	—	—	—	—	—	—	—	—	N	N	1	2	1	NP	NP	NP	3	4	2	3	2	NP
B, F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	—	—	N	N	1	NP	NP	NP	2	3	1	2	1	NP
L	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	NP	NP	NP	2	NP	1	NP	1	NP
H-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	NP	NP	NP	NP	NP	NP	NP
H-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	1	NP	1	NP	NP
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1 ^d	NP	1	NP
H-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
 NS = Buildings not equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
 N = No separation requirement.
 NP = Not permitted.
 a. See Section 420.
 b. The required separation from areas used only for private or pleasure vehicles shall be reduced by 1 hour but to not less than 1 hour.
 c. See Section 406.3.4.
 d. Separation is not required between occupancies of the same classification.
 e. [SFM] Group I and F1 occupancies and Group R-2.1 and F-1 occupancies shall have a 3 hour separation.
 f. [SFM] Commercial kitchens not associated with cafeterias and similar dining facilities in Group I-2 and Group R-2.1 shall have a 2-hour separation and shall be protected by an automatic sprinkler system.

707.3.10 Fire areas. The fire barriers or horizontal assemblies, or both, separating a single occupancy into different fire areas shall have a fire-resistance rating of not less than that indicated in Table 707.3.10. The fire barriers or horizontal assemblies, or both, separating fire areas of mixed occupancies shall have a fire-resistance rating of not less than the highest value indicated in Table 707.3.10 for the occupancies under consideration.

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

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
H-1, H-2	4
F-1, H-3, S-1	3
A, B, E, F-2, H-4, H-5, I, L, M, R, S-2	2
U	1





GIVEN: A large building is to be divided into various retail, business, and assembly tenants having the floor areas indicated.

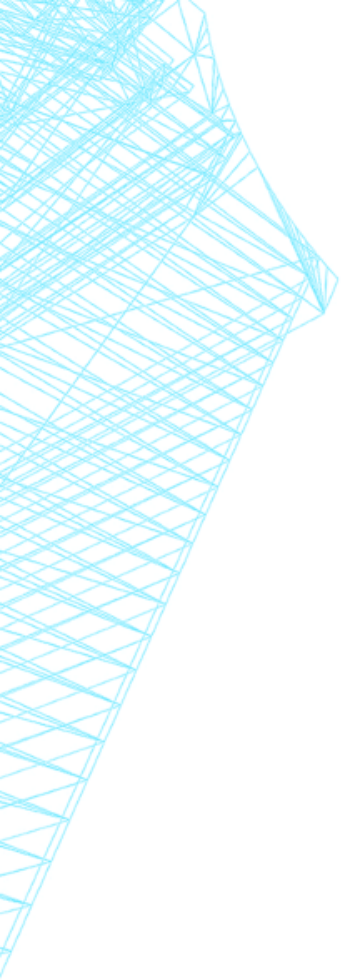
DETERMINE: A method in which the space can be subdivided into individual fire areas by fire barriers and not be required to be protected by an automatic sprinkler system.



- Automatic sprinkler system is not required by Section 903.2 based on creation of complying fire areas
- Fire areas are created with fire barriers rated in accordance with Table 707.3.10 (not Table 508.4)

AREA CALCULATION: PLUMBING OCCUPANT AREA

Occupancy Area
Plumbing Code (Chapter 4)



PLUMBING OCCUPANT AREA

OCCUPANTS
→ PLUMBING
FIXTURES

Purpose

- Determines the anticipated number of occupants that need access to plumbing fixtures in a given “use area”
- Determines the minimum number of plumbing fixtures required to exist within 500 feet and/or 1 floor of travel distance



- *Not to be confused with accessibility requirements of CBC Chapter 11B!*

Calculation: Net SF, per occupancy group, per “access area”

- Includes:
 - Usable areas (interior or exterior)
- Excludes:
 - *Accessory areas, e.g.:*
 - *Hallway*
 - *Restroom*
 - *Stair Enclosure*
 - *Unusable/unreachable areas*

422.0 Minimum Number of Required Fixtures.

422.1 Fixture Count. Plumbing fixtures shall be provided for the type of building occupancy and in the minimum number shown in Table 422.1. *[OSHPD 1, 2, 3 & 4] and Table 4-2* The total occupant load and occupancy classification shall be determined in accordance with Occupant Load Factor Table A and the California Building Code. Occupancy classification not shown in Table 422.1 shall be considered separately by the Authority Having Jurisdiction.

The minimum number of fixtures shall be calculated at 50 percent male and 50 percent female based on the total occupant load. Where information submitted indicates a difference in distribution of the sexes such information shall be used in order to determine the number of fixtures for each sex. Once the occupancy load and occupancy are determined, Table 422.1 shall be applied to determine the minimum number of plumbing fixtures required. Where applying the fixture ratios in Table 422.1 results in fractional numbers, such numbers shall be rounded to the next whole number. For multiple occupancies, fractional numbers shall be first summed and then rounded to the next whole number.

422.1.1 Family or Assisted-Use Toilet and Bathing Facilities. Where family or assisted-use toilet and bathing rooms are required, in applicable building regulations, the facilities shall be installed in accordance with those regulations.

422.1.2 [DSA-AC] Effective January 1, 1990, in new construction and those existing facilities which occupancy type are listed in Tables 422.1 and 4-4 for public use, which apply for permit to undertake construction, structural alterations, repairs or improvement which exceed 50 percent of the square footage of the entire facility, shall install water closets, urinals, lavatories and drinking fountains as stipulated in Tables 422.1 and 4-4 for public use. Community and/or municipal parks with a bleacher capacity not exceeding 500 seats shall be exempt from the requirements of this section and Tables 422.1 and 4-4. Each bathroom shall comply with Part 2, Chapter 11A and 11B of the California Building Code.

422.2 Separate Facilities. Separate toilet facilities shall be provided for each sex.

Exceptions: *[Not adopted for OSHPD 1, 2, 3 & 4]*

- (1) Residential installations.
- (2) In occupancies with a total occupant load of 10 or less, including customers and employees, one toilet facility, designed for use by no more than one person at a time, shall be permitted for use by both sexes.
- (3) In business and mercantile occupancies with a total occupant load of 50 or less including customers and employees, one toilet facility, designed for use by no more than one person at a time, shall be permitted for use by both sexes.

422.2.1 Family or Assisted-Use Toilet Facilities. Where a separate toilet facility is required for each sex, and each toilet facility is required to have only one water closet, two family or assisted-use toilet facilities shall be permitted in place of the required separate toilet facilities.

422.2.2 [OSHPD 1, 2, 3 & 4] Separate toilet facilities shall be provided for the use of patients, staff personnel and visitors.

Exception for Primary Care Clinics only: *Where a facility contains no more than three examination and/or treatment rooms, the patient toilet shall be permitted to serve waiting areas.*

422.3 Fixture Requirements for Special Occupancies. Additional fixtures shall be permitted to be required where unusual environmental conditions or referenced activities are encountered. In food preparation areas, fixture requirements shall be permitted to be dictated by health codes.

422.4 Toilet Facilities Serving Employees and Customers. Each building or structure shall be provided with toilet facilities for employees and customers. Requirements for customers and employees shall be permitted to be met with a single set of restrooms accessible to both groups.

Required toilet facilities for employees and customers located in shopping malls or centers shall be permitted to be met by providing a centrally located toilet facility accessible to several stores. The maximum travel distance from entry to any store to the toilet facility shall not exceed 300 feet (91 440 mm).

Required toilet facilities for employees and customers in other than shopping malls or centers shall have a maximum travel distance not to exceed 500 feet (152 m).

422.4.1 Access to Toilet Facilities. In multi-story buildings, accessibility to the required toilet facilities shall not exceed one vertical story. Access to the required toilet facilities for customers shall not pass through areas designated as for employee use only such as kitchens, food preparation areas, storage rooms, closets, or similar spaces. Toilet facilities accessible only to private offices shall not be counted to determine compliance with this section.

422.5 Toilet Facilities for Workers. Toilet facilities shall be provided and maintained in a sanitary condition for the use of workers during construction.

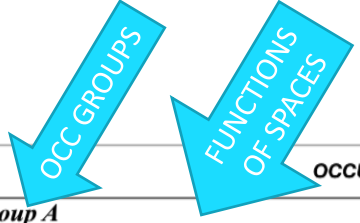
**TABLE 422.1
MINIMUM PLUMBING FACILITIES¹**

Each building shall be provided with sanitary facilities, including provisions for persons with disabilities as prescribed by the Department Having Jurisdiction⁷. Table 422.1 applies to new buildings, additions to a building, and changes of occupancy or type in an existing building resulting in increased occupant load.

For requirements for persons with disabilities, Chapter 11A or 11B of the California Building Code shall be used.

The total occupant load shall be determined in accordance with the [BSC, DSA-SS & DSA-SS/CC] Occupant Load Factor Table A.

The total occupant load shall be determined in accordance with the Occupant Load Factor Table A.



**TABLE A.
OCCUPANT LOAD FACTOR:
[DSA-SS & DSA-SS/CC]**

BASED ON 2001 CBC TABLE 29-A

OCCUPANCY ^{1,2}	OCCUPANT LOAD FACTOR (square feet)
Group A	
1. Auditoriums, convention halls, dance floors, lodge rooms, stadiums, and casinos (where no fixed seating is provided) (use 1/2 "one-half" the number of fixed seating)	15 (5n/7n/11g/15n)
2. Conference rooms, dining rooms, drinking establishments, exhibit rooms, gymnasiums, lounges, stages, and similar uses, including restaurants classified as Group B occupancies	30 (7n/15n/30n)
3. Worship places; principal assembly area, educational and activity unit (where no fixed seating is provided) (use 1/2 "one-half" the number of fixed seating)	30 (7n/15n/20n)
Group B Office or public buildings (area accessible to the public)	200 (100g)
Group E Schools for day care, elementary, secondary	50 (20n/50g)
Educational Facilities Other than Group E Colleges, universities, adult centers, etc.	50 (20n/50g)
Group F Workshops, foundries and similar establishments	2,000 (100g/200g)
Group H Hazardous materials fabrication and storage	2,000 (200g)
Group I Hospital general use area, health care facilities	200 (100g/120g/240g)
Group M Retail or wholesale stores	200 (60g/300g)
Group R Congregate residence, Group R-1	200 (50g/200g)
Group S Warehouse	5,000 (300g/500g)

A-1
A-2
A-3
A-4
A-5

**TABLE 1004.1.2
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT**

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR ^a
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit Gallery and Museum	30 net
Assembly with fixed seats	See Section 1004.4
Assembly without fixed seats	
Concentrated (chairs only-not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net
Stages and platforms	15 net
Business areas	100 gross
Educational	
Classroom area	20 net
Shops and other vocational room areas	50 net
H-5 Fabrication and manufacturing areas	200 gross
Industrial areas	100 gross
Institutional areas	
Inpatient treatment areas	240 gross
Outpatient areas	100 gross
Sleeping areas	120 gross
Mercantile	60 gross
Storage, stock, shipping areas	300 gross
Residential	200 gross
Dormitories	50 gross
Warehouses	500 gross
Accessory storage areas, mechanical equipment room	300 gross

* Any uses not specifically listed shall be based on similar uses listed in this table.
 ** For building or space with mixed occupancies, use appropriate occupancy group for each area (for example, a school may have an "A" occupancy for the gymnasium, a "B" occupancy for the office, an "E" occupancy for the classrooms, etc.)
 Accessory areas may be excluded (for example: hallway, restroom, stair enclosure)

** For building or space with mixed occupancies, use appropriate occupancy group for each area (for example, a school may have an "A" occupancy for the gymnasium, a "B" occupancy for the office, an "E" occupancy for the classrooms, etc.)

IAPMO ≠ ICC

SUMMARY

Area Calculations and Applications

ZONING FLOOR AREA

Zoning Code / Planning Regulations

GSF

with varying exclusions

Conditional Use Permit?
Zoning Variance?

$$A_{\text{zoning}} \div A_{\text{site}} \leq \text{F.A.R.}$$

ALLOWABLE BUILDING AREA

Building Code (CBC Chapter 5)

GSF

with limited exclusions

Occupancy Group (CBC Chapter 3)
Mixed Occupancy (CBC Chapter 5)
Construction Type (CBC Chapter 6)
Sprinkler Coverage (SBC Chapter 9)

$$A_{\text{bldg}} \leq A_{\text{allow}}$$

EGRESS OCCUPANT AREA

Building Code (CBC Chapter 10)

GSF or NSF

per referenced table

Occupant Load Factor *based on Function of Space* (CBC Table 1004.1.2)

OCCUPANTS
→ EGRESS COMPONENTS

FIRE AREA

Building Code (CBC Chapter 9)

GSF

*(per floor area @ interior)
(per building area @ exterior)*

Occupancy Group (CBC Chapter 3)
Fire Resistive Construction (CBC Chapter 7)
Sprinkler Coverage (CBC Chapter 9)

$$A_{\text{fire}} \leq A_{\text{sprinkler}}$$

PLUMBING OCCUPANT AREA

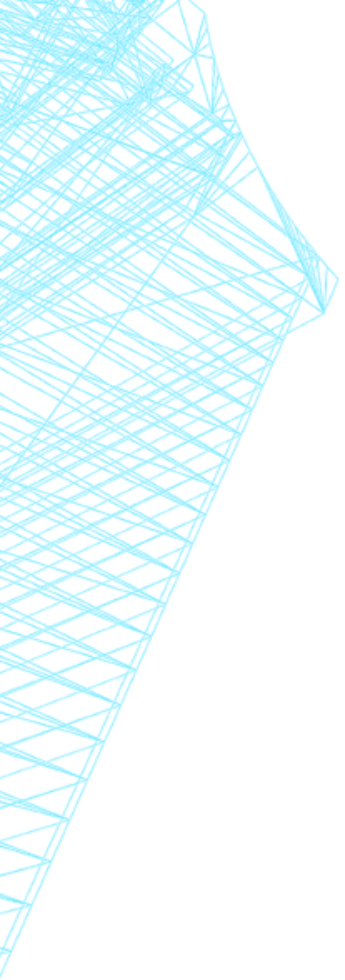
Plumbing Code (CPC Chapter 4)

NSF

with generous exclusions

Occupant Load Factor *based on Occupancy Group* (CPC Table A)
Occupancy Group (CBC Chapter 3)

OCCUPANTS
→ PLUMBING FIXTURES



AREA TYPE	Code Type (Chapter)	Reference Codes / Chapters	Area Calculation Rules	Typical Area Granularity	Ultimate Purpose
ZONING FLOOR AREA	Zoning Code or Planning Regulation	Municipal Code	GSF with varying exclusions	Per Site	Check: Less than F.A.R.?
ALLOWABLE BUILDING AREA	Building Code (CBC Chapter 5)	CBC Chapter 3 CBC Chapter 5 CBC Chapter 6 CBC Chapter 9	GSF with varying exclusions	Per Story Per Building	Check: Greater than Actual Building Area?
EGRESS OCCUPANT AREA	Building Code (CBC Chapter 10)	CBC Chapter 10	NSF or GSF per referenced table	Per Space Per Story	Determine: # Occupants; Calculate # Egress Components & Minimum Widths
FIRE AREA	Building Code (CBC Chapter 9)	CBC Chapter 7 CBC Chapter 9	GSF (floor area @ int.) (bldg. area @ ext.)	Per Fire Area (multi-story)	Check: Less than Maximum Unsprinklered Area?
PLUMBING OCCUPANT AREA	Plumbing Code (CBC Chapter 4)	CPC Chapter 4 CBC Chapter 3 (CBC Chapter 10?*)	NSF with generous exclusions	Per Occupancy Group* Per "Access Area"	Determine: # Occupants; Calculate # Fixtures

▪ Laziness

- The quality that makes you go to great effort to reduce overall energy expenditure. It makes you write labor-saving programs that other people will find useful and document what you wrote so you don't have to answer so many questions about it.

▪ Impatience

- The anger you feel when the computer is being lazy. This makes you write programs that don't just react to your needs, but actually anticipate them. Or at least pretend to.

▪ Hubris

- The quality that makes you write (and maintain) programs that other people won't want to say bad things about.

THE THREE GREAT VIRTUES OF A PROGRAMMER

According to Larry Wall*, the original author of the Perl programming language, there are **three great virtues of a programmer.**

The quality that makes you go to great effort to reduce overall energy expenditure.

As architects, we often **go to great effort** to combine all possible area calculations into a single step so that we can **reduce overall energy expenditure**.

Often, it works.

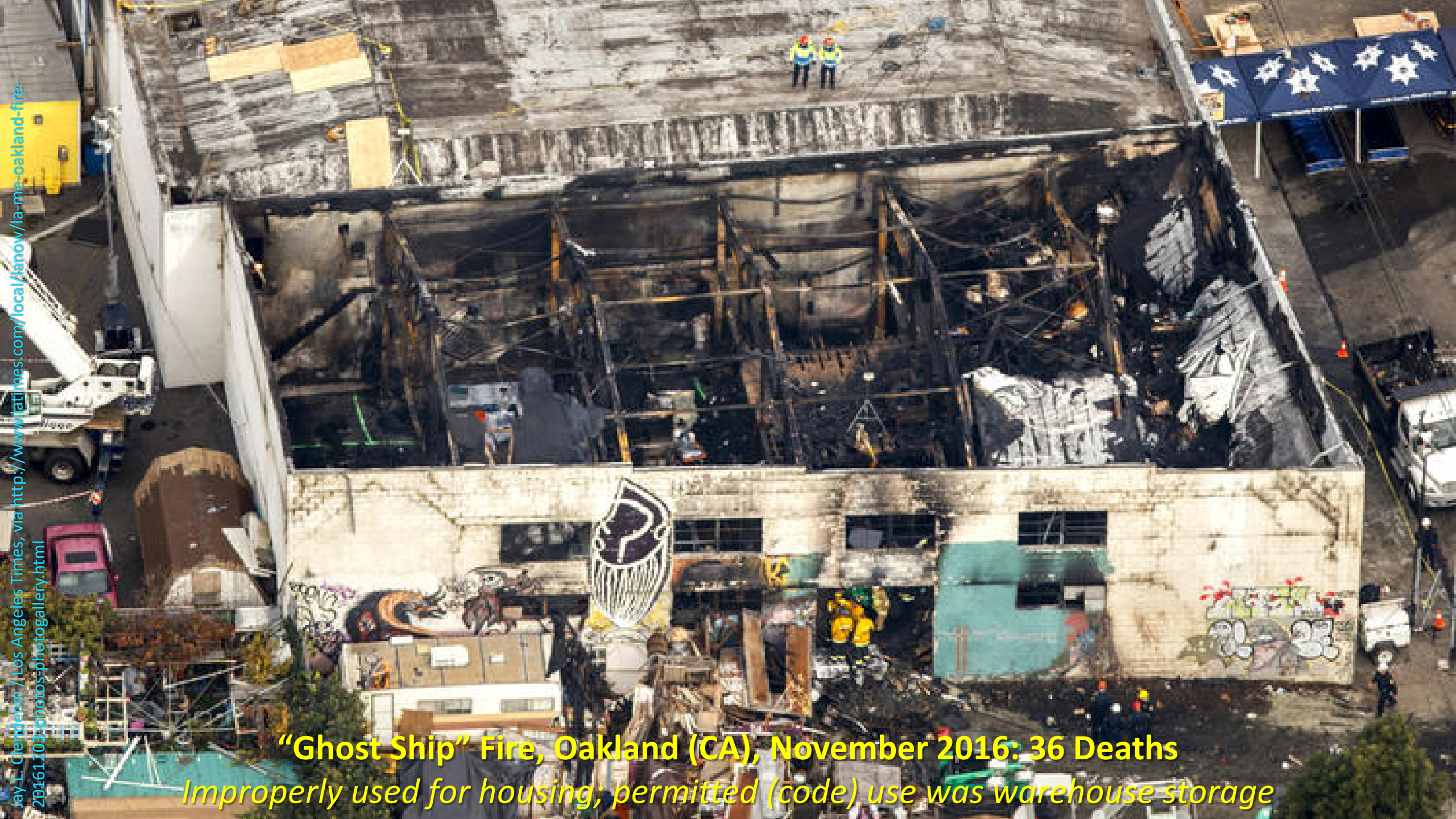
BUT WHEN IT *DOESN'T* WORK, THE RESULTS CAN BE **DISASTROUS.**



WHAT'S THE WORST THAT COULD HAPPEN?

- Delay of plan check approval
- “Recreational redesign” of project during plan check
- Increase in project construction cost due to additional features
 - Fire resistive construction
 - Fireproofing
 - Sprinklers
 - Additional means of egress (stairs, exterior doors, etc.)
- Loss of desired functions
 - Too many occupants than can be accommodated by means of egress
 - Inability to position certain spaces above a given story, or at all
- Required retrofit of existing building and/or site elements not previously part of scope
- **Loss of life due to improper fire resistance or protection, or inadequate means of egress**

Jay L. Clendenin / Los Angeles Times, via <http://www.latimes.com/local/lanow/la-me-oakland-fire-20161103-photos-photogallery.html>



“Ghost Ship” Fire, Oakland (CA), November 2016: 36 Deaths
Improperly used for housing; permitted (code) use was warehouse storage



WHAT IF I DON'T GET CAUGHT? (A/K/A *WHAT IF THE BUILDING OFFICIAL MISSES IT?*)

PROFESSIONAL RESPONSIBILITY

- Licensed architects (a/k/a person stamping the code analysis drawings) has a duty to protect health, safety and welfare of the public, including (especially?) the building occupants
- Review/approval of building official does not transfer liability to building official – 100% of responsibility for proper code compliance remains with licensed architect

CONSEQUENCES

- Professional reputation
- Monetary fine
- Loss of license to practice architecture
- Lawsuit (breach of contract)
- Prosecution (criminal charges)
- Future liability for client



SO MY ONLY OPTION IS TO CALCULATE THREE OR MORE CODE AREAS FOR EVERY PROJECT?

The answer is possibly “no” — but with some important caveats.

1. If your building has any level of complexity, any code-related feature that is not covered by the code in a completely straightforward manner, and/or it appears that the building will be close to a threshold for Allowable Building Area or the required number of means of egress — then **at least** Allowable Building Area and Egress Occupant Area should be separately calculated.

SO MY ONLY OPTION IS TO CALCULATE THREE OR MORE CODE AREAS FOR EVERY PROJECT?

The answer is possibly “no” — but with some important caveats.

2. Given its nature as the governing criteria for type of construction and building height, Allowable Building Area must **always** be calculated.
 - Building Area is always 100% gross area (limited exclusions), so using it for Egress Occupant Area or Plumbing Occupant Area will usually result in a larger number of occupants than would be calculated for those separate analyses
 - Building Area uses Occupancy **groups** (CBC Chapter 3), which are similar to but not the same as the Occupant Load Factor **functions** (CBC Chapter 10), so additional classification of spaces is necessary beyond basic Occupancy groups
 - *Gross floor area* OLF functions are calculated per overall area of function, not per individual space, so using Building Area for them should be OK; however, *net floor area* OLF functions are cumulative per space, so additional breakdown/delineation of spaces may be necessary to use *gross* Building Area for *net* Egress Occupant Area

There is nothing wrong with providing more than “code minimum” (except added expense)

SO MY ONLY OPTION IS TO CALCULATE THREE OR MORE CODE AREAS FOR EVERY PROJECT?

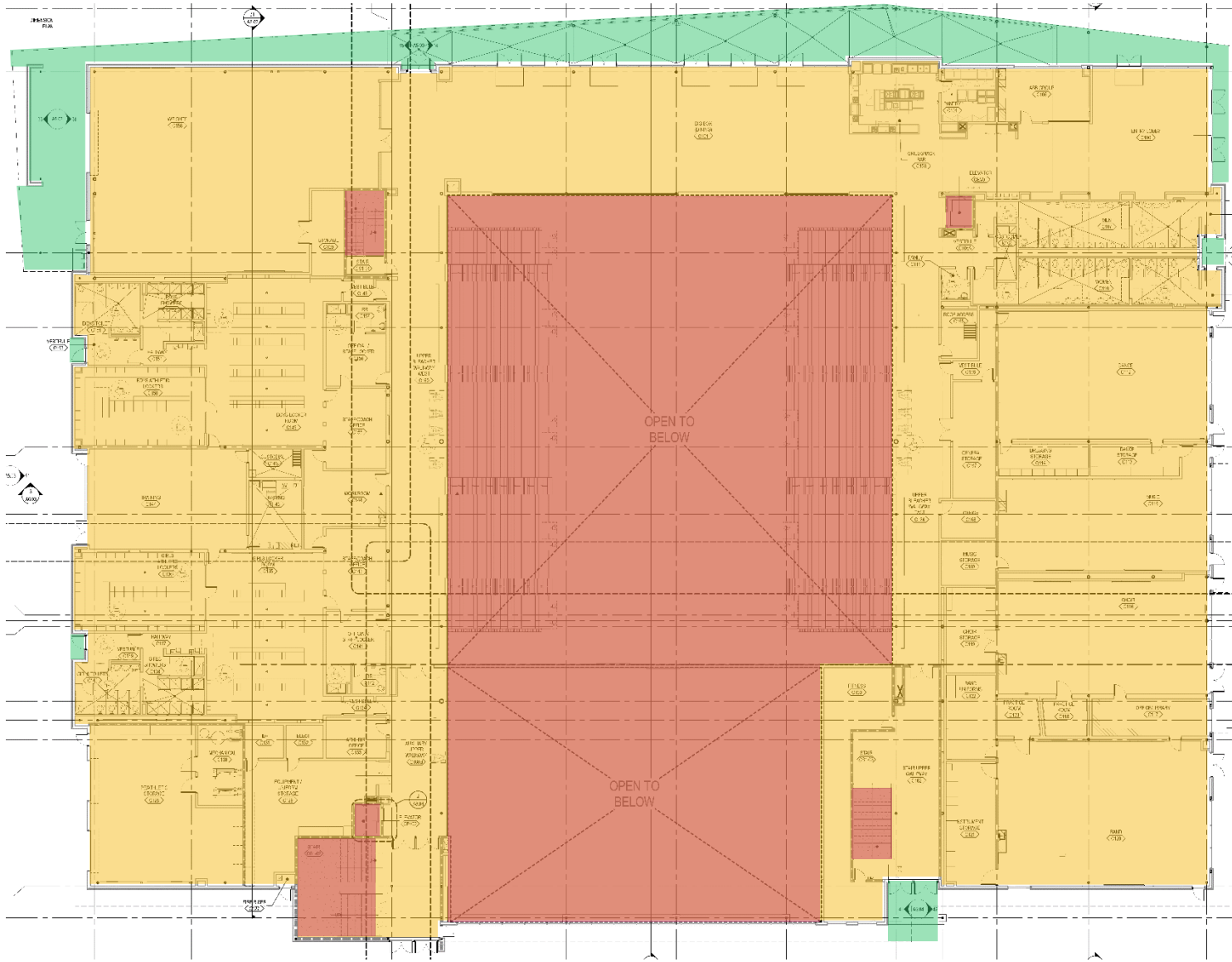
The answer is possibly “no” — but with some important caveats.

3. Egress Occupant Area *can* be used for Plumbing Occupant Area, but it should not be used for Allowable Building Area (unless it is 100% GSF).
 - Relying on *net floor area* calculations for Allowable Building Area is **dangerous**.
 - If caught before construction, could require significant redesign.
 - If caught during or after construction, could require retrofit or demolition.
 - Most spaces calculated using gross floor area for Egress Occupant Area will result in more plumbing occupants (and more plumbing fixtures) than actually required.
 - Not all spaces required to be included in Egress Occupant Area are included in Plumbing Occupant Area, so you need to either accept there will be more plumbing occupants than actually required or implement some method of filtering out Egress Occupant Area spaces that are not included in Plumbing Occupant Area.

There is nothing wrong with providing more than “code minimum” (except added expense)

EXAMPLE CALCULATION

Allowable Building Area



67,796
GSF

Area within exterior walls, exclusive
of vent shafts and courts

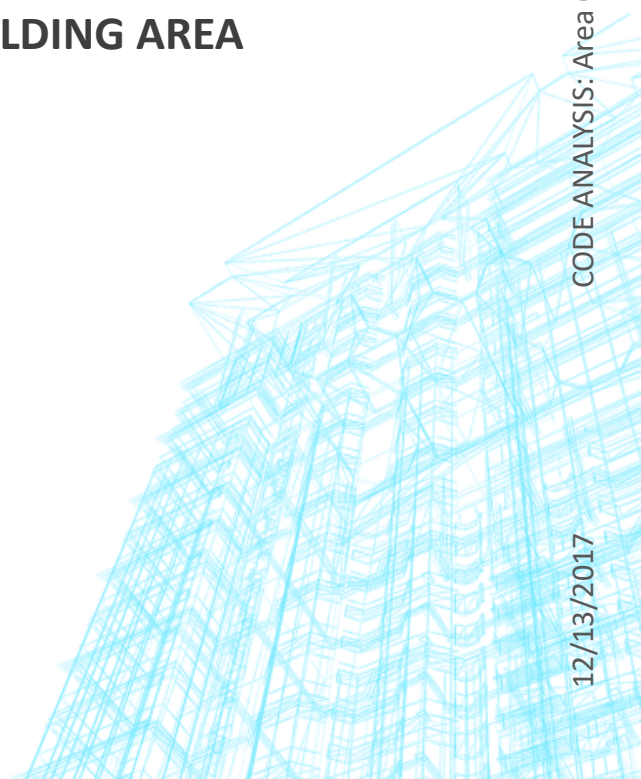
4,629
GSF

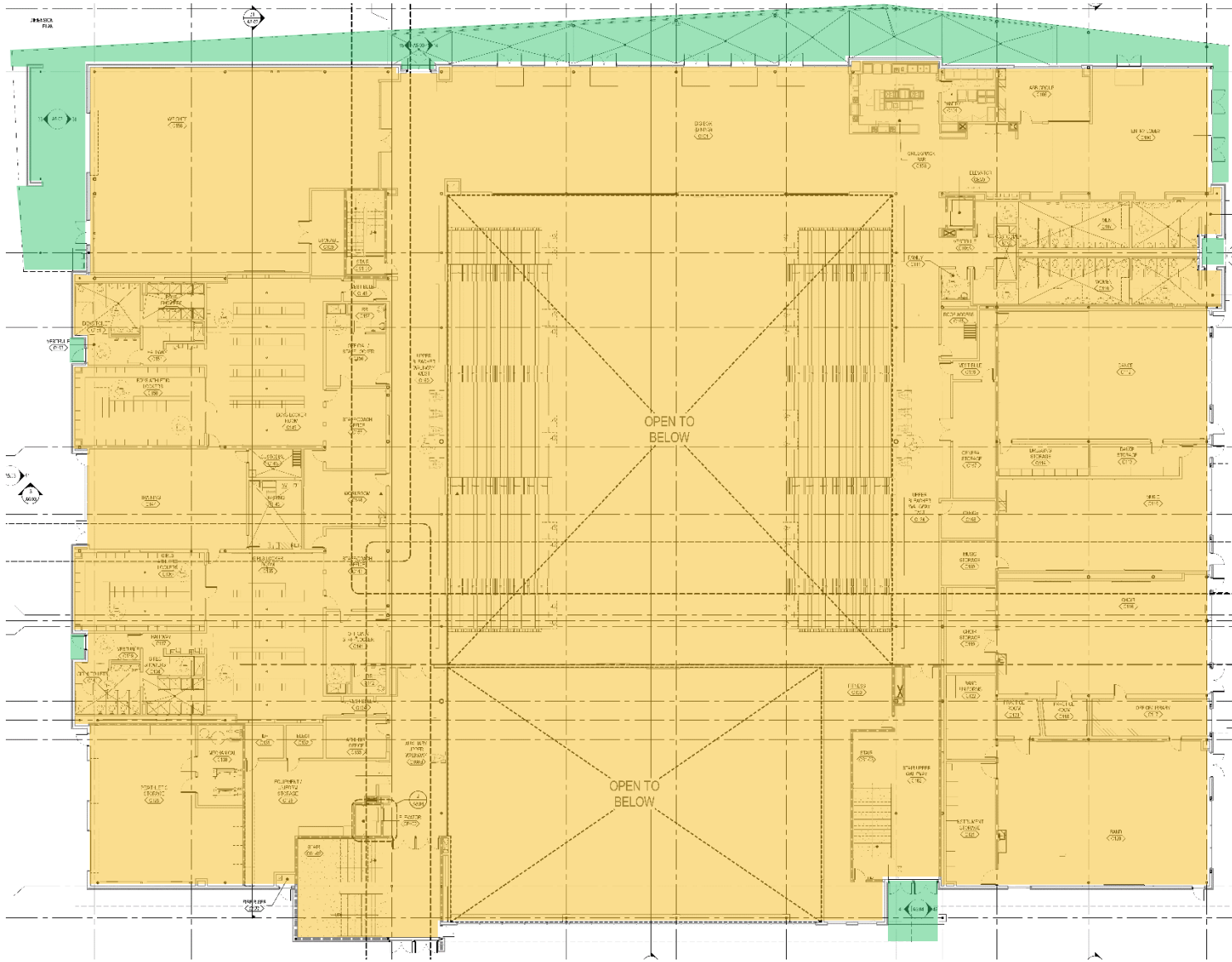
Area under horizontal projection of
floor or roof above

Area open to below (no actual floor)

72,425
GSF

TOTAL BUILDING AREA





67,796
GSF

GROUP A-4 (PRIMARY)

4,629
GSF

GROUP A-4 (EXTERIOR COVERED)

72,425
GSF

TOTAL BUILDING AREA

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

TABLE 506.2^{a, b, f}
ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, or SM, as applicable) IN SQUARE FEET

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
	S1	UL	UL	62,000	34,000	56,000	34,000	60,000	46,000	22,000
	SM (without height increase)	UL	UL	46,500	25,500	42,000	25,500	45,000	34,500	16,500
	SM (with height increase)	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
A-2	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM (without height increase)	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
	SM (with height increase)	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-3	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM (without height increase)	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
	SM (with height increase)	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-4	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000
	SM (without height increase)	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000
	SM (with height increase)	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000

Maximum possible frontage increase (I_f) is **0.75**

72,425
GSF

73,625 w/ I_f
 45,125 w/ I_f
 66,500 w/ I_f
 45,125 w/ I_f
 71,250 w/ I_f
 54,625 w/ I_f

NS = Buildings not equipped throughout with an automatic sprinkler system; S1 = Buildings one or two stories above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; SM = Buildings two or more stories above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13D = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3.

TABLE 506.2^{a, b, i}
ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, or SM, as applicable) IN SQUARE FEET

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
B	NS	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	108,000	54,000	27,000
E	NS	UL	UL	26,500	14,500	23,500	14,500	25,500	18,500	9,500
	S1	UL	UL	106,000	58,000	94,000	58,000	102,000	74,000	38,000
	SM (without height increase)	UL	UL	79,500	43,500	70,500	43,500	76,500	55,500	28,500
	SM (with height increase)	UL	UL	26,500	14,500	23,500	14,500	25,500	18,500	9,500
S-1	NS	UL	48,000	26,000	17,500	26,000	17,500	25,500	14,000	9,000
	S1	UL	192,000	104,000	70,000	104,000	70,000	102,000	56,000	36,000
	SM	UL	144,000	78,000	52,500	78,000	52,500	76,500	42,000	27,000
S-2	NS	UL	79,000	39,000	26,000	39,000	26,000	38,500	21,000	13,500
	S1	UL	316,000	156,000	104,000	156,000	104,000	154,000	84,000	54,000
	SM	UL	237,000	117,000	78,000	117,000	78,000	115,500	63,000	40,500

NS = Buildings not equipped throughout with an automatic sprinkler system; S1 = Buildings a maximum of one story above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; SM = Buildings two or more stories above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13D = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3.

**TABLE 508.4
REQUIRED SEPARATION OF OCCUPANCIES (HOURS)**

OCCUPANCY	A, E		I-4, R-2.1		I-2, I-2.1		I-3		R-1, R-2, R-3, R-3.1, R-4		F-2, S-2 ^b , U		B ^f , F-1 ^{a,f} , M, S-1		L		H-1		H-2		H-3, H-4		H-5		
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	
A, E	N	N	2	2	2	NP	2	NP	1	2	N	1	1	2	2	NP	NP	NP	3	4	2	3	2	NP	
I-4, R-2.1	—	—	1 ^e	NP	2	NP	2	NP	1	NP	1	2	1	2	2	NP	NP	NP	4	NP	4	NP	4	NP	
I-2, I-2.1	—	—	—	—	N	NP	2	NP	2	NP	2	NP	2	NP	2	NP	NP	NP	4	NP	4	NP	4	NP	
I-3	—	—	—	—	—	—	N	NP	2	NP	2	2	2	2	2	NP	NP	NP	4	NP	4	NP	4	NP	
R-1, R-2, R-3, R-3.1, R-4	—	—	—	—	—	—	—	—	N	N	1 ^c	2 ^c	1	2	4	NP	NP	NP	3	NP	2	NP	2	NP	
F-2, S-2 ^b , U	—	—	—	—	—	—	—	—	—	—	N	N	1	2	1	NP	NP	NP	3	4	2	3	2	NP	
B, F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	—	—	N	N	1	NP	NP	NP	2	3	1	2	1	NP	
L	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	NP	NP	NP	2	NP	1	NP	1	NP	
H-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	NP	NP	NP	NP	NP	NP	
H-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	1	NP	1	NP	
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1 ^d	NP	1	NP
H-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.

NS = Buildings not equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.

N = No separation requirement.

NP = Not permitted.

a. See Section 420.

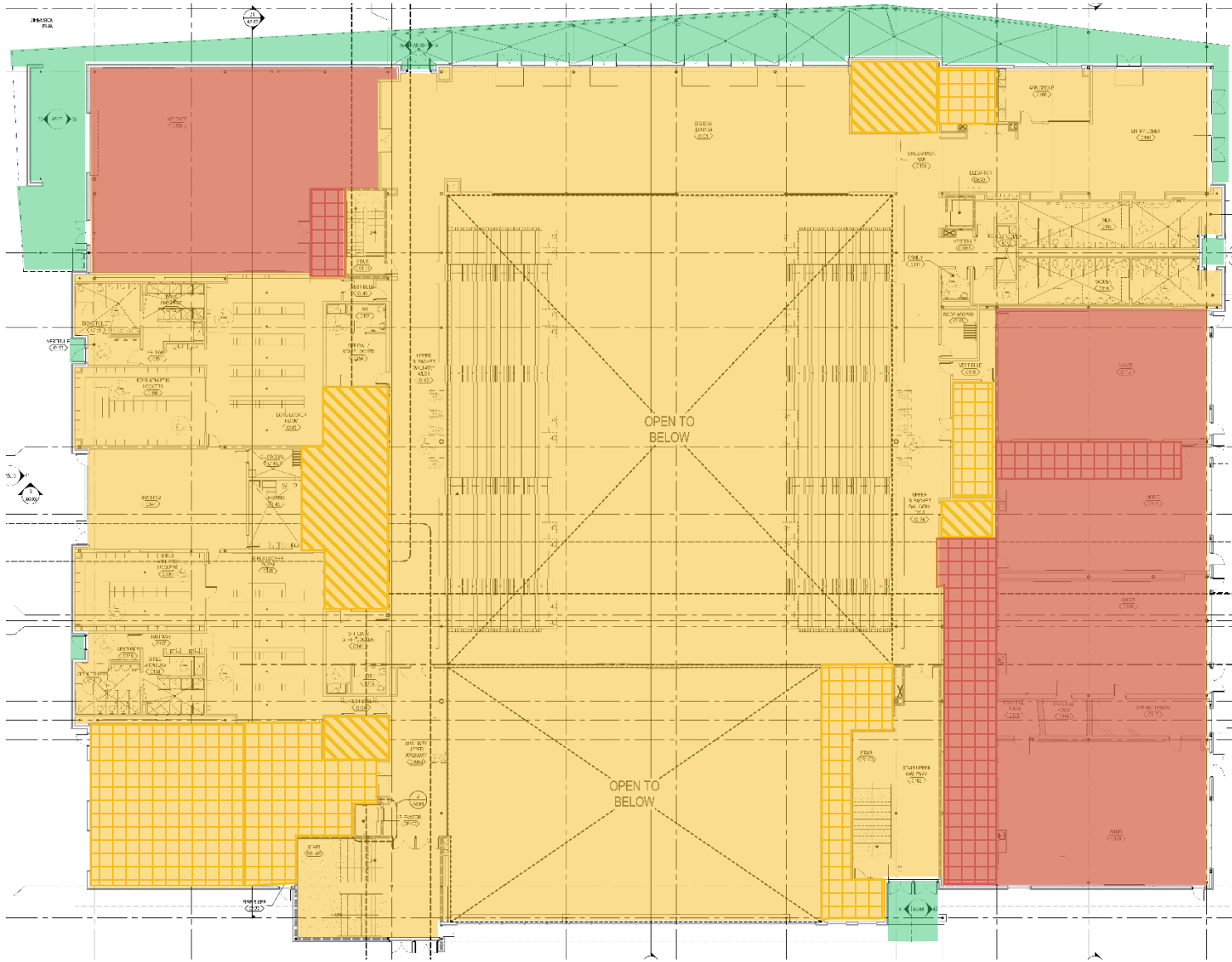
b. The required separation from areas used only for private or pleasure vehicles shall be reduced by 1 hour but to not less than 1 hour.

c. See Section 406.3.4.

d. Separation is not required between occupancies of the same classification.

e. [SFM] Group I and F1 occupancies and Group R-2.1 and F-1 occupancies shall have a 3 hour separation.

f. [SFM] Commercial kitchens not associated with cafeterias and similar dining facilities in Group I-2 and Group R-2.1 shall have a 2-hour separation and shall be protected by an automatic sprinkler system.

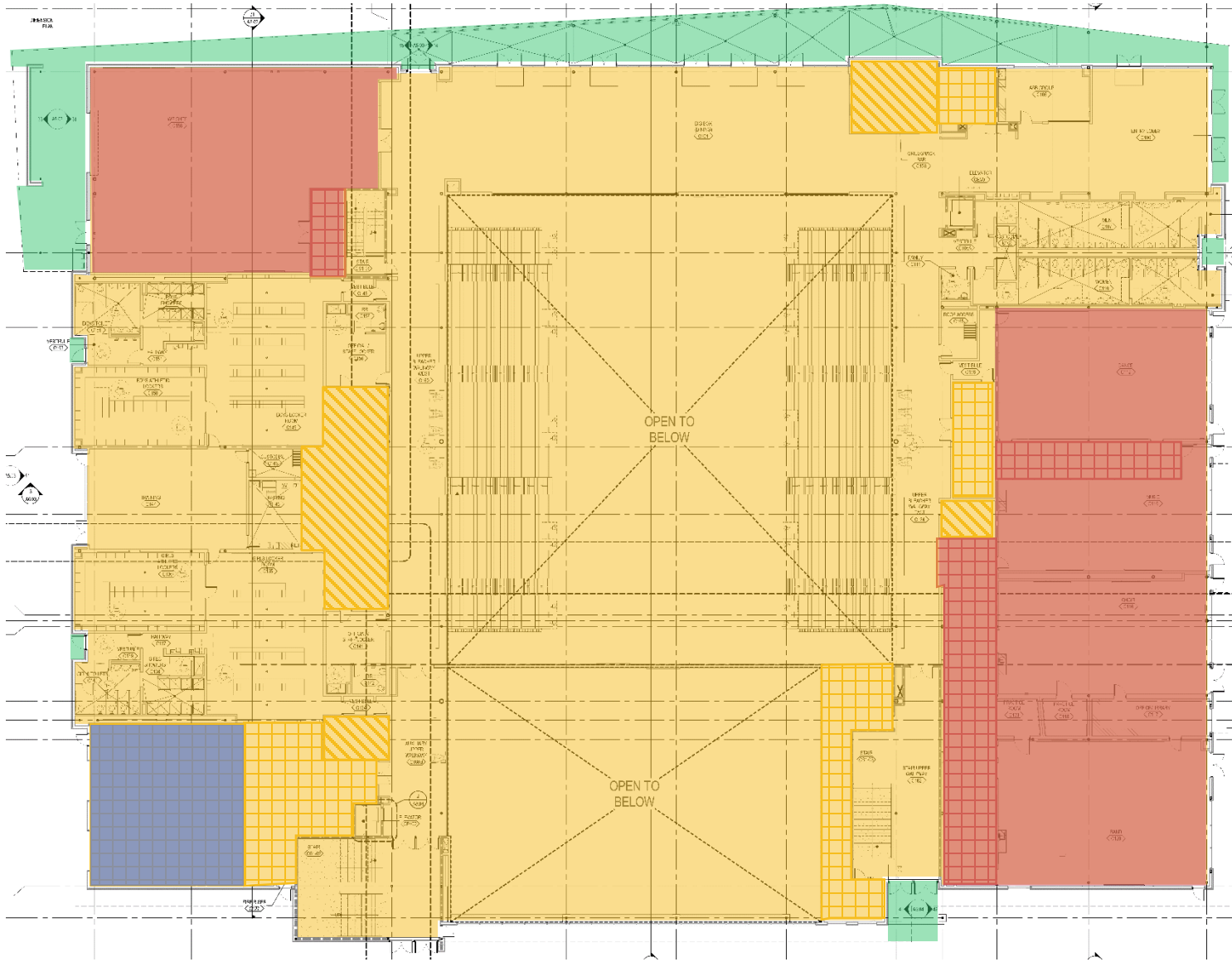


- 53,300
GSF
GROUP A-4 (PRIMARY)
- GROUP B, ACCESSORY TO A
- GROUP S-1, ACCESSORY TO A
- 4,629
GSF
GROUP A-4 (EXTERIOR COVERED)
- 14,496
GSF
GROUP E (SECONDARY)
- GROUP S-1, ACCESSORY TO E
- 72,425
GSF
TOTAL BUILDING AREA

Maximum aggregate accessory
 area = 10% of story area

8,544 GSF = 11.8%





- 51,304
GSF
GROUP A-4 (PRIMARY)
 - GROUP B, ACCESSORY TO A
 - GROUP S-1, ACCESSORY TO A

- 4,629
GSF
GROUP A-4 (EXTERIOR COVERED)

- 14,496
GSF
GROUP E (SECONDARY)
 - GROUP S-1, ACCESSORY TO E

- 1,996
GSF
GROUP S-1 (TERTIARY)
SEPARATED OCCUPANCY

- 72,425
GSF
TOTAL BUILDING AREA

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

Assume $I_f = 0.75$

A-4: $A_a = 62,000 + (15,500 \times 0.75) = 73,625$
 $51,304 \div 73,625 = 0.6968$ [< 1.0 → OK]

A-4 ext: $A_a = 62,000 + (15,500 \times 0.75) = 73,625$
 $4,629 \div 73,625 = 0.0629$ [< 1.0 → OK]

E: $A_a = 106,000 + (26,500 \times 0.75) = 125,875$
 $14,496 \div 125,875 = 0.1152$ [< 1.0 → OK]

S-1: $A_a = 104,000 + (26,000 \times 0.75) = 123,500$
 $1,996 \div 123,500 = 0.0162$ [< 1.0 → OK]

51,304 GSF **GROUP A-4 (PRIMARY)**

4,629 GSF **GROUP A-4 (EXTERIOR COVERED)**

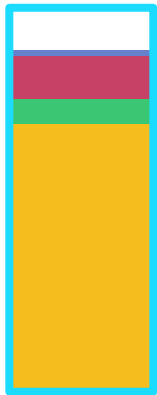
14,496 GSF **GROUP E (SECONDARY)**

1,996 GSF **GROUP S-1 (TERTIARY)**

72,425 GSF **TOTAL BUILDING AREA**

SUM OF RATIOS:

$$\begin{array}{r}
 0.6968 \\
 0.0629 \\
 0.1152 \\
 + 0.0162 \\
 \hline
 0.8911 \text{ [< 1.0 → OK]}
 \end{array}$$



THANK YOU

Questions?