

# Outside the Box Plan Review



Shums Coda Associates, Inc.






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## Class Summary

- Discuss very large and unusual buildings
  - Large Buildings
  - High Rise Buildings
  - Atriums
- Review of Alternate Designs
- Performance Based Design




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## Instructor Steve Thomas, CBO


- Colorado Regional Manager, Education Director, SCA
- 40+ years experience in code administration
- ICC Committees
  - Means of Egress
  - Codes & Standards
  - Code Correlation
- Author of Building Code Basics, Building Code Essentials, Applying Codes to Cannabis Facilities



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## The Fine Print!

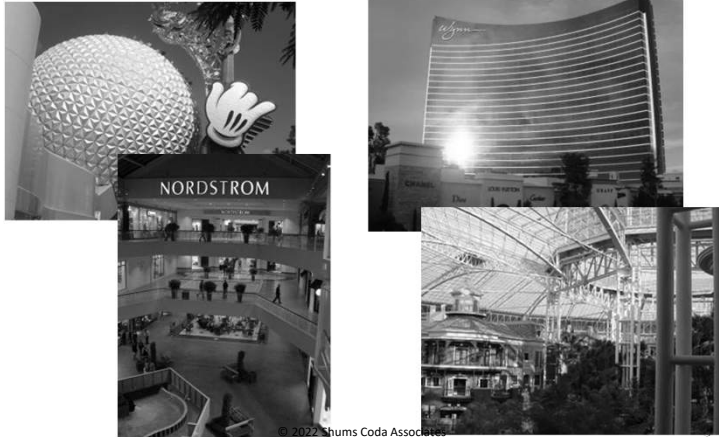


- There are times when the code is vague.
- You may get my opinion.
- You have yours!
- AHJ makes final determination

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## What is an extreme building?



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## Prescriptive v. Performance



- What is the difference between:
  1. Prescriptive
  2. Performance

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## Applicable Codes



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## Kinds of Codes

- Prescriptive Codes
- Performance Codes



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## Prescriptive Codes

- Generic occupancy groups
- Employ fixed values
  - Area
  - Occupant capacity
- Cover buildings and systems
- Assume requirements describe acceptable risk

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## Prescriptive Code Examples

- “Handrail height, measured above stair tread nosings, or finish surface of ramp slope, shall be uniform, not less than 34 inches and not more than 38 inches”.
- “The height, in feet, and the number of stories of a building shall be determined based on the type of construction, occupancy classification and whether there is an automatic sprinkler system installed throughout the building”.

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## Prescriptive Codes



- History
  - Not necessarily based on current fire science or engineering principles
  - Often “consensus” based
  - Local changes to reflect local conditions
  - May provide for equivalencies
    - Alternate methods or materials

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## Performance-based Codes

- State goals and compliance methods
- Identify non-specific performance criteria
- Cover buildings and facilities
  - *Systems* still prescriptive
    - *Mechanical/Electrical*
    - *Fire protection*
- Can reference prescriptive codes



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## Performance Requirements

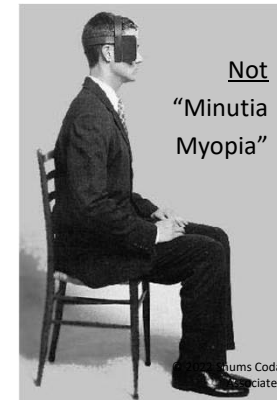
- “Fire walls shall be designed and constructed to allow collapse of the structure on either side without collapse of the wall under fire conditions”.

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## Big Picture...

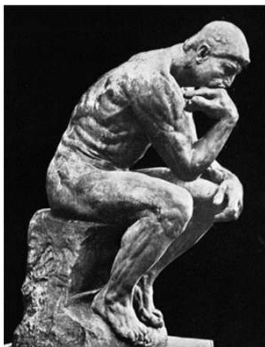


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## INTENT!!



- Quick assessment...
- What is the code's philosophy??

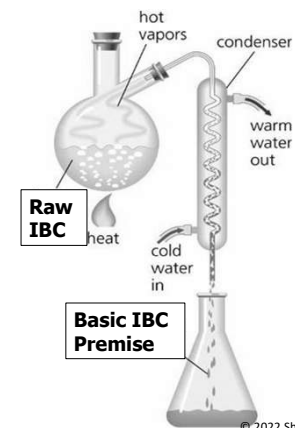
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## Distillation

- Distill the code to its very essence.
- Must get to the basic premise.



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## Prescriptive Requirements for Extreme Buildings



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## Use and Occupancy Classification

- The objective of the assignment of use and occupancy classification is to identify the primary uses of buildings and facilities, and portions of buildings and facilities, and to identify risk factors associated with these uses, in order to facilitate design and construction in accordance with other provisions of this code.



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## Occupancy Classification 302.1



- Structures shall be classified into one or more of the occupancy groups listed in this section based on the nature of the hazards and risks to building occupants generally associated with the intended purpose of the building or structure.

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## Determination of Use



- The principal purpose or function of the building or facility
- The hazard-related risk(s) to the users of the building or facility.

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## Nature of the hazard

- The nature of the hazard, whether it is likely to originate internal or external to the building or facility, and how it may impact the occupants, the building or facility, and the contents.



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## Length of occupancy

- The length of time the building or facility is normally occupied by people.



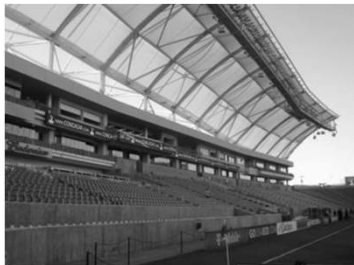
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## Number of occupants

- The number of persons normally occupying, visiting, employed in or otherwise using the building, facility or portion of the building or facility.



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## Sleeping characteristics

- Whether people normally sleep in the building



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## Familiarity

- Whether the building or facility occupants and other users are expected to be familiar with the building or facility layout and means of egress.



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## Relationships

- Whether a significant percentage of building or facility occupants and other users have family or dependent relationships



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## Vulnerability

- Whether a significant percentage of the building or facility occupants are, or are expected to be, members of vulnerable population groups such as infants, young children, elderly persons, persons with physical disabilities, persons with mental disabilities, or persons with other conditions or impairments that could affect their ability to make decisions, egress without the physical assistance of others or tolerate adverse conditions.

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## Occupancy Classifications Review

- A Assembly
- B Business
- E Educational
- F Factory/Industrial
- H Hazardous
- I Institutional
- M Mercantile
- R Residential
- S Storage
- U Utility/Misc.



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## Name that Occupancy

- Crime Laboratory
- FedEx Distribution Center
  - Vans park inside building for overnight loading via conveyors
- Photovoltaic Panel Manufacturer

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## Unlimited Area Buildings 507.4.1

- Group A-1 and A-2 Occupancies of other than Type V Construction
  - Assembly occupancies separated from other spaces as required in 508.4.4 without sprinkler reduction
  - Assembly area cannot exceed allowable area
  - All exit doors shall discharge directly to the exterior



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## Unlimited Area Buildings 507.4

- Sprinklered, one-story
  - The area of a Group A-4 building not more than one story above grade plane of other than Type V construction, or the area of a Group B, F, M or S building no more than one story above grade plane of any construction type, shall not be limited where the building is provided with an automatic sprinkler system throughout in accordance with Section 903.3.1.1 and is surrounded and adjoined by public ways or yards not less than 60 feet in width.



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## Unlimited Area Buildings 507.5

- Sprinklered, two-story
  - The area of a Group B, F, M or S building no more than two stories above grade plane shall not be limited when the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, and is surrounded and adjoined by public ways or yards not less than 60 feet in width.



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## Group E buildings 507.11



- The area of a Group E building no more than one story above grade plane, of Type II, IIIA or IV construction, shall not be limited when all of the following criteria are met:
  1. Each classroom shall have not less than two means of egress, with one of the means of egress being a direct exit to the outside of the building complying with Section 1020.
  2. The building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
  3. The building is surrounded and adjoined by public ways or yards not less than 60 feet in width.

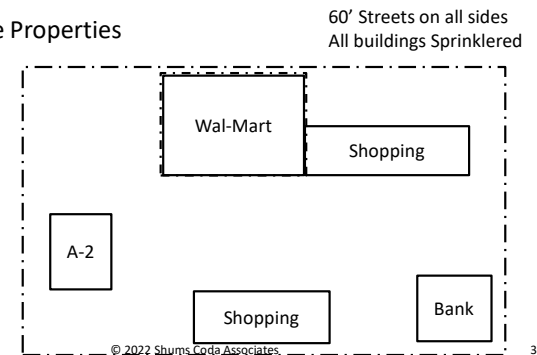
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## Unlimited Area Buildings Challenges

- Shopping Centers
  - Multiple Properties

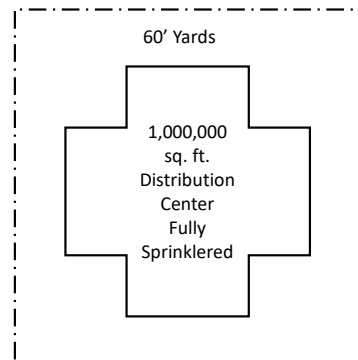


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## Unlimited Area Buildings Challenges

- Super Large Buildings
  - Exit Access Travel Distance
  - Fire Department Access
  - Standpipe locations



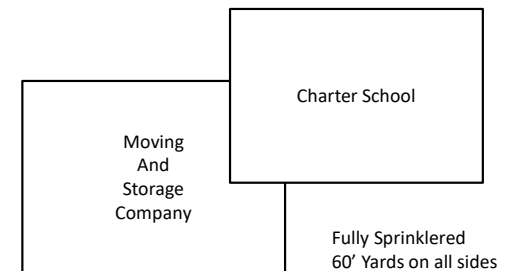
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## Unlimited Area Buildings Challenges

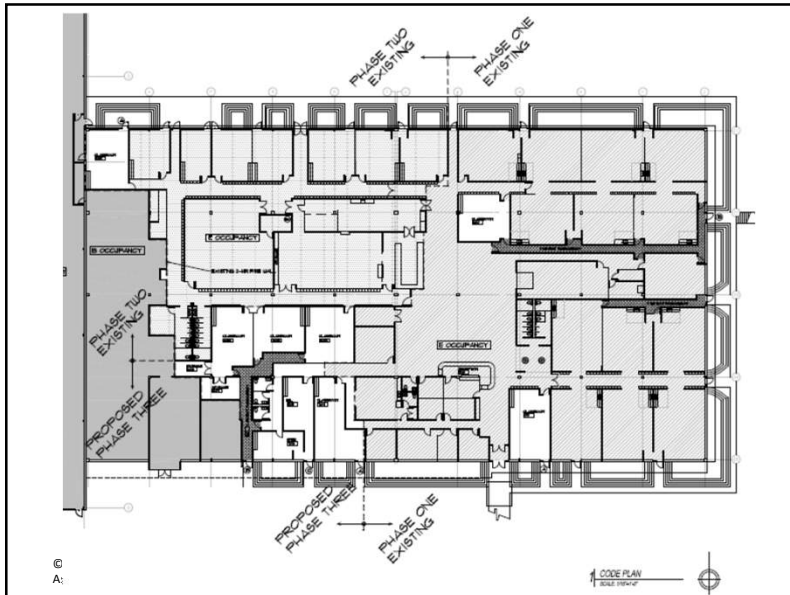
- Mixed Unlimited Area Buildings ?



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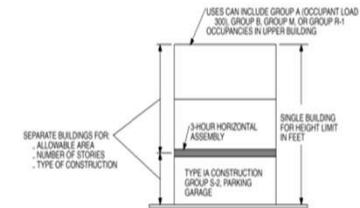
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## Horizontal Building Separation Allowance - 510.2

1. The buildings are separated with a horizontal assembly having a fire-resistance rating of not less than 3 hours. Where vertical offsets are provided as part of a horizontal assembly, the vertical offset and the structure supporting the vertical offset shall have a fire-resistance rating of not less than 3 hours.
2. The building below, including the horizontal assembly, is of Type IA construction.



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## Platform/Podium Buildings 510.2

- A building shall be considered as separate and distinct buildings for the purpose of determining area limitations, continuity of fire walls, limitation of number of stories and type of construction where all of the following conditions are met:



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## Horizontal Building Separation Allowance - 510.2

3. Shaft, stairway, ramp and escalator enclosures through the horizontal assembly shall have not less than a 2-hour fire-resistance rating with opening protectives in accordance with Section 716.

Exception: Where the enclosure walls below the horizontal assembly have not less than a 3-hour fire-resistance rating with opening protectives in accordance with Section 716, the enclosure walls extending above the horizontal assembly shall be permitted to have a 1-hour fire-resistance rating, provided:

1. The building above the horizontal assembly is not required to be of Type I construction;
2. The enclosure connects less than four stories; and
3. The enclosure opening protectives above the horizontal assembly have a minimum 1-hour fire protection rating.

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## Horizontal Building Separation Allowance - 510.2

- 4. Interior exit stairways located within the Type IA building are permitted to be of combustible materials where the following requirements are met:
  - 4.1. The building above the Type IA building is of Type III, IV, or V construction.
  - 4.2. The stairway located in the Type IA building is enclosed by 3-hour fire-resistance-rated construction with opening protectives in accordance with Section 716.



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## Horizontal Building Separation Allowance - 510.2

- 6. The building below the horizontal assembly shall be protected throughout by an approved automatic sprinkler system in accordance with Section 903.3.1.1, and shall be permitted to be any occupancy allowed by this code except Group H.



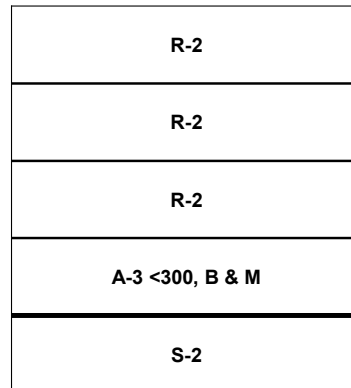
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## Horizontal Building Separation Allowance - 510.2

- 5. The building or buildings above the horizontal assembly shall be permitted to have multiple Group A occupancy uses, each with an occupant load of less than 300, or Group B, M, R or S occupancies.



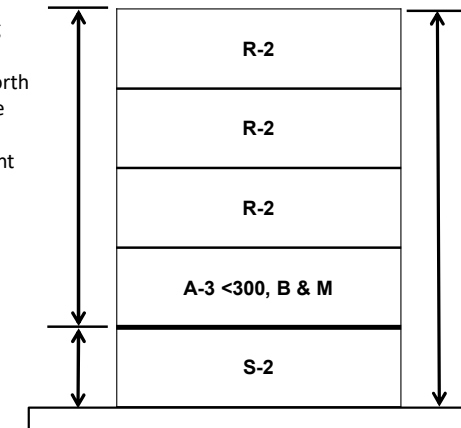
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## Horizontal Building Separation Allowance - 510.2

- 7. The maximum building height in feet shall not exceed the limits set forth in Section 504.3 for the building having the smaller allowable height as measured from the grade plane.



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## Podium Building Challenges

- High-Rise?
- Multiple Buildings above podium
- Outdoor amenity spaces & egress

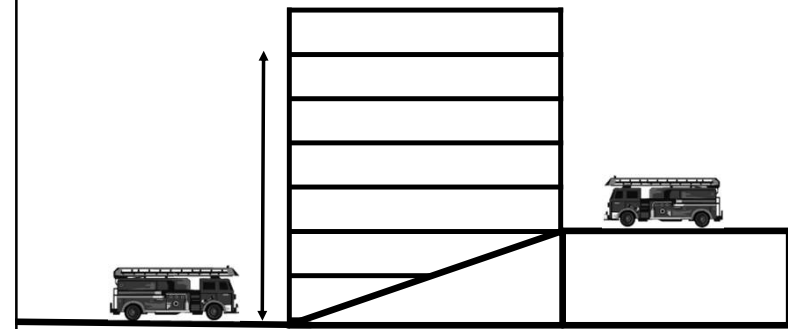


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## Lowest Fire Department Vehicle Access



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## High-Rise Buildings 403

- **Definition (202)**  
A building with an occupied floor located more than 75 feet above the lowest level of fire department vehicle access.



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## High-Rise Buildings 403.1 (Exceptions)

Does not apply to:

1. Airport traffic control towers (Section 412.3)
2. Open parking garages (Section 406.3)
3. The portion of a buildings with a Group A-5 occupancy
4. Special industrial occupancies (Section 503.1.1)
5. Buildings with a Group H-1, H-2 or H-3 occupancy (Section 415)



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## Reduction in fire-resistance rating - 403.2.1



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- The fire-resistance-rating reductions listed in Sections 403.2.1.1 and 403.2.1.2 shall be allowed in buildings that have sprinkler control valves equipped with supervisory initiating devices and water-flow initiating devices for each floor.

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## Shaft enclosures 403.2.1.2

- For buildings not greater than 420 feet in building height, the required fire-resistance rating of the fire barriers enclosing vertical shafts, other than interior exit stairway and elevator hoistway enclosures, is permitted to be reduced to 1 hour where automatic sprinklers are installed within the shafts at the top and at alternate floor levels.



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## Type of construction 403.2.1.1

- The following reductions in the minimum fire-resistance rating of the building elements in Table 601 shall be permitted as follows:
    1. For buildings not greater than 420 feet in building height, the fire-resistance rating of the building elements in Type IA construction shall be permitted to be reduced to the minimum fire-resistance ratings for the building elements in Type IB.
    2. In other than Group F-1, H-2, H-3, H-5, M and S-1 occupancies, the fire-resistance rating of the building elements in Type IB construction shall be permitted to be reduced to the fire-resistance ratings in Type IIA.
    3. The building height and building area limitations of a building containing building elements with reduced fire-resistance ratings shall be permitted to be the same as the building without such reductions.
- Exception: The required fire-resistance rating of columns supporting floors shall not be reduced.

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## Structural integrity of exit & hoistway enclosures - 403.2.2

- For high-rise buildings of Risk Category III or IV in accordance with Section 1604.5, and for all buildings that are more than 420 feet in building height, enclosures for interior exit stairways and elevator hoistway enclosures shall comply with Sections 403.2.3.1 through 403.2.3.4.



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## Wall assembly materials—soft body impact - 403.2.2.1

- The panels making up the enclosures for interior exit stairways and elevator hoistway enclosures shall meet or exceed Soft Body Impact Classification Level 2 as measured by the test method described in ASTM C 1629/C 1629M.



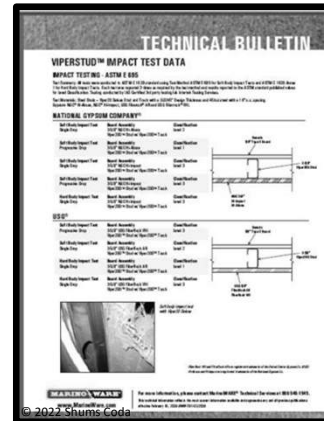
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## Hard Body Impact Classification

ASTM C1629



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## Wall assembly materials—hard body impact - 403.2.2.2

- The panels making up the enclosures for interior exit stairways and elevator hoistway enclosures that are not exposed to the interior of the enclosure shall be in accordance with one of the following:
- The wall assembly shall incorporate not fewer than two layers of impact-resistant panels, each of which meets or exceeds Hard Body Impact Classification Level 2 as measured by the test method described in ASTM C1629/C1629M.
  - The wall assembly shall incorporate not fewer than one layer of impact-resistant panels that meet or exceed Hard Body Impact Classification Level 3 as measured by the test method described in ASTM C1629/C1629M.
  - The wall assembly incorporates multiple layers of any material, tested in tandem, that meets or exceeds Hard Body Impact Classification Level 3 as measured by the test method described in ASTM C1629/C1629M.

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## Concrete and masonry walls 403.2.3.3

- Concrete or masonry walls shall be deemed to satisfy the requirements of Sections 403.2.3.1 and 403.2.3.2.



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## Other wall assemblies 403.2.3.4

- Any other wall assembly that provides impact resistance equivalent to that required by Sections 403.2.3.1 and 403.2.3.2 for Hard Body Impact Classification Level 3, as measured by the test method described in ASTM C 1629/C 1629M, shall be permitted.



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## Automatic sprinkler system 403.3

- Buildings and structures shall be equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 and a secondary water supply where required by Section 403.3.

### Exceptions:

- Telecommunications equipment buildings



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## Sprayed Fire-Resistant Materials 403.2.3



- The bond strength of the SFRM installed throughout the building shall be in accordance with Table 403.2.4.

TABLE 403.2.4  
MINIMUM BOND STRENGTH

HEIGHT OF BUILDING*	SFRM MINIMUM BOND STRENGTH
Up to 420 feet	430 psf
Greater than 420 feet	1,000 psf

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## Sprinkler risers and system design - 403.3.1

- Each sprinkler system zone in buildings that are more than 420 feet in building height shall be supplied by a minimum of two risers.
- Each riser shall supply sprinklers on alternate floors.
- If more than two risers are provided for a zone, sprinklers on adjacent floors shall not be supplied from the same riser.
- Remotely located in stairway and per 1007.1



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## Water supply to required fire pumps - 403.3.2



- In all buildings that are more than 420 feet in building height, and buildings of Type IVA and IVB construction that are more than 120 feet in building height required fire pumps shall be supplied by connections to no fewer than two water mains located in different streets.
- Separate supply piping shall be provided between each connection to the water main and the pumps.
- Each connection and the supply piping between the connection and the pumps shall be sized to supply the flow and pressure required for the pumps to operate.

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## 403.3.3 Secondary water supply

- An automatic secondary on-site water supply having a capacity not less than the hydraulically calculated sprinkler demand, including the hose stream requirement, shall be provided for highrise buildings assigned to Seismic Design Category C, D, E or F as determined by Section 1613.
- An additional fire pump shall not be required for the secondary water supply unless needed to provide the minimum design intake pressure at the suction side of the fire pump supplying the automatic sprinkler system.
- The secondary water supply shall have a duration of not less than 30 minutes as determined by the occupancy hazard classification in accordance with NFPA 13..



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## Water supply to required fire pumps - 403.3.2

- Exception:
- Two connections to the same main shall be permitted provided the main is valved such that an interruption can be isolated so that the water supply will continue without interruption through at least one of the connections.



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## Emergency Systems 403.4

- Smoke detection per Section 907.2.13.1.
- Fire alarm per Section 907.2.13
- Standpipe system per Section 905.3
- Emergency voice/alarm communication system per Section 907.5.2.2.
- Emergency communication coverage per IFC 510
- Fire Command Center per Section 911



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## Smoke removal 403.4.7

- To facilitate smoke removal in post-fire salvage and overhaul operations, buildings and structures shall be equipped with natural or mechanical ventilation for removal of products of combustion in accordance with one of the following:
  - 1. Easily identifiable, manually operable windows or panels shall be distributed around the perimeter of each floor at not more than 50-foot intervals. The area of operable windows or panels shall not be less than 40 square feet per 50 linear feet of perimeter.
- **Exceptions:**
  - 1. In Group R-1 occupancies, each *sleeping unit or suite having an exterior wall shall be permitted to be provided with 2 square feet of venting area in lieu of the area specified in Item 1.*
  - 2. Windows shall be permitted to be fixed provided that glazing can be cleared by fire fighters.

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## Standby/Emergency power 403.4.8

- **A standby power system complying with Section 2702 and Section 3003 shall be provided for the standby power loads specified in Section 403.4.8.3.**
- **An emergency power system complying with Section 2702 shall be provided for the emergency power loads specified in Section 403.4.8.4.**



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## Smoke removal 403.4.6

2. Mechanical air-handling equipment providing one exhaust air change every 15 minutes for the area involved. Return and exhaust air shall be moved directly to the outside without recirculation to other portions of the building.
3. Any other approved design that will produce equivalent results.



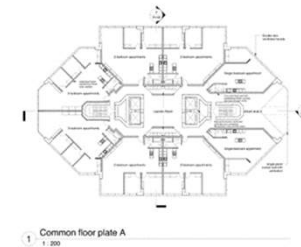
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## 403.5.1 Remoteness of interior exit stairways

- Required interior exit stairways shall be separated by a distance not less than 30 feet or not less than one-fourth of the length of the maximum overall diagonal dimension of the building or area to be served, whichever is less.
- The distance shall be measured in a straight line between the nearest points of the enclosure surrounding the interior exit stairways.
- In buildings with three or more interior exit stairways, no fewer than two of the interior exit stairways shall comply with this section.
- Interlocking or scissor stairs shall be counted as one interior exit stairway.



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## Additional Interior Exit Stairway 403.5.2



- For buildings other than Group R-2 and their ancillary spaces that are more than 420 feet in building height, one additional interior exit stairway meeting the requirements of Sections 1011 and 1023 shall be provided in addition to the minimum number of exits required by Section 1006.3.
- The total capacity of any combination of remaining interior exit stairways with one interior exit stairway removed shall be not less than the total capacity required by Section 1005.1.
- Scissor stairways shall not be considered the additional interior exit stairway required by this section.

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## 403.5.3 Stairway door operation

- Stairway doors other than the exit discharge doors shall be permitted to be locked from the stairway side.
- Stairway doors that are locked from the stairway side shall be capable of being unlocked simultaneously without unlatching upon a signal from the fire command center.



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## Additional Interior Exit Stairway 403.5.2



- Exceptions:
  1. An additional interior exit stairway shall not be required to be installed in buildings having elevators used for occupant self-evacuation in accordance with Section 3008.
  2. An additional interior exit stairway shall not be required for other portions of the building where the highest occupiable floor level in those areas is less than 420 feet in building height.

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## 403.5.3.1 Stairway communication system



- A telephone or other two-way communications system connected to an approved constantly attended station shall be provided at not less than every fifth floor in each stairway where the doors to the stairway are locked.

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## Smokeproof exit enclosures

### 403.5.4

- Every required stairway serving floors more than 75 feet above the lowest level of fire department vehicle access shall comply with Sections 909.20 and 1023.10



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## Luminous Egress Path Markings

### 1025.1



- Approved luminous egress path markings delineating the exit path shall be provided in high-rise buildings of Group A, B, E, I-1, M or R-1 occupancies in accordance with this section.

- Exceptions:

Not required on the level of exit discharge in lobbies that serve as part of the exit path in accordance with Section 1028.1, Exception 1.

Retroactive in IFC!

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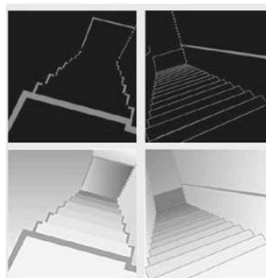
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## Luminous Egress Path Markings -

### 403.5.5

- Luminous egress path markings shall be provided in accordance with Section 1025.



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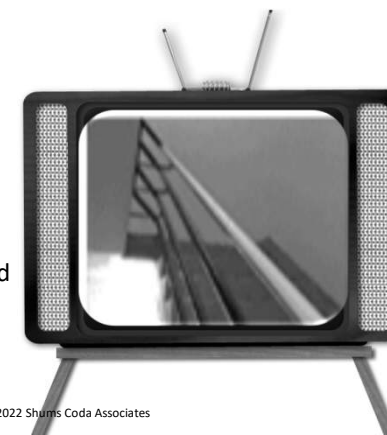
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## Markings within Exit Enclosures

### 1025.2

- Steps
  - 1-2" at leading edge
- Landings
  - 1-2" at leading edge
- Handrails
  - 1" min. on handrail and extension



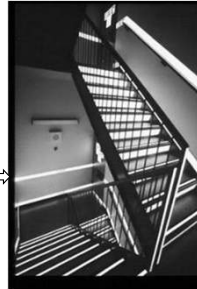
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## Markings within Exit Enclosures 1025.2

- Floor Mounted
  - Placed within 4" of the wall
- Wall Mounted
  - Placed within 4" of the floor
- Transition
  - ?



- Stair landings and other floor areas within exit enclosures, with the exception of the sides of steps, shall be provided with solid and continuous demarcation lines on the floor or on the walls or a combination of both.
- The stripes shall be 1 to 2 inches wide with interruptions not exceeding 4 inches.

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## Self Luminous and Photoluminescent 1025.4

- If photoluminescent material is used, egress lighting must be maintained for 60 minutes BEFORE the building is occupied.
- Luminous egress path markings shall be permitted to be made of any material, including paint, provided that an electrical charge is not required to maintain the required luminance. Such materials shall include, but are not limited to, *self-luminous materials* and *photoluminescent materials*. *Materials shall comply with* either of the following standards:
  1. UL 1994; or
  2. ASTM E 2072, except that the charging source shall be 1 foot-candle of fluorescent illumination for 60 minutes, and the minimum luminance shall be 30 millicandelas per square meter at 10 minutes and 5 millicandelas per square meter after 90 minutes.

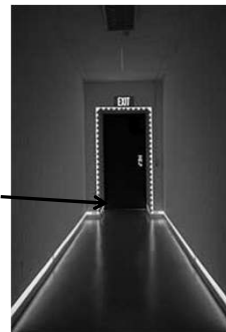
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## Markings within Exit Enclosures 1025.2

- Obstacles
  - Located below 78" and extending out more than 4" must be marked
- Doors
  - Hardware
  - Frame
  - Low level exit sign per NFPA 170 (18" above floor)



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## Fire Service & Evacuation Elevators – 403.6



- In buildings with an occupied floor more than 120 feet above the lowest level of fire department vehicle access, no fewer than two fire service access elevators, or all elevators, whichever is less, shall be provided in accordance with Section 3007.
- Each fire service access elevator shall have a capacity of not less than 3500 pounds and shall comply with Section 3002.4.
- Where installed in accordance with Section 3008, passenger elevators for general public use shall be permitted to be used for occupant self-evacuation

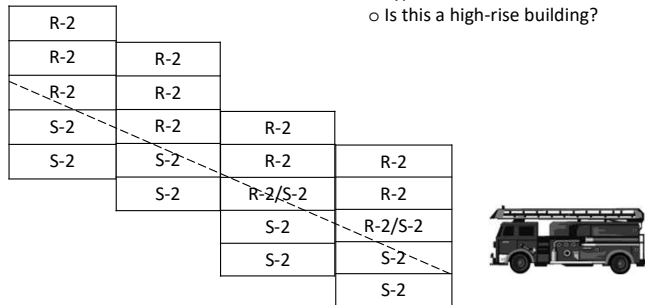
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## High-Rise Buildings Challenges

- 12' floor to floor height
- How many story building?
- Type of Construction?
- Is this a high-rise building?



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## Atriums 202

- A vertical space that is closed at the top, connecting two or more stories in Group I-2 and I-3 occupancies or three or more stories in all other occupancies.



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## Atriums 404.1



- The provisions of Sections 404.1 through 404.11 shall apply to buildings containing atriums. Atriums are not permitted in buildings or structures classified as Group H.

- Exception: Vertical openings that comply with Sections 712.1.1 through 712.1.3, and Sections 712.1.9 through 712.1.14.

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## Use 404.2



- The floor of the atrium shall not be used for other than low fire hazard uses and only approved materials and decorations in accordance with the IFC shall be used in the atrium space.
  - Unless sprinklered

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## Automatic Sprinklers 404.3

- Sprinklers required throughout building except:
  - Area adjacent to or above the atrium, provided area is separated from the atrium by a 2-hour fire barrier wall or horizontal assembly or both.
  - Sprinklers not required in atrium if ceiling of the atrium is more than 55 feet above the floor



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## Smoke Control 404.5

- Smoke Control System Required except atriums that connect only two stories
- Exception:
  - In other than Group I-2, and Group I-1, Condition 2, smoke control is not required for atriums that connect only two stories.



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## Fire alarm system 404.4

- A fire alarm system shall be provided in accordance with Section 907.2.14.



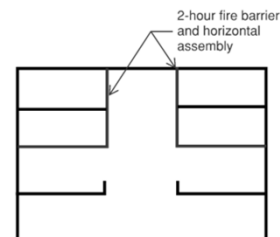
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## 404.5 Smoke control

- 2. A smoke control system shall be installed in accordance with Section 909.
  - Exceptions:
    - 2. A smoke control system is not required for atriums connecting more than two stories when all of the following are met:
      - 2.1. Only the two lowest stories shall be permitted to be open to the atrium.
      - 2.2. All stories above the lowest two stories shall be separated from the atrium in accordance with the provisions for a shaft in Section 713.4.



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## Enclosure of Atriums 404.6

- Atrium spaces shall be separated from adjacent spaces by a 1-hour fire barrier wall except:
  - A glass smoke partition
    - Sprinklers spaced 6 feet or less along both sides of the separation wall, or on the room side only if there is not a walkway on the atrium side
    - Sprinklers 4" – 12" away from the glass
    - Wet the entire glass
  - Glass installed in a gasketed frame
  - ¾ hour glass-block wall assembly
  - The adjacent spaces of any three floors of the atrium shall not be required to be separated from the atrium where such spaces are accounted for in the design of the smoke control system.



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## Interior Finish 404.8

- The interior finish of walls and ceilings of the atrium shall not be less than Class B with no reduction in class for sprinkler protection.



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## Standby Power 404.7



- Equipment required to provide smoke control shall be connected to a standby power system in accordance with Section 909.11.

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## Travel Distance 404.9

- Exit access travel distance for areas open to an atrium shall comply with the requirements of Section 1017.



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## Egress not through the atrium 1017.3.2.1

- Where required access to the exits is not through the atrium, exit access travel distance shall comply with Section 1017.2.



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## Exit access travel distance at other than the level of exit discharge - 1017.3.2.3

- Where the path of egress travel is not at the level of exit discharge from the atrium, that portion of the total permitted exit access travel distance that occurs within the atrium shall be not greater than 200 feet



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## Exit access travel distance at the level of exit discharge - 1017.3.2.2

- Where the path of egress travel is through an atrium space, exit access travel distance at the level of exit discharge shall be determined in accordance with Section 1017.2.



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## Exit stairways in an atrium 404.10

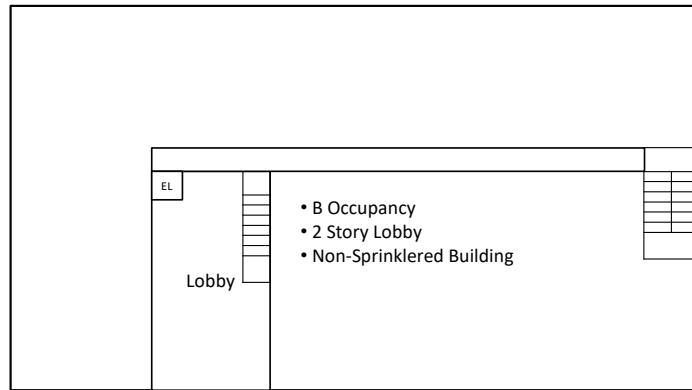
- Where an atrium contains an interior exit stairway all the following shall be met:
  - 1. The entry to the exit stairway is the edge of the closest riser of the exit stairway.
  - 2. The entry of the exit stairway shall have access from a minimum of two directions.
  - 3. The distance between the entry to an exit stairway in an atrium and the entrance to a minimum of one exit stairway enclosed in accordance with Section 1023.2 shall comply with the separation required by Section 1007.1.1.
  - 4. Exit access travel distance shall be measured to the closest riser of the exit stairway.
  - 5. Not more than 50 percent of the exit stairways shall be located in the same atrium.

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## Is This an Atrium?



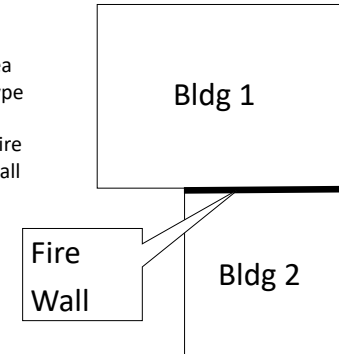
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## Fire Walls 503.1

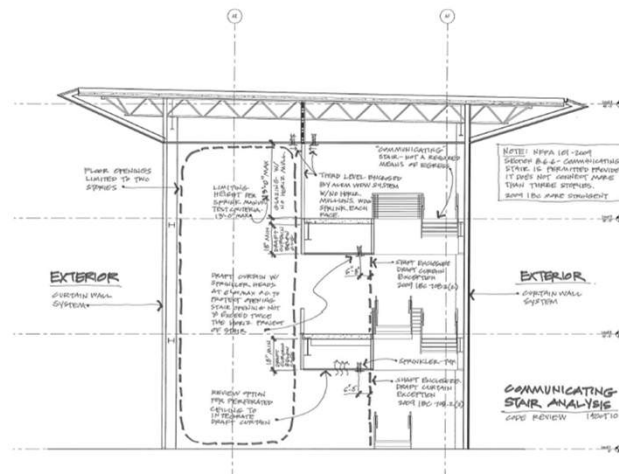
- For the purposes of determining area limitations, height limitations and type of construction, each portion of a building separated by one or more fire walls complying with Section 706 shall be considered to be a separate building.



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## 706 Fire Walls

- Fire walls shall be constructed in accordance with Sections 706.2 through 706.11. The extent and location of such fire walls shall provide a complete separation.
- Where a fire wall separates occupancies that are required to be separated by a fire barrier wall, the most restrictive requirements of each separation shall apply.



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## 706.1.1 Party walls

- Any wall located on a lot line between adjacent buildings, which is used or adapted for joint service between the two buildings, shall be constructed as a fire wall in accordance with Section 706.
- Party walls shall be constructed without openings and shall create separate buildings.
- Exceptions:
  - 1. Openings in a party wall separating an anchor building and a mall shall be in accordance with Section 402.4.2.2.1.



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## Structural Stability 706.2

- Fire walls shall be designed and constructed to allow collapse of the structure on either side without collapse of the wall under fire conditions.
- Fire walls designed and constructed in accordance with NFPA 221 shall be deemed to comply with this section.



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## 706.1.1 Party walls

### Exception

Party walls and fire walls are not required on lot lines dividing a building for ownership purposes where the aggregate height and area of the portions of the building located on both sides of the lot line do not exceed the maximum height and area requirements of this code.

For the building official's review and approval, the official shall be provided with copies of dedicated access easements and contractual agreements that permit the owners of portions of the building located on either side of the lot line access to the other side for purposes of maintaining fire and life safety systems necessary for the operation of the building.



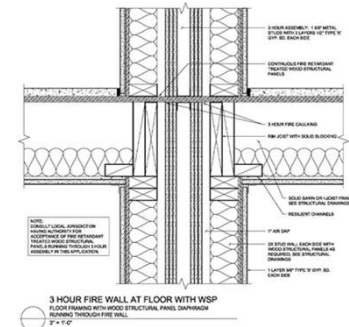
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## Structural Stability 706.2

- Exception:
  - In Seismic Design Categories D through F, where double fire walls are used in accordance with NFPA 221, floor and roof sheathing not exceeding 3/4 inch thickness shall be permitted to be continuous through the wall assemblies of light frame construction.

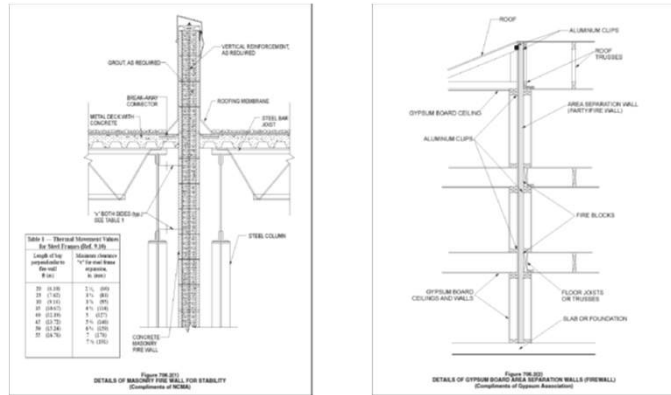


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## Fire Wall Options



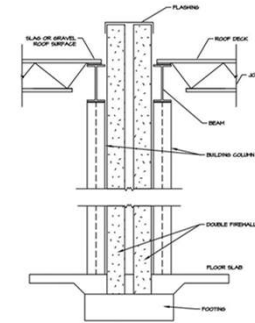
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## NFPA 221 Double Fire Walls

- 6.5.1 A double fire wall shall consist of two back-to-back walls.
- 6.5.2 There shall be no connections, other than to the flashing, between the walls.
- 6.5.3 Each fire wall shall be supported laterally by the building frame on its respective side and shall be independent of the fire wall and framing on the opposite side.



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## NFPA 221

- 4.5\* Double Wall Assemblies.
- Where either wall of a double wall is laterally supported by a building frame with a fire resistance rating less than that required for the wall, double wall assemblies shall be considered to have a combined assembly fire resistance rating as specified in Table 4.5.

Table 4.5 Fire Resistance Ratings for Double Wall Assemblies

Fire Resistance Rating of Each Wall (hr)	Equivalent to Single Wall (hr)
3	4
2	3
1	2

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## NFPA 221 Double Fire Walls

- 6.10.3\*. Openings in double fire walls shall be protected using one fire door in each separate wall.

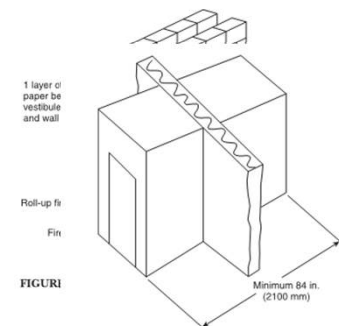


FIGURE A.5.8.3(b) Vestibule Arrangement for Egress Purposes in an HC Fire Wall.

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## Materials 706.3

- Noncombustible materials except Type V

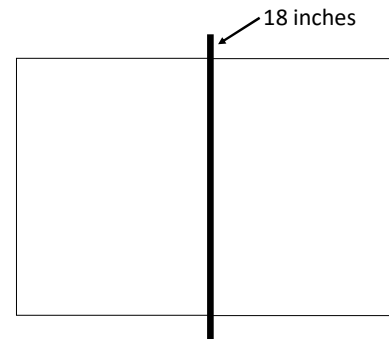


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## Horizontal Continuity 706.5



- Fire walls shall be continuous from exterior wall to exterior wall and shall extend not less than 18 inches beyond the exterior surface of exterior walls.

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## Fire Resistance Rating Table 706.4

TABLE 706.4  
FIRE WALL FIRE-RESISTANCE RATINGS

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3 <sup>a</sup>
F-1, H-3 <sup>b</sup> , H-5, M, S-1	3
H-1, H-2	4 <sup>b</sup>
F-2, S-2, R-3, R-4	2

- In Type II or V construction, walls shall be permitted to have a 2-hour fire-resistance rating.
- For Group H-1, H-2 or H-3 buildings, also see Sections 415.4 and 415.5.

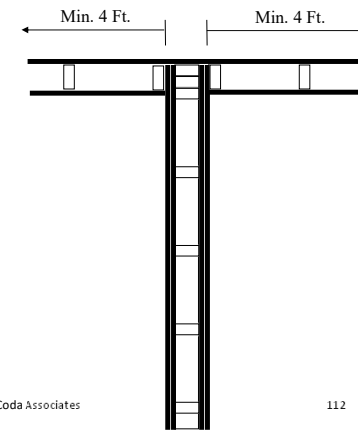
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## Horizontal Continuity 706.5, Exception 1

- Shall be permitted to terminate at the interior surface of combustible exterior sheathing or siding provided the exterior wall has a fire-resistance rating of not less than 1 hour for a horizontal distance of not less than 4 feet on both sides of the fire wall.
- Openings within such exterior walls shall be protected by fire assemblies having a fire-protection rating of not less than 3/4 hour.



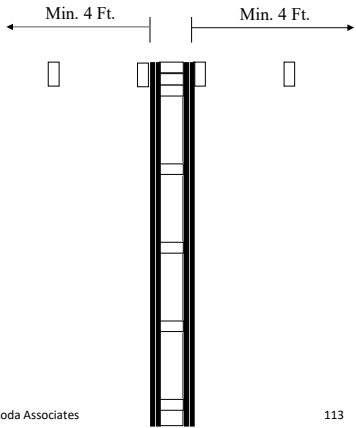
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### Horizontal Continuity 706.5, Exception 2

- Shall be permitted to terminate at the interior surface of noncombustible exterior sheathing, exterior siding or other noncombustible exterior finishes provided the sheathing, siding, or other exterior noncombustible finish extends a horizontal distance of not less than 4 feet on both sides of the fire wall.
- Openings?



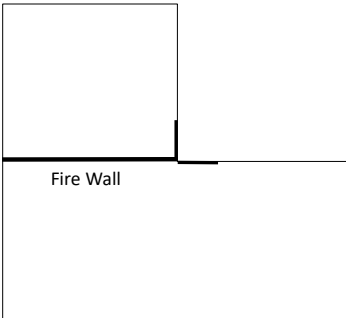
Min. 4 Ft.      Min. 4 Ft.

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### Exterior Walls 706.5.1

- Where the fire wall intersects exterior walls, the fire-resistance rating and opening protection of the exterior walls shall comply with one of the following:




Fire Wall

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### Horizontal Continuity 706.5, Exception 3

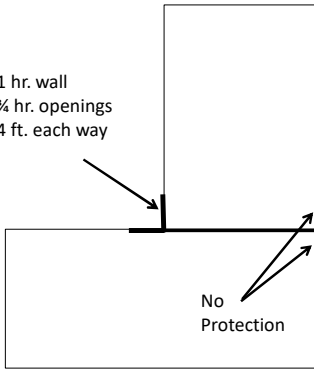


- Fire walls shall be permitted to terminate at the interior surface of noncombustible exterior sheathing where the building on each side of the fire wall is protected by an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.
- Width of NC exterior sheathing?
- Openings?

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### Horizontal Continuity 706.5.1



1 hr. wall  
¾ hr. openings  
4 ft. each way

No Protection

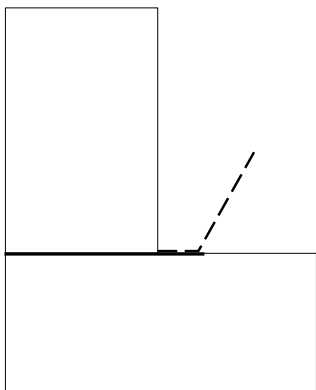
1. The exterior walls on both sides of the fire wall shall have a 1-hour fire-resistance rating with 3/4-hour protection where opening protection is required by Section 705.8. The fire-resistance rating of the exterior wall shall extend not less than 4 feet on each side of the intersection of the fire wall to exterior wall.

- Exterior wall intersections at fire walls that form an angle equal to or greater than 180 degrees do not need exterior wall protection.

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## Horizontal Continuity 706.5.1



- Buildings or spaces on both sides of the intersecting fire wall shall assume to have an imaginary lot line at the fire wall and extending beyond the exterior of the fire wall. The location of the assumed line in relation to the exterior walls and the fire wall shall be such that the exterior wall and opening protection meet the requirements set forth in Sections 705.5 and 705.8.
- Such protection is not required for exterior walls terminating at fire walls that form an angle equal to or greater than 180 degrees

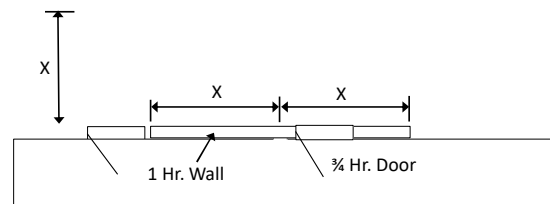
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## Horizontal Projecting Elements Exceptions

- Horizontal projecting elements without concealed spaces provided the exterior wall behind and below the projecting element has not less than 1-hour fire-resistance-rated construction for a distance not less than the depth of the projecting element on both sides of the fire wall. Openings within such exterior walls shall be protected by fire assemblies having a fire protection rating of not less than ¾ hour.



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## Horizontal Projecting Elements 706.5.2

- Fire walls shall extend to the outer edge of horizontal projecting elements such as balconies, roof overhangs, canopies, marquees and similar projections that are within 4 feet of the fire wall.



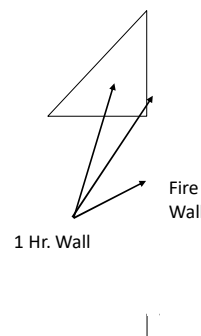
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## Horizontal Projecting Elements Exceptions

- Noncombustible horizontal projecting elements with concealed spaces, provided a minimum 1-hour fire-resistance-rated wall extends through the concealed space.
  - The projecting element shall be separated from the building by not less than 1-hour fire-resistance-rated construction for a distance on each side of the firewall equal to the depth of the projecting element.
  - The wall is not required to extend under the projecting element where the building exterior wall is not less than 1-hour fire-resistance rated for a distance on each side of the firewall equal to the depth of the projecting element.
  - Openings within such exterior walls shall be protected by fire assemblies having a fire protection rating of not less than ¾ hour.

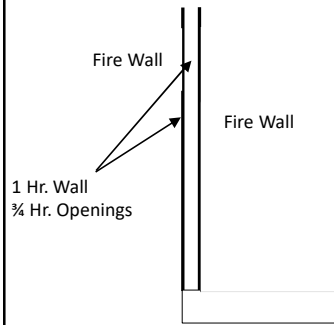


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### Horizontal Projecting Elements Exceptions



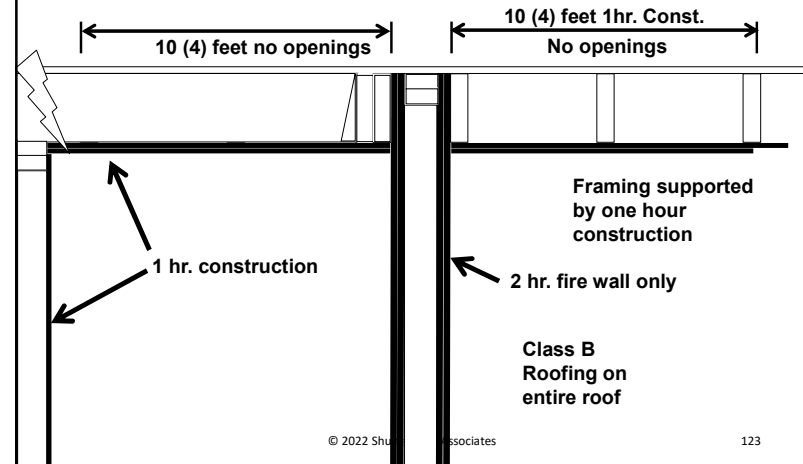
- For combustible horizontal projecting elements with concealed spaces, the fire wall need only extend through the concealed space to the outer edges of the projecting elements. The exterior wall behind and below the projecting element shall be of not less than 1-hour fire-resistance-rated construction for a distance not less than the depth of the projecting elements on both sides of the fire wall. Openings within such exterior walls shall be protected by opening protectives having a fire-protection rating of not less than 3/4 hour.

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### Vertically Continuity 706.6, Exception 2



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### Vertical continuity 706.6



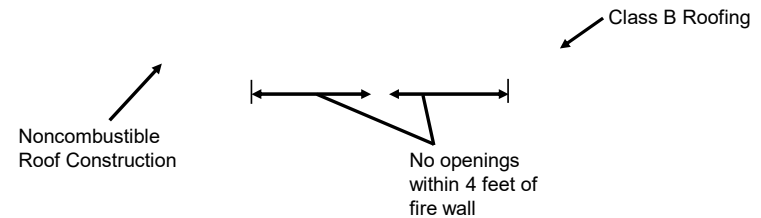
- Fire walls shall extend from the foundation to a termination point at least 30 inches above both adjacent roofs.

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### Vertically Continuity 706.6, Exception 3



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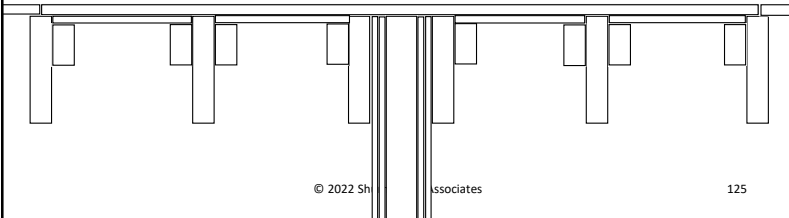
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## Vertically Continuity 706.6, Exception 4

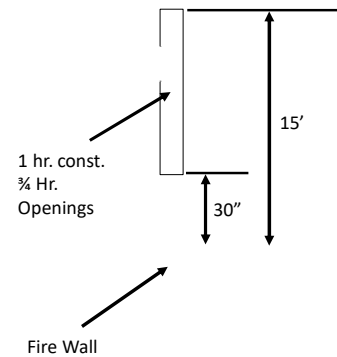
- Type III, IV and V Construction
  - No openings within 4 feet of fire wall
  - Roof is covered with a minimum class B roof covering
  - Roof sheathing or deck is constructed of fire-retardant-treated wood for a distance of 4 feet on each side of the wall or walls, or
  - 5/8 -inch Type X gypsum board is installed directly beneath the roof sheathing supported by 2" ledgers attached to sides of framing members for a distance of not less than 4 feet on each side of the fire walls.



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## Stepped Buildings 706.6.1



- Where a fire wall also serves as an exterior wall for a building and separates buildings having different roof levels, such wall shall terminate at a point not less than 30 inches above the lower roof level.
- Exterior walls above the fire wall extending more than 30 inches above the lower roof shall be of not less than 1-hour fire-resistance-rated construction from both sides with openings protected by fire assemblies having a fire protection rating of not less than 3/4 hour.

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## Vertically Continuity 706.6, Exception 5

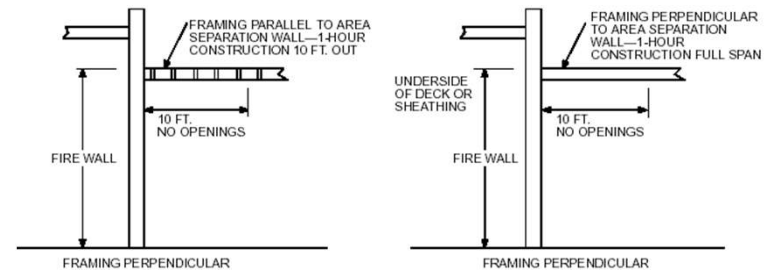
- In buildings designed in accordance with Section 509.2, fire walls located above the 3-hour horizontal assembly required by Section 509.2, Item 1 shall be permitted to extend from the top of this horizontal assembly.



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## Stepped Buildings 706.6.1, Exceptions



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## Fire Wall Openings 706.8

- Section 715.4
- Each opening limited to 156 square feet
- Aggregate width at any floor limited to 25 % of length of wall

TABLE 715.4  
FIRE DOOR AND FIRE SHUTTER FIRE PROTECTION RATINGS

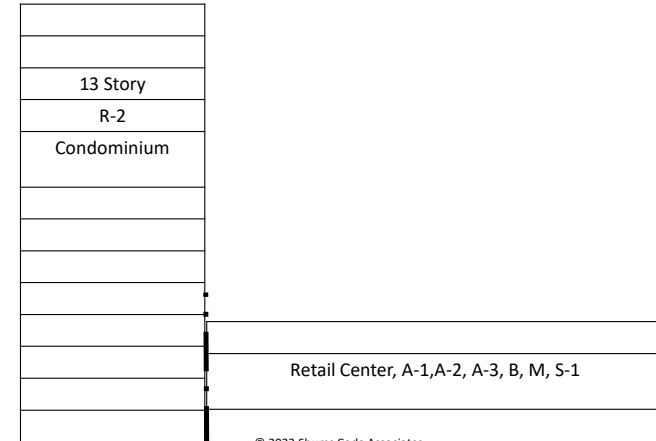
TYPE OF ASSEMBLY	REQUIRED ASSEMBLY RATING (hours)	MINIMUM FIRE DOOR AND FIRE SHUTTER ASSEMBLY RATING (hours)
Fire walls and fire barriers having a required fire-resistance rating greater than 1 hour	4	3
	3	3*
	2	1½
	1½	1½

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## Case Study



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## Ducts and Air Transfer Openings – 706.11



- Ducts and air transfer openings shall not penetrate fire walls.
  - Exception: walls not located on a lot line complying with 716 Limited 25% of length of wall

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## Means of Egress Chapter 10



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## Means of Egress Philosophy

- A safe means to allow the occupant of a building to egress the building in a safe, timely and orderly manner.



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## A Quick Review

- Means of Egress Definition
  - From any occupied portion of building to the public way
- Three Parts of the Means of Egress
  - Exit Access
    - From any occupied point to the exit
  - Exit
    - Protected portion of Means of Egress
  - Exit Discharge
    - From the exit to the public way



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## Means of Egress Philosophy

- Give the occupants alternative paths of travel to a place of safety to avoid fire
- Shelter occupants from fire and smoke
- Accommodate all occupants of the structure
- Provide a clear, unobstructed, well marked and illuminated path under the control of the user without special tools, effort, knowledge or keys



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## Means of Egress Design

- Determine Occupant Load
  - Floor Area/Occupant Load Factor (Table 1004.1.1)

TABLE 1004.5  
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR <sup>a</sup>
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 1004.6
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	150 gross
Concentrated business use areas	See Section 1004.8

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## Means of Egress Design

- Determine number of exit access doorways or exits
  - Occupant load
  - Common path of egress

TABLE 1008.2.1  
SPACES WITH ONE EXIT OR EXIT ACCESS DOORWAY

OCCUPANCY	MAXIMUM OCCUPANT LOAD OF SPACE	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (feet)		
		Without Sprinkler System (feet)	With Sprinkler System (feet)	With Sprinkler System (feet)
A <sup>1</sup> , E, M	49	75	75	75 <sup>a</sup>
B	49	100	75	100 <sup>a</sup>
F	49	75	75	100 <sup>a</sup>
H-1, H-2, H-3	25	50	50	75 <sup>a</sup>
H-4, H-5	10	50 <sup>b</sup>	50 <sup>b</sup>	75 <sup>a</sup>
I-1, I-2, I-4	10	50	50	75 <sup>a</sup>
I-3	10	50	50	100 <sup>a</sup>
R-1	10	50	50	75 <sup>a</sup>
R-2	10	50	50	75 <sup>a</sup>
S-1 <sup>a</sup>	10	50	50	100 <sup>a</sup>
S-2 <sup>a</sup>	10	75	75	100 <sup>a</sup>
U	49	100	75	75 <sup>a</sup>

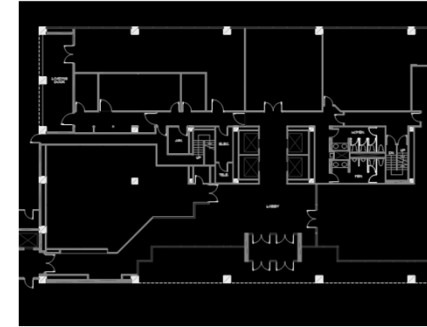
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## Exit Components

- Exterior Exit Doors
- Exit Enclosures
- Exit Passageways
- Horizontal Exits
- Exterior Exit Stair/Ramps



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## Means of Egress Design

- Determine Egress Widths
  - Occupant Load X Egress Width Factor



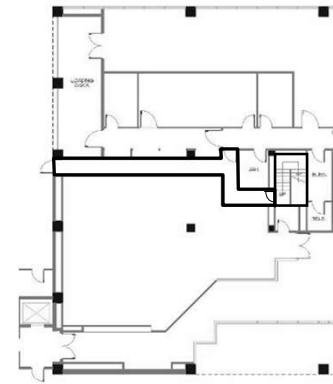
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## Exit Passageways 202

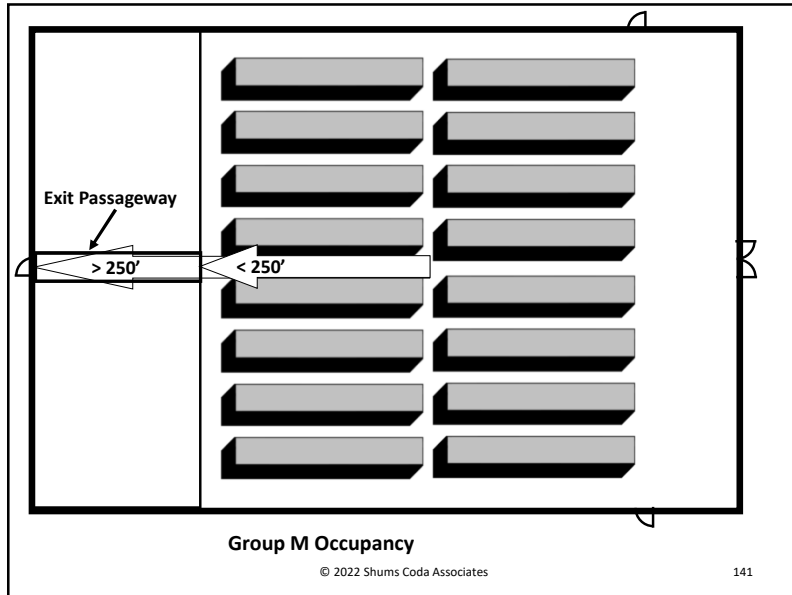
- An exit component that is separated from other interior spaces of a building or structure by fire resistance-rated construction and opening protectives, and provides for a protected path of egress travel in a horizontal direction to an exit or to the exit discharge.



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## Construction 1024.3

- Exit passageway enclosures shall have walls, floors and ceilings of not less than 1-hour fire-resistance rating, and not less than that required for any connecting exit enclosure. Exit passageways shall be constructed as fire barriers or horizontal assemblies, or both.

US Gypsum Co.

2 Hour Fire-rated Construction	NER-258
	<ul style="list-style-type: none"> <li>— corridor ceiling, and stair soffit</li> <li>• 1" SHEERROCK Brand Gypsum Liner Panels</li> <li>• 1/2" SHEERROCK Brand Firecode C Core Gypsum Panels</li> <li>• USG steel C-H Stud spanning horizontally 24" o.c.</li> <li>• USG steel J-runner</li> <li>— joints finished</li> </ul>

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## Width 1024.2

- The required capacity of exit passageways shall be determined as specified in Section 1005.1 but the minimum width shall be not less than 44 inches, except that exit passageways serving an occupant load of less than 50 shall be not less than 36 inches in width.
- The minimum width or required capacity of exit passageways shall be unobstructed.

— Exception: Encroachments complying with Section 1005.7.

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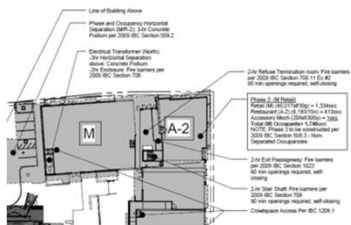
## Termination 1024.4

- Exit passageways shall terminate at an exit discharge or a public way.

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## Openings 1024.5



- Exit passageway opening protectives shall be in accordance with the requirements of Section 716.
- Except as permitted in Section 402.8.7, openings in exit passageways other than unprotected exterior openings shall be limited to those necessary for exit access to the exit passageway from normally occupied spaces and for egress from the exit passageway.
- Where an interior exit stairway or ramp is extended to an exit discharge or a public way by an exit passageway, the exit passageway shall comply with Section 1023.3.1.
- Elevators shall not open into an exit passageway.

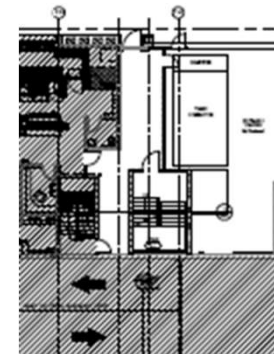
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## 1023.3.1 Extension

- A fire door assembly complying with Section 716.5 shall be installed in the fire barrier to provide a means of egress from the interior exit stairway and ramp to the exit passageway.
- Openings in the fire barrier other than the fire door assembly are prohibited. Penetrations of the fire barrier are prohibited.



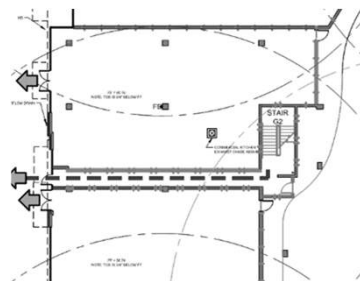
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## 1023.3.1 Extension

- Where interior exit stairways and ramps are extended to an exit discharge or a public way by an exit passageway, the interior exit stairway and ramp shall be separated from the exit passageway by a fire barrier or a horizontal assembly, or both.
- The fire-resistance rating shall be not less than that required for the interior exit stairway and ramp.



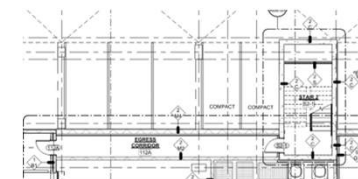
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## 1023.3.1 Extension

- Exceptions:
  - Penetrations of the fire barrier in accordance with Section 1023.5 shall be permitted.
  - Separation between an interior exit stairway or ramp and the exit passageway extension shall not be required where there are no openings into the exit passageway extension.
  - Separation between an interior exit stairway or ramp and the exit passageway extension shall not be required where the interior exit stairway and the exit passageway extension are pressurized in accordance with Section 909.20.5.



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## Penetrations 1024.6

- Penetrations into or through an exit passageway are prohibited except for the following:
  1. Equipment and ductwork necessary for independent pressurization.
  2. Fire protection systems.
  3. Security systems.
  4. Two-way communication systems.
  5. Electrical raceway for fire department communication.
  6. Electrical raceway serving the exit passageway and terminating at a steel box not exceeding 16 square inches (0.010 m<sup>2</sup>).
- Such penetrations shall be protected in accordance with Section 714. There shall not be penetrations or communicating openings, whether protected or not, between adjacent exit passageways.
  - Exception: Membrane penetrations shall be permitted on the outside of the exit passageway. Such penetrations shall be protected in accordance with Section 714.4.2.

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## 1024.7 Ventilation

- 3. Where located within the building, the equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required for shafts.
- In each case, openings into the fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by opening protectives in accordance with Section 716 for shaft enclosures.
- Exit passageway ventilation systems shall be independent of other building ventilation systems.



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## 1024.7 Ventilation

- Equipment and ductwork for exit passageway ventilation as permitted by Section 1024.6 shall comply with one of the following:
  - 1. The equipment and ductwork shall be located exterior to the building and shall be directly connected to the exit passageway by ductwork enclosed in construction as required for shafts.
  - 2. Where the equipment and ductwork is located within the exit passageway, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or the air shall be conveyed through ducts enclosed in construction as required for shafts.



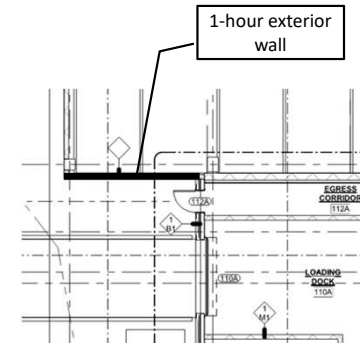
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## 1024.8 Exit passageway exterior walls

- Exterior walls of the exit passageway shall comply with Section 705.
- Where nonrated walls or unprotected openings enclose the exterior of the exit passageway and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees, the building exterior walls within 10 feet horizontally of a nonrated wall or unprotected opening shall have a fire-resistance rating of not less than 1 hour.



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## 1024.8

### Exit passageway exterior walls

- Openings within such exterior walls shall be protected by opening protectives having a fire protection rating of not less than 3/4 hour. This construction shall extend vertically from the ground to a point 10 feet above the floor of the exit passageway, or to the roof line, whichever is lower.

Cut-to-size up to 48" x 96"



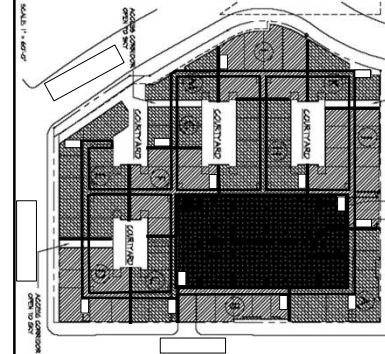
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## Horizontal Exits

### 1026



- Horizontal exits serving as an exit in a means of egress system shall comply with the requirements of this section.
- A horizontal exit shall not serve as the only exit from a portion of a building, and where two or more exits are required, not more than one-half of the total number of exits or total exit minimum width or required capacity shall be horizontal exits.

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## 1024.9 Standpipes

- Standpipes and standpipe hose connections shall be provided where required by Sections 905.3 and 905.4.
  - Mall buildings



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## Horizontal Exits (Exceptions)

### 1026



1. Horizontal exits are permitted to comprise two-thirds of the required exits from any building or floor area for occupancies in Group I-2.
2. Horizontal exits are permitted to comprise 100 percent of the exits required for occupancies in Group I-3. Not less than 6 square feet of accessible space per occupant shall be provided on each side of the horizontal exit for the total number of people in adjoining compartments.

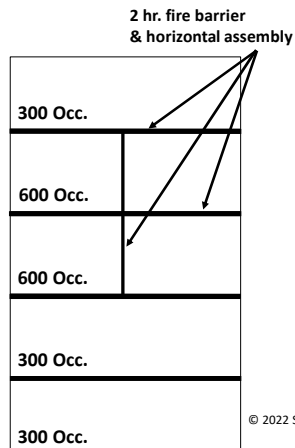
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### Separation 1026.2



- The separation between buildings or areas of refuge connected by a horizontal exit shall be provided by a fire wall or a fire barrier having a fire-resistance rating of not less than 2 hours.
- Opening protectives in horizontal exit walls shall also comply with Section 716.
- Duct and air transfer openings in a fire wall or fire barrier that serves as a horizontal exit shall also comply with Section 716.
- The horizontal exit separation shall extend vertically through all levels of the building unless floor assemblies have a fire-resistance rating of not less than 2 hours with no unprotected openings.

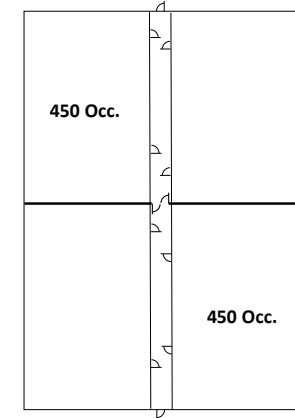
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### Refuge Area 1026.4

- The refuge area of a horizontal exit shall be a space occupied by the same tenant or a public area and each such area of refuge shall be adequate to house the original occupant load of the refuge space plus the occupant load anticipated from the adjoining compartment.
- The anticipated occupant load from the adjoining compartment shall be based on the capacity of the horizontal exit doors entering the refuge area or the total occupant load of the adjoining compartment, whichever is less.



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### Opening Protectives 1026.3



- Fire doors in horizontal exits shall be self-closing or automatic-closing when activated by a smoke detector installed in accordance with Section 716.5.9.3.
- Opening protectives in horizontal exits shall be consistent with the fire-resistance rating of the wall.
- Such doors where located in a cross-corridor condition shall be automatic-closing by activation of a smoke detector installed in accordance with Section 716.5.9.3.

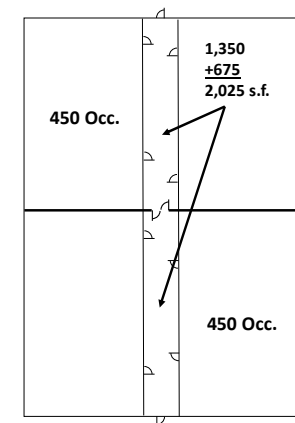
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### Capacity 1026.4.1

- The capacity of the refuge area shall be computed based on a net floor area allowance of 3 square feet for each occupant to be accommodated therein.
- Where the horizontal exit also forms a smoke compartment, the capacity of the refuge area for Group I-1, I-2 and I-3 occupancies and Group B ambulatory care facilities shall comply with Sections 407.5.3, 408.6.2, 420.6.1 and 422.3.2 as applicable.

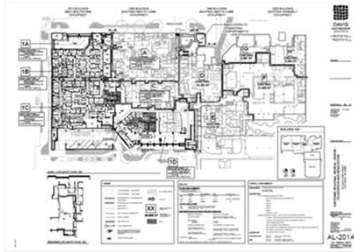


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## Capacity Of Refuge Area 1026.4.1



- Exception: The net floor area allowable per occupant shall be as follows for the indicated occupancies:
  1. Six square feet per occupant for occupancies in Group I-3.
  2. Fifteen square feet per occupant for ambulatory occupancies in Group I-2.
  3. Thirty square feet per occupant for nonambulatory occupancies in Group I-2.

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## Number of Exits 1026.4.2



- Exception:
  - The adjoining compartment shall not be required to have a stairway or door leading directly outside, provided the refuge area into which a horizontal exit leads has stairways or doors leading directly outside and are so arranged that egress shall not require the occupants to return through the compartment from which egress originates.

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## Number of Exits 1026.4.2

- The refuge area into which a horizontal exit leads shall be provided with exits adequate to meet the occupant requirements of this chapter, but not including the added occupant load imposed by persons entering the refuge area through horizontal exits from other areas.
- Not less than one refuge area exit shall lead directly to the exterior or to an interior exit stairway or ramp.



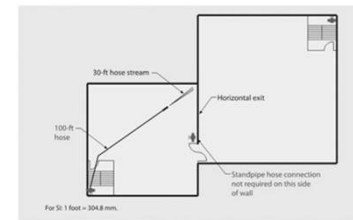
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## 905.4 Location of Class I standpipe hose connections

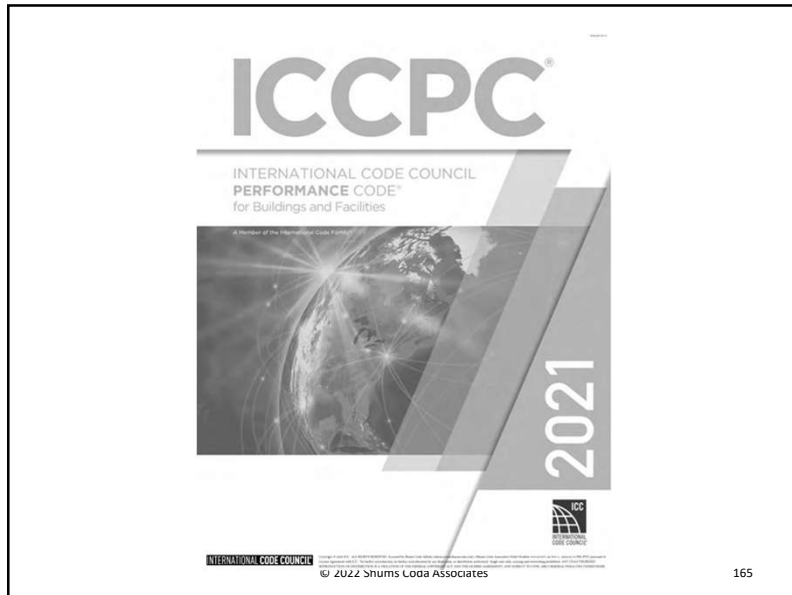
- Class I standpipe hose connections shall be provided in all of the following locations:
  2. On each side of the wall adjacent to the exit opening of a horizontal exit.
    - Exception: Where floor areas adjacent to a horizontal exit are reachable from an interior exit stairway hose connection by a 30-foot hose stream from a nozzle attached to 100 feet of hose, a hose connection shall not be required at the horizontal exit.



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## Principles




- Adequately protect public health, safety, and welfare;
- Provisions that do not unnecessarily increase construction costs;
- Provisions that do not restrict the use of new materials, products, or methods of construction;
- Provisions that do not give preferential treatment to particular types or classes of materials, products, or methods of construction.

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## Appendix O Performance-Based Application

- The following administrative provisions are excerpted from the ICC Performance Code for Buildings and Facilities and can be used in conjunction with the Alternate Methods provisions in Chapter 1, or for a review of submittals requiring a rational analysis or performance-based design.
- These provisions provide an established framework for the building official in terms of the design expertise needed, the necessary submittals, a review framework and related items.




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## Format

- Part I – Administrative
- Part II – Building
  - Stability, Fire Safety, Pedestrian Circulation, Safety of Users, etc.
- Part III – Fire
  - Fire Prevention, Fire Impact Management, Management of People, Emergency Notification, etc.
- Part IV – Appendices
- Users Guide



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## Intent 101.4



- Building – Part II
- Intends buildings and structures to provide for:
  - An environment free of unreasonable risk of death and injury from fires.
  - A structure that will withstand loads associated with normal use and of the severity associated with the location in which the structure is constructed.
  - Means of egress and access for normal and emergency circumstances.
  - Limited spread of fire both within the building and to adjacent properties.

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## Intent 101.4



- Fire - Part III
- Provide an acceptable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions in all facilities, equipment and processes.

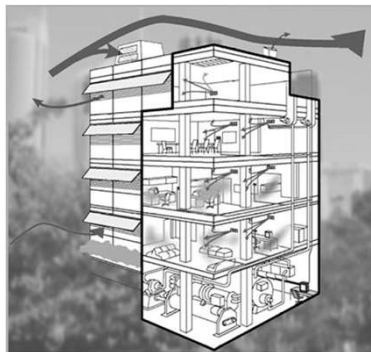
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## Intent 101.4

- Building - Part II (continued)
  - Ventilation and sanitation facilities to maintain the health of the occupants.
  - Natural light, heating, cooking and other amenities necessary for the well being of the occupants.
  - Efficient use of energy.
  - Safety to firefighters and emergency responders during emergency operations.



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## Minimum Performance 301.1

- Provides the basis for developing the acceptable level of design based upon building use, risk factors and magnitudes of event.
- Magnitudes are defined in subsequent chapters of this code but interrelate with this chapter in the development of design methods for the mitigation of hazards.



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## 301.2 Objective

- To establish performance groups for buildings and facilities and to establish minimum acceptable losses based on those performance groups.



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## 301.3.2 Demonstration of performance

- Performance is acceptable where the design performance levels are demonstrated to be met or exceeded, to the satisfaction of the code official, in accordance with the assigned or designated use groups, performance groups, magnitudes of event and maximum tolerable damage limits; and the objectives, functional statements and performance requirements of this code.



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## 301.3.1 Performance level

- The performance of a building or facility is based on the ability of the building or facility to tolerate specified magnitudes of event within tolerable limits of damage.



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## 302.2 Determination of use

- In determining the primary use of a building or facility, or portion of a building or facility, the following shall be considered:
  - 1. Principal purpose or function. The principal purpose or function of the building or facility.
  - 2. Hazards. The hazard-related risk(s) to the users of the building or facility.



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## 302.4 Risk factors

- In determining the hazard-related risk(s) to users of buildings and facilities, the following risk factors shall be considered:
  - Nature of the hazard
  - Number of occupants
  - Length of occupancy
  - Sleeping characteristics
  - Familiarity
  - Vulnerability
  - Relationships



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[B]TABLE 302.4  
PERFORMANCE GROUP CLASSIFICATIONS FOR BUILDINGS AND FACILITIES

PERFORMANCE GROUP	USE AND OCCUPANCY CLASSIFICATIONS FOR SPECIFIC BUILDINGS OR FACILITIES
I	Buildings and facilities that represent a low hazard to human life in the event of failure, including, but not limited to: <ol style="list-style-type: none"> <li>Agricultural facilities.</li> <li>Certain temporary facilities.</li> <li>Minor storage facilities.</li> </ol>
II	All buildings and facilities except those listed in Performance Groups I, III and IV.
III	Buildings and facilities that represent a substantial hazard to human life in the event of failure, including, but not limited to: <ol style="list-style-type: none"> <li>Buildings and facilities where more than 300 people congregate in one area.</li> <li>Buildings and facilities with elementary school, secondary school or day care facilities with a capacity greater than 250.</li> <li>Buildings and facilities with a capacity greater than 500 for colleges or adult education facilities.</li> <li>Health-care facilities with a capacity of 50 or more residents but not having surgery or emergency treatment facilities.</li> <li>Jails and detention facilities.</li> <li>Any other occupancy with an occupant load greater than 5,000.</li> <li>Power-generating facilities, water treatment for potable water, wastewater treatment facilities and other public utilities facilities not included in Performance Group IV.</li> <li>Buildings and facilities not included in Performance Group IV containing sufficient quantities of highly toxic gas or explosive materials capable of causing acutely hazardous conditions that do not extend beyond property boundaries.</li> </ol>
IV	Buildings and facilities designated as essential facilities, including, but not limited to: <ol style="list-style-type: none"> <li>Hospitals and other health-care facilities having surgery or emergency treatment facilities.</li> <li>Fire, rescue and police stations and emergency vehicle garages.</li> <li>Designated earthquake, hurricane or other emergency shelters.</li> <li>Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response.</li> <li>Power-generating stations and other utilities required as emergency backup facilities for Performance Group IV buildings or facilities.</li> <li>Buildings and facilities containing highly toxic gas or explosive materials capable of causing acutely hazardous conditions beyond the property boundaries.</li> <li>Aviation control towers, air traffic control centers and emergency aircraft hangars.</li> <li>Buildings and facilities having critical national defense functions.</li> <li>Water treatment facilities required to maintain water pressure for fire suppression.</li> <li>Ancillary structures (including, but not limited to, communication towers, fuel storage tanks or other structures housing or supporting water or other fire suppression material or equipment) required for operation of Performance Group IV structures during an emergency.</li> </ol>

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## 303.1 Performance group allocation

- Use groups and hazard-related occupancies have been allocated to performance groups using the risk factors identified in Section 302.4.
- Specific buildings and facilities have been allocated to performance groups using the risk factors identified in Section 302.4 combined with the relative importance of protecting the building or facility to the community.
- These performance group allocations are shown in Table 303.1.



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## 303.3 - Magnitudes of event and level of damage

- Performance groups identify the minimum required performance of buildings or facilities through a relationship of the magnitude of an event to the maximum level of damage to be tolerated shown in Table 303.3.

[B]TABLE 303.3  
MAXIMUM LEVEL OF DAMAGE TO BE TOLERATED BASED ON PERFORMANCE GROUPS AND DESIGN EVENT MAGNITUDES

		INCREASING LEVEL OF PERFORMANCE			
		PERFORMANCE GROUPS			
		Performance Group I	Performance Group II	Performance Group III	Performance Group IV
MAGNITUDE OF DESIGN EVENT INCREASING MAGNITUDE OF EVENT	VERY LARGE (Very Rare)	SEVERE	SEVERE	HIGH	MODERATE
	LARGE (Rare)	SEVERE	HIGH	MODERATE	MILD
	MEDIUM (Less Frequent)	HIGH	MODERATE	MILD	MILD
	SMALL (Frequent)	MODERATE	MILD	MILD	MILD

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## Part II - Building



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## Sources of Fire Ignition 601



- To prevent unwanted ignition caused by building equipment and systems.
- Fuel burning appliances and services shall be installed in a manner that reduces their potential as a source of fire ignition.
- Electrical equipment, appliances and services shall be installed in a manner that reduces their potential as a source of fire ignition.

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## Stability 501

- To provide a desired level of structural performance when structures are subjected to the loads that are expected during construction or alteration and throughout their intended lives.
- Structures shall be designed and constructed to prevent injury to occupants due to loading of a structural element or system consistent with the design performance level determined in Chapter 3.
- Structures shall be designed and constructed to prevent loss of property and amenity consistent with the design performance level determined in Chapter 3.



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## Means of Egress 701



- To protect people during egress and rescue operations.
- Enable occupants to exit the building, facility and premise or reach a safe place as appropriate to the design performance level determined in Chapter 3.

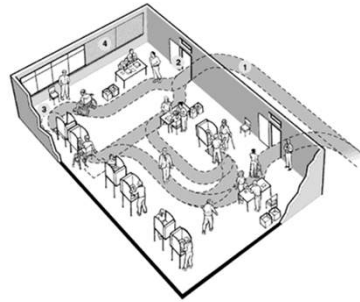
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## Accessibility 702

- To provide people with disabilities reasonable use of the built environment in a manner consistent with that provided to people without disabilities in nonemergency conditions.
- Buildings and their site
- adjacent facilities shall allow all people, including but not limited to people with disabilities, functional use of spaces based on a space's intended purpose.



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## 801 Hazardous Materials

- To protect people and property from the consequences of unauthorized discharge, fires or explosions involving hazardous materials.
- Provide adequate safeguards to minimize the risk of unwanted releases, fires or explosions involving hazardous materials as appropriate to the design performance level determined in Chapter 3.
- Provide adequate safeguards to minimize the consequences of an unsafe condition involving hazardous materials during normal operations and in the event of an abnormal condition in accordance with the design performance level determined in Chapter 3.



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## Transportation Equipment 703



- To ensure the safety of all people using, maintaining and inspecting elevators, escalators and similar building transportation equipment inside or outside of buildings.
- Building transportation equipment installations for access into, within and outside of buildings shall provide for the safe movement of all people and the safety of maintenance and inspection personnel.

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## Hazards from Building Materials 802



- To safeguard people from injury caused by exposure to hazards from building materials.
- Building materials that are potentially hazardous shall be used in ways to avoid undue risk to people.

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## Prevention of Falls 803

- To prevent people from unintentionally falling from one level to another.
- Buildings and their facilities shall be constructed to reduce the likelihood of unintentional falls.



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## Construction and Demolition Hazards - 804

- Provisions are required during construction and demolition work to:
  1. Protect authorized personnel from injury resulting from falling objects, fire, blasts, tripping or falling, or any other risk posed by the construction or demolition operation.
  2. Prevent the entry of unauthorized personnel on the construction or demolition site.
  3. Protect property off site from damage resulting from falling objects, fire, blasts or any other risk posed by the construction or demolition operations.



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## Construction and Demolition Hazards - 804

- To safeguard people from injury or illness and to protect property from damage during the construction or demolition processes.



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## 805 Signs

- To identify essential features of the building to its users.
- Signs shall identify escape and rescue routes, hazards, accessible elements where not all elements are accessible and other essential features of a building.



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## Emergency Notification 806

- Requires that emergency notification systems be provided to initiate manual intervention needed to limit hazards to people or property



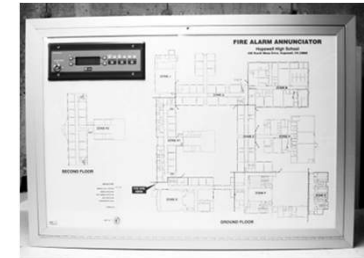
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## Emergency Notification 806

- Where systems are designed to notify emergency responders, such systems shall indicate the type of emergency and the location of the building.
- Where buildings are large enough to expect difficulty in prompt location of the fire or other public emergency, identification of the fire zone of origin shall be provided at the building.



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## Emergency Notification 806

- Where required, adequate means of occupant notification shall be provided to warn of the presence of a fire or other emergency in sufficient time to enable occupants to take the contemplated action without being exposed to unreasonable risk of injury or death.



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## Moisture – Surface Water 901

- To safeguard people from injury and protect the building or other property from damage caused by surface water and to protect outfalls of drainage systems that may become contaminated from on-site hazardous material storage.



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## Moisture – Surface Water 901

- Buildings and sites shall be constructed in a way that protects people and other property from the adverse effects of surface water.
- Building or building sites used for the storage or use of hazardous materials shall include provisions to ensure that hazardous materials are not accidentally transported across property lines into drainage outfalls.



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## Internal Moisture 903

- To safeguard people against illness or injury that could result from accumulation of internal moisture, and to protect an occupancy from damage caused by free water from another occupancy in the same building.
- Buildings shall be constructed to avoid the likelihood of:
  1. Fungal growths or the accumulation of contaminants on linings and other building elements.
  2. Free water overflow penetrating to an adjoining occupancy.
  3. Damage to building elements being caused by the use of water.



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## External Moisture 902

- To safeguard people from injury and property from damage that could result from external moisture entering the building.
- Buildings shall be constructed to provide adequate resistance to penetration by, and the accumulation of, moisture from the outside.



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## 1001 Climate And Building Functionality

- To safeguard people from illness caused by air temperature and to safeguard people from injury or loss of amenity caused by inadequate activity space.
- Buildings shall be constructed to provide:
  1. Adequately controlled interior temperatures.
  2. Adequate activity space for the intended use.

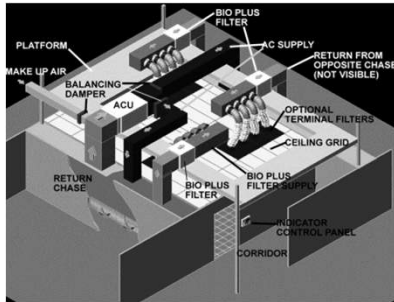


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## Indoor Air Quality 1002



- To maintain the habitable spaces of buildings and facilities with an environment that is conducive to the comfort, health and safety of the occupants.
- Habitable spaces within buildings shall be provided with air that contains sufficient oxygen and limits the levels of moisture and contaminants to levels that are consistent with good health, safety and comfort.

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## Artificial And Natural Light 1004



- To safeguard people from injury or loss of amenity due to lack of adequate lighting.
- Habitable spaces and means of egress within buildings shall be provided with adequate artificial lighting to enable safe movement.
- Adequate natural or artificial light shall be provided in all habitable spaces.

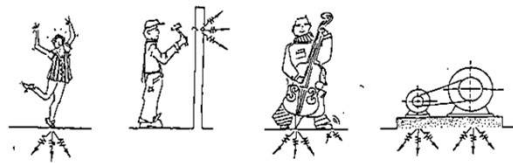
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## Air-borne And Impact Sound 1003

- To safeguard people from loss of amenity as a result of excessive noise being transmitted between adjacent tenants or occupancies.
- Building elements that are common between tenants or occupancies shall be constructed to prevent excessive noise transmission from other tenants or occupancies or common spaces to habitable spaces.



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## HVAC Equipment 1101

- To provide the safe installation of the equipment to condition the air for the health and comfort of the occupants.
- The installation of equipment shall safeguard maintenance personnel and building occupants from injury and deliver air at the appropriate temperature for health and comfort.



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## Refrigeration 1102



- To provide the safe installation and operation of refrigeration equipment.
- The installation of equipment shall safeguard maintenance personnel and building occupants from injury.

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## Personal Hygiene 1201



- To provide facilities with appropriate space, fixtures and equipment for personal hygiene.
- To provide adequate plumbing fixtures that reasonably protect people from illness and provide reasonable access to such fixtures conducive to health, safety and comfort of the occupants.

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## Piped Services 1103

- To safeguard people from injury or illness caused by extreme temperatures or hazardous substances associated with building services.
- In buildings with potentially hazardous services containing hot, cold, flammable, corrosive or toxic liquids or gases, the installations shall be constructed to provide adequate safety for people.



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## Laundrying 1202

- To provide adequate facilities for laundry.
- Laundry facilities shall be provided for use by occupants of dwelling units.



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## Domestic Water Supplies 1203



- To provide sanitary distribution of water for drinking, food preparation and hygiene.
- Sanitary water shall be delivered to fixtures, appliances and equipment at temperatures appropriate for the intended use.

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## Fuel Gas Piping & Vents 1301



- To ensure that fuel gas is distributed and utilized in a safe manner.
- In buildings where fuel gas is used as an energy source, the gas piping vented and unvented systems shall be safe and adequate for their intended use.

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## Wastewater 1204

- To provide safe drainage and disposal systems for waste water from plumbing fixtures, appliances and equipment.
- The drainage system shall conduct waste water to an appropriate disposal point, protect people from contamination and unpleasant odor, and avoid blockages.



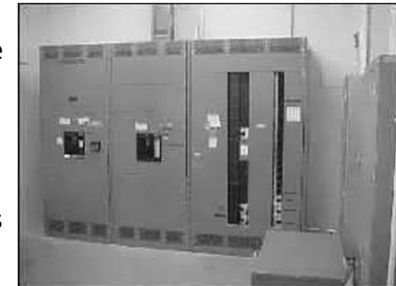
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## Electricity 1401

- To provide safe installation of electrical power and lighting for the building systems and use by the building occupants.
- The electrical installations shall have safeguards against personal injury and the outbreak of fire.



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## Energy Efficiency 1501



- To facilitate efficient use of energy.
- Buildings shall have provisions ensuring efficient use of nonrenewable energy.

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## Fire Prevention 1601



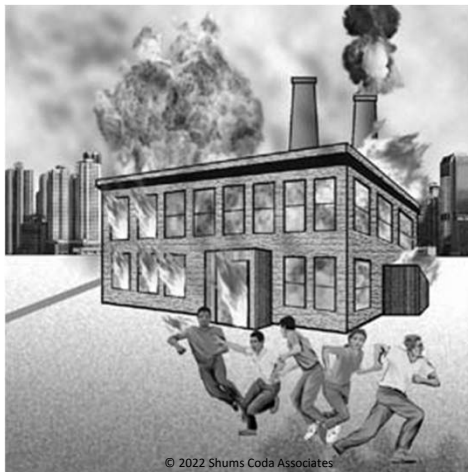
- To limit or control the likelihood that a fire will start because of the design, operation or maintenance of a facility or its systems so as to minimize impacts on people, property, processes and the environment.
- Facility services, systems and activities that represent a potential source of ignition or can contribute fuel to an incipient fire shall be designed, operated, managed and maintained to reduce the likelihood of a fire starting.

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## Part III - Fire



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## Fire Impact Management 1701

- To provide an acceptable level of fire safety performance when facilities are subjected to fires that could occur in the fire loads that may be present in the facility during construction or alteration and throughout the intended life.



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## Fire Impact Management 1701

- Facilities shall be designed with safeguards against the spread of fire so that persons not directly adjacent to or involved in the ignition of a fire shall not suffer serious injury or death from a fire, and so that the magnitude of the property loss is limited as follows:



- Performance Group I—High
- Performance Group II—Moderate
- Performance Group III—Mild
- Performance Group IV—Mild

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## Means of Egress 1901

- To protect people during egress and rescue operations.
- Enable occupants to exit the building, facility and premises or reach a safe place as appropriate to the design performance level determined in Chapter 3.



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## Management of People 1801



- To promote safe practices and actions of people, and to ensure that the actions and practices of people who are components of a design are maintained.
- Through training and education, ensure that people possess the necessary skills and implement the appropriate actions to prevent fires or other emergencies as appropriate to the design performance level determined in Chapter 3.
- Through training and education, ensure that people possess the necessary skills and implement the appropriate actions during a fire or other emergency as appropriate to the design performance level determined in Chapter 3.

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## Emergency Notification, Access and Facilities - 2001

- To provide and maintain means of notification, access and facilities for emergency operations and responders.
- To provide notification of the need to take some manual action to preserve the safety of occupants or to limit property damage.



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## Emergency Notification, Access and Facilities - 2001

- As appropriate to the design performance level in Chapter 3, the following shall be addressed:
  1. Provide and maintain appropriate access for emergency vehicles.
  2. Provide and maintain appropriate access for emergency responders.
  3. Provide and maintain necessary staging, command and control areas, support facilities and equipment for emergency operations.
  4. Provide sufficient, reliable water for fire-fighting operations.
  5. Provide and maintain appropriate means of promptly notifying emergency responders.
  6. Where required, provide and maintain adequate means of occupant notification to warn of the presence of a fire or other emergency in sufficient time to enable occupants to take the contemplated action without being exposed to unreasonable risk of injury or death.



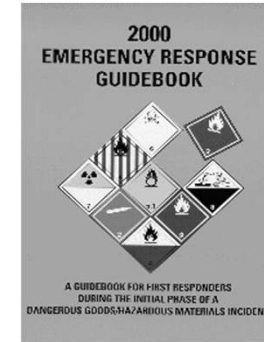
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## Hazardous Materials 2201

- To protect people and property from the consequences of unauthorized discharge, fires or explosions involving hazardous materials.
- Provide adequate safeguards to minimize the risk of unwanted releases, fires or explosions involving hazardous materials as appropriate to the design performance level determined in Chapter 3.



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## Emergency Responder Safety 2101

- As appropriate to the design performance level determined in Chapter 3, the following shall be provided:
  1. Information to responders regarding hazards present at the building or premises.
  2. Protection against unanticipated structural collapse.
  3. Appropriate fire service communications capability.



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## Hazardous Materials 2201

- Provide adequate safeguards to minimize the consequences of an unsafe condition involving hazardous materials during normal operations and in the event of an abnormal condition in accordance with the design performance level determined in Chapter 3.



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# Project Rio

## PROJECT RIO FULFILLMENT CENTER



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# Project Rio

- Tenant wants to construct four levels of “proprietary robotic storage and retrieval system”.
- Total area of all levels and ground floor
  - 2,313,835 Square Feet
- Now what?



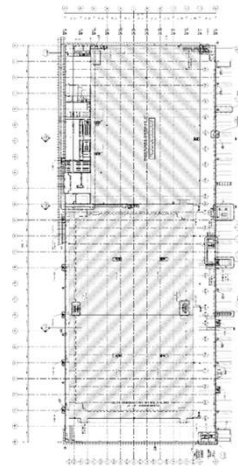
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# Project Rio

- Base building
  - Group S-1
  - 857,400 SF floor plate
  - One story, 53 feet height
  - Fire sprinklered
  - 60+ feet open space around entire building
- How do we build this?



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# Project Rio

- Prescriptive code
  - Base building
    - Unlimited area per Section 507.2
    - Type VB or IIB Construction
  - Proposed building
    - Unlimited area per Table 506.2
    - Type IA



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## What are the issues?

- Size of the building
- Fire load of contents
- Protection of the occupants
- Protection of the structure
- Others?



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## Strength

- The building will comply with the structural requirements of the IBC.
- No alternate evaluated



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## Quality

- What standards are applicable?
  - IBC
  - Structural Standards
- The building will comply with most of the prescriptive code



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## Effectiveness

- Will the building meet the other desired results of the code?
- Prescriptive requirements



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## Fire resistance

- Will the building comply with the fire-resistance requirements of the code?
- NO!
- So...



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## Proposed alternate

- Provide sprinkler protection for each elevated platform with a higher level of sprinkler discharge than the hazard being protected would minimally require.
- ESFR sprinklers at the roof



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## Fire resistance

- The design professional will need to present and alternative to fireproofing the structure as required by the code
- Performance Based Design submitted for review



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## Proposed alternate

- Provide a completely independent and redundant water source for the facility fire sprinkler systems.



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## Proposed alternate

- Automatic mechanical smoke and heat removal in the form of mechanical smoke exhaust will be provided.



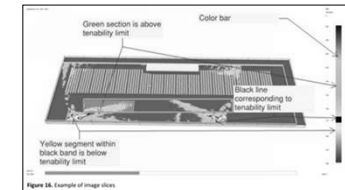
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## Proposed alternate

- Design Approach
- Building & Hazard Description
- Code Analysis
- Building Design Characteristics
- Occupant Characteristics
- Evaluation Methodology
- Evaluation of Results



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## Proposed alternate

- Stated goals
  - Provide a safe environment for occupants to egress the building by maintaining tenable conditions during the time it takes to exit.
  - Protect the structure for a time commensurate with what is required for Type I-A.



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## Proposed alternate

- Evaluation Methodology
  - Fire Scenarios
  - Other Considerations
  - Fire Modeling
  - Egress Analysis



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## Proposed alternate

- Reviewed by:
  - Building Department
  - Fire Department
  - Code Consultant
  - Fire Protection Engineer
- Comments provided and responded to



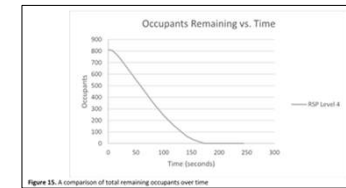
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## Safety

- Mostly addressed by prescriptive code
- Performance-Based Design Approach used for travel distance and openings between floors



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## Durability

- Addressed by prescriptive code



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## Verdict?

- Based on the information we have, would you approve or deny this alternate design?
- If not, what the basis of denial?



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