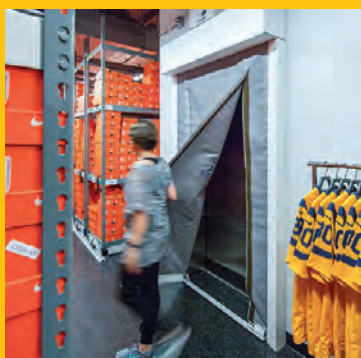




Fire Door Systems

A Guide to Code Compliance





McKEON®

Fire Door Systems

A Guide to Code Compliance



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CONTENTS

APPLICATIONS

1 ELEVATOR SEPARATION

Elevator Lobbies & Hoistway Protection	2
Elevator Smoke & Draft	12

2 EXIT ACCESS SEPARATION

Horizontal Exit	22
Exit Passageways	26
Pedestrian Walkways & Tunnels	29

3 VERTICAL OPENING SEPARATION

Fundamental Guidelines	34
Vertical Compartmentation	36
Escalator Openings	42
Atriums	46
Exit Access Stairways	51
Interior Exit Stairways	57
Draft Curtains, a Fire Protection Feature.....	62

4 OCCUPANCY SEPARATION

Fundamental Guidelines	68
Mixed Occupancy - Accessory Use	70
Mixed Occupancy Use - Non-Separated vs. Separated	74

5 AREA SEPARATION

Allowable Area	82
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6 CORRIDOR SEPARATION

Fundamental Guidelines	88
I-2 Occupancies - Hospitals.....	90

I-1 and R Occupancies	96
B Occupancies - to Include NFPA 101 Provisions.....	98
7 SMOKE COMPARTMENTATION	
Smoke Compartments - Healthcare	102
Smoke Barriers - Healthcare	107
8 RESILIENT CONSTRUCTION	
Storm Shelters	112

APPENDIX

DEFINITIONS

Fire Walls - Section 706	122
Fire Barriers - Section 707	123
Fire Partitions - Section 708	124
Smoke Barriers - Section 709	125
Smoke Partitions - Section 710	126

RESOURCES

IBC 2024 Means of Egress	127
NFPA 101 Life Safety Code, 2024	128
INTERTEK Code Compliance Research Reports.....	128
IBC 2021 Code Change	129
Curtain Systems Egress Feature	130

13th Edition - August 2024

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Introduction

THIS EDITION of *Fire Door Systems, A Guide to Code Compliance* is based on the 2000 thru 2024 editions of the IBC. Regardless of the edition currently adopted by your jurisdiction, the fundamental code principles discussed herein apply to all editions of the IBC through 2024. The specific code section references in this volume reflect the 2024 edition of the IBC.

THE INTERNATIONAL BUILDING CODE has been widely accepted in the United States and is recognized as a uniform code addressing the design and installation of building systems with performance-based requirements. The current International Building Code has been developed over the last two and one half decades through the extensive work and efforts of code enforcement personnel organized at both local and national levels under the direction of the International Code Council. A vital part of the development of the building code is the involvement of industry and nationally recognized organizations with interests in building product development and the protection of public health, safety and welfare.

McKEON develops and manufactures numerous smoke and fire rated assemblies that function as wide-span opening protectives. These building products enter the marketplace specifically to assist design professionals and code enforcement personnel in satisfying open design without compromising fire and life safety requirements. This document is formatted to present the building code as it pertains to the use of opening protectives; first, recite specific prescriptive code requirements, second, performance-based language in laymen's terms for common sense understanding, and third, illustrate product case studies presented as design solutions to frequently approached complex code application challenges. The building code interpretations found herein represent the opinion and experience of the preparer, intended only to assist the reader in recognizing and understanding the potential use and application of McKEON fire and smoke rated opening protective assembly products.

The logo consists of a solid yellow square at the top, followed by the word "McKEON" in a bold, yellow, sans-serif font. Below the text are two horizontal yellow bars of equal length.

McKEON®

1 | Elevator Separation

Elevator Lobbies & Hoistway Protection

Elevator Smoke & Draft

Elevator Lobbies & Hoistway Protection

Section 3006

Hoistway protection is designed to isolate fire, smoke, heat and toxic gases or fumes from migrating floor to floor through vertical hoistways in multi-story structures. There are two fundamental methods prescribed in this code section - elevator lobbies or protection at the point of access to the elevator car.

Fire & Life Safety Concerns

Elevator hoistways are the most common inter-connecting vertical shafts in multi-story buildings. These shafts become conduits for fire, heat, smoke and other toxins between the fire floor(s) and additional floors.

Code Requirements

3006.1 General. Enclosed elevator lobbies and elevator hoistway door protection shall be provided in accordance with the following:

1. Where elevator hoistway door protection is required by Section 3006.2, such protection shall be provided in accordance with Section 3006.3.
2. Where enclosed elevator lobbies are required for underground buildings, such lobbies shall comply with Section 405.4.3.
3. Where an area of refuge is required and an enclosed elevator lobby is provided to serve as an area of refuge, the enclosed elevator lobby shall comply with Section 1009.6.
4. Where fire service access elevators are provided, enclosed elevator lobbies shall comply with Section 3007.6.
5. Where occupant evacuation elevators are provided, enclosed elevator lobbies shall comply with Section 3008.6.

3006.2 Elevator hoistway door protection required. Elevator hoistway doors shall be protected in accordance with Section 3006.3 where an elevator hoistway connects more than three stories, is required to be enclosed within a shaft enclosure in accordance with Section 712.1.1 and any of the following conditions apply:

1. The building is not protected throughout with an automatic

ELEVATOR SEPARATION

sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2.

2. The building contains a Group I-1 Condition 2 occupancy.
3. The building contains a Group I-2 occupancy.
4. The building contains a Group I-3 occupancy.
5. The building is a high rise and the elevator hoistway is more than 75 feet (22 860 mm) in height. The height of the hoistway shall be measured from the lowest floor to the highest floor of the floors served by the hoistway.
6. The elevator hoistway door is located in the wall of a corridor required to be fire-resistance rated in accordance with Section 1020.1

Exceptions:

1. Protection of elevator hoistway doors is not required where the elevator serves only open parking garages in accordance with Section 406.5.
2. Protection of elevator hoistway doors is not required at the level(s) of exit discharge, provided the level(s) of exit discharge is equipped with an automatic sprinkler system in accordance with Section 903.3.1.1.
3. Protection of elevator hoistway doors are not required on levels where the elevator hoistway doors opens to the exterior.

3006.2.1 Rated Corridors. Where corridors are required to be fire-resistance rated in accordance with Section 1020.2, elevator hoistway openings shall be protected in accordance with Section 3006.3.

3006.3 Elevator hoistway opening door protection. Where Section 3006.2 requires protection of the elevator hoistway door opening, the protection shall be provided by one of the following:

1. An enclosed elevator lobby shall be pro-

vided at each floor to separate the elevator hoistway doors from each floor with fire partitions in accordance with Section 708. In addition, doors protecting openings in the fire partitions shall comply with Section 716.2.2.1. Penetrations of the fire partitions by ducts and air transfer openings shall be protected as required for corridors in accordance with Section 717.5.4.1.

2. An enclosed elevator lobby shall be provided at each floor to separate the elevator hoistway doors from each floor by smoke partitions in accordance with Section 710. In addition, doors protecting openings in the smoke partitions shall comply with Sections 710.5.2.2, 710.5.2.3 and 716.2.6.1. Penetrations of the smoke partitions by ducts and air transfer openings shall be protected as required for corridors in accordance with Section 717.5.4.1. Note: Smoke partitions as defined in Section 710.3 are not required to be fire rated. The doors located in smoke partition walls referenced in Section 710.5.2.2 are required to be UL 1784 labeled as smoke & draft control assemblies.
3. Additional doors or other devices shall be provided at each elevator hoistway door opening in accordance with Section 3002.6. Such doors or other devices shall comply with the smoke and draft control door assembly requirements in Section 716.2.2.1.1 when tested in accordance with UL 1784 without an artificial bottom seal.
4. The elevator hoistway shall be pressurized in accordance with Section 909.21.
5. A smoke-protective curtain assembly for hoistways shall be provided at each elevator hoistway door opening in accordance with Section 3002.6. Such curtain assemblies shall comply with the smoke and draft con-

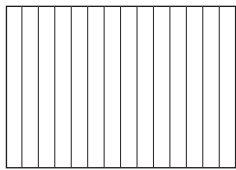
ELEVATOR SEPARATION

trol requirements in Section 716.2.2.1.1 when tested in accordance with UL 1784 without an artificial bottom seal. Such curtain assemblies shall be equipped with a control unit listed to UL 864. Such curtain assemblies shall comply with Section 2.11.6.3 of ASME A17.1/CSA B44. Installation and maintenance shall be in accordance with NFPA 105.

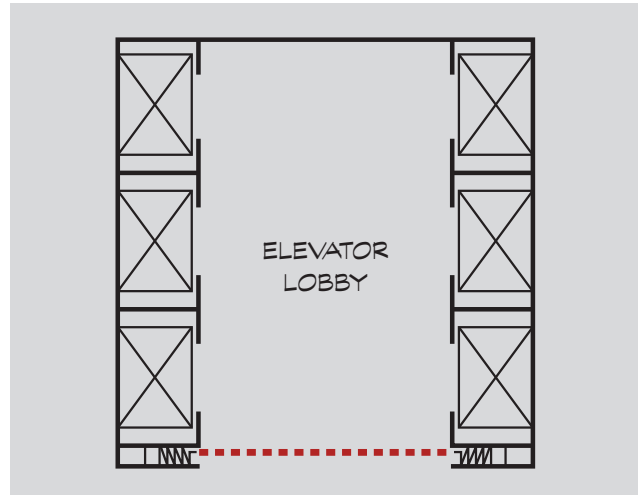
3006.4 Means of egress. Elevator lobbies shall be provided with at least one means of egress complying with Chapter 10 and other provisions in this code. Egress through an elevator lobby shall be permitted in accordance with Item 1 of Section 1016.2. Electrically locked exit access doors providing egress from elevator lobbies shall be permitted in accordance with Section 1010.2.14.

Design Solutions

CASE 1: Side Acting Accordion with Power-assisted Egress

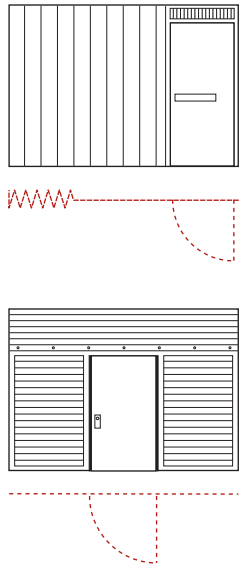


In the first case study, there is no headroom and side stacking space is limited. The McKEON bi-parting accordion fire door technology stepped up to meet the demand of hi-end design without compromising specific code requirements including conforming side acting accordion fire door egress acceptance.

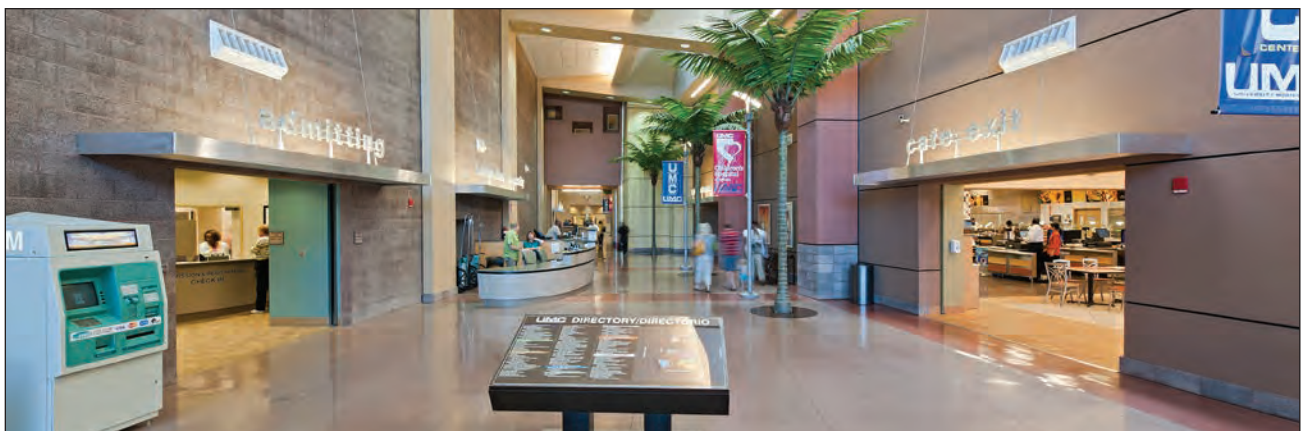
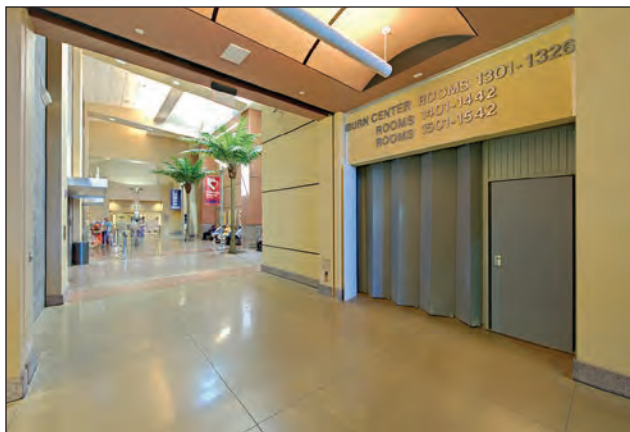
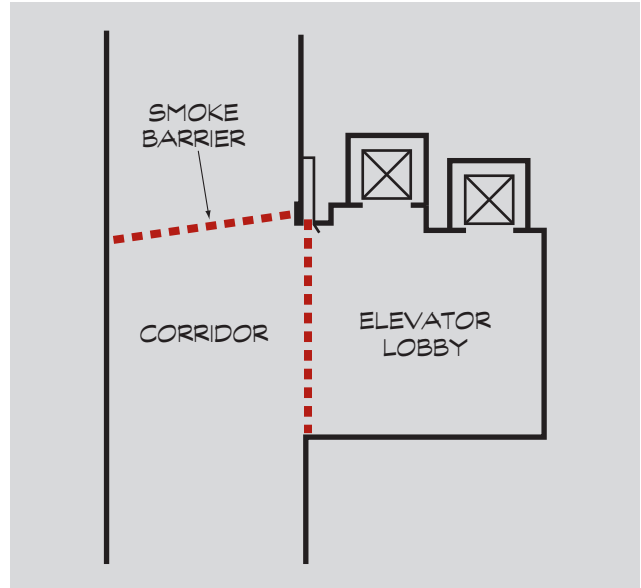


ELEVATOR SEPARATION

CASE 2: Side Acting Accordion with Complying Swing Egress Door & Vertical Acting with Complying Swing Egress Door(s)

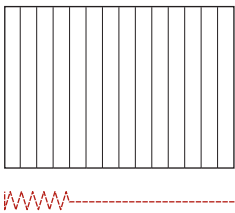


This case study includes both a side acting accordion with conventional egress elevator lobby separation and a vertical acting with conventional egress smoke barrier opening protective.

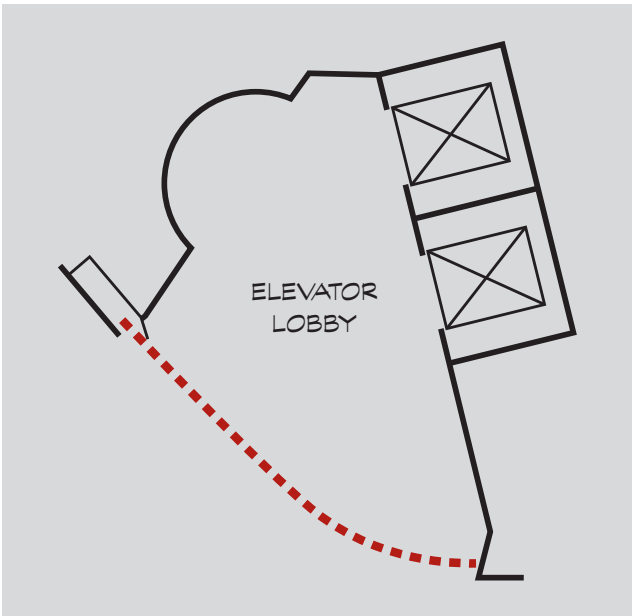


ELEVATOR SEPARATION

CASE 3: Side Acting Accordion with Power-assisted Egress

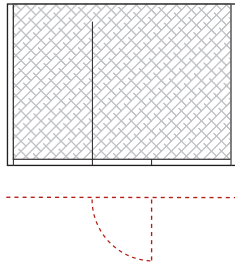


The side acting accordion technology will accommodate custom radius applications as well as serve as the primary means of egress from the space.

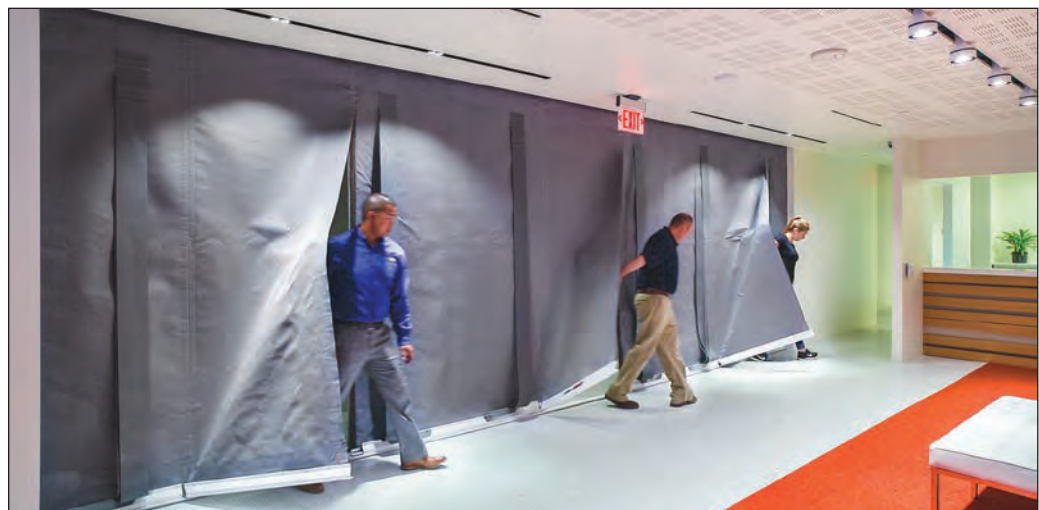
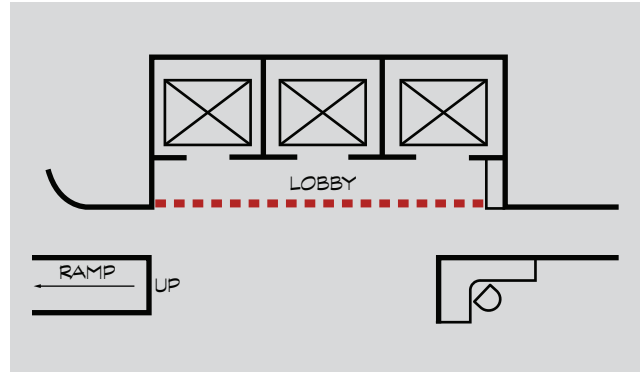


ELEVATOR SEPARATION

CASE 4: Vertical Acting with Multiple Complying Swing Egress Doors

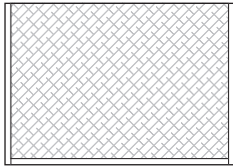


This project introduces the use of fire protective curtain assemblies that have been approved in accordance with the current editions of the model buildings codes (see IBC Section 3006.3, Item #2. Specific reference to this technology is now approved as opening protectives without hose stream performance [UL 10D 20-minute fire rated] for publication in the 2021 edition of the IBC [See Appendix, Resource IBC 2021]).



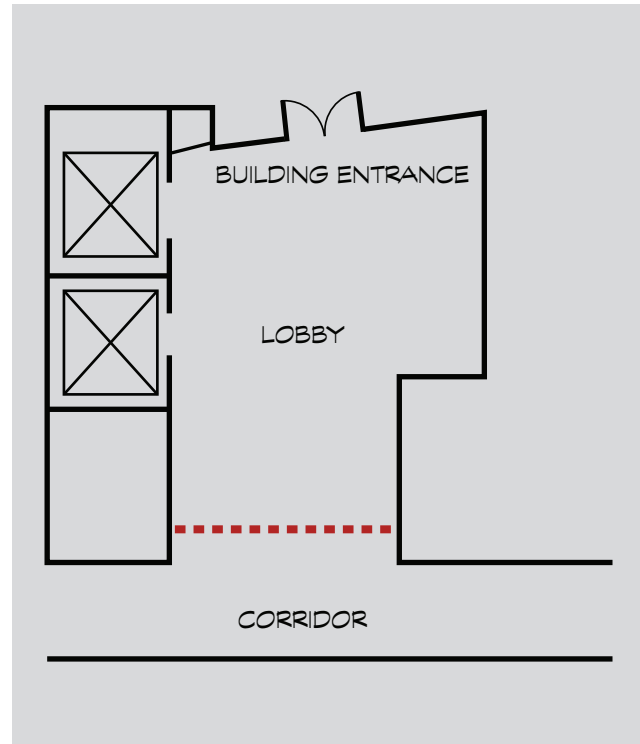
ELEVATOR SEPARATION

CASE 5: Vertical Acting without Egress



For the same reasons of acceptance explained in CASE 4, Fire Protective Curtain Assemblies satisfied two code compliance challenges in this design. Even though an elevator lobby is not necessarily required on the level of exit discharge in a sprinklered building, this separation takes on the form of a lobby since it protects the remaining structure from the vertical features of the building. Egress is not required though the fire protective curtain due to exiting out of the lobby or separated space through the main entrance.

Specific reference to this technology is now approved as opening protectives without hose stream performance (UL 10D 20-minute fire rated) for publication in the 2021 edition of the IBC (See Appendix, Resource IBC 2021).



ELEVATOR SEPARATION

Inquiry Discussion & Questions

There has been much discussion in the regulatory arena about the purpose and usefulness of the elevator lobby. It can be argued the lobby is a dual application fire and life safety component of the structure, a barrier against smoke migration in and out of the vertical shaft as well as an area of refuge for building occupants. These fundamental occupant safety features are tempered with sprinkler exceptions but consistently remain as salient provisions each code development cycle.

If there is a trend in preference it appears to be for more passive redundant protection surrounding the elevator shaft rather than less. For example, the code requirements outlined in this application study include several sprinkler exceptions that allow the elimination of the elevator lobby for normal-use passenger elevators in Section 3006. However, once the building goes into alarm, Section 3007 Fire Service Access Elevator and Section 3008 Occupant Evacuation Elevators do not allow the same exceptions. Not only are lobbies required in these two applications, with no exemptions, each lobby must be fully fire and smoke rated with prescribed physical size requirements. Interestingly, in a fire event the elevator often becomes an integral part of the means of egress system.

Elevator lobbies can be considered a viable choice based on three premises. Let's use the layout as diagrammed in Case Study #2 as an example. First, from a design ambiance perspective, it is cumbersome to provide independent separation at the point of each elevator car to simply eliminate the lobby. The space would certainly be interrupted at each elevator car opening. A single separation creating a full space lobby would have less impact on the overall design. Secondly, a single separation opening protective is clearly less costly than multiple systems located at each car opening. The third and perhaps the most important consideration is fire and life safety. By creating a conforming full space lobby we stop smoke and heat from penetrating the shaft, and provide an area of refuge for building occupants. In other words, rather than provide closures at each individual point-of-access location to the elevator car, why not create an elevator lobby that is unobtrusive, costs less and will adequately serve as an area of refuge.

ELEVATOR SEPARATION

Uncompromised Elevator Lobby Requirements

As we examine the code provisions for Fire Service Access elevators and Occupant Evacuation elevators (shown at the right) we find a significant difference from typical passenger elevators. In both design applications the required elevator lobbies must include fire resistance and fire protection ratings in addition to the standard smoke mitigation provisions in vertical spaces. In essence, the elevator lobbies become extensions of the ultimate protection served up by vertical shaft enclosures. They become viable areas of refuge potentially protecting building occupants for anticipated extended lengths of time.

In particular, the fire service access elevator lobbies must coordinate with the fire-fighting crews to protect building occupants and not hinder mobilization to fight the fire.

Section 3007

Fire Service Access Elevator

3007.6 Fire service access elevator lobby.

- The fire service access elevator shall open into a fire service access elevator lobby in accordance with Sections 3007.6.1 through 3007.6.5.
- Exception: Where a fire service access elevator has two entrances onto a floor, the second entrance shall be permitted to be protected in accordance with Section 3006.3.

3007.6.1 Access to interior exit stairway or ramp.

- The fire service access elevator lobby shall have direct access to an enclosure for an interior exit stairway.
- **California** - The fire service access elevator lobby shall have direct access **from the enclosed elevator lobby to a smoke-roof enclosure complying with Section 909.20.** (a pointer to Section 1023, Interior Exit Stairways)
- **Exception: Access to a smoke proof enclosure shall be permitted to be through a protected path of travel that has a level of fire protection not less than the elevator lobby enclosure. The protected path shall be separated from the enclosed elevator lobby through an opening protected by a smoke and draft control assembly in accordance with Section 716.2.2.1.**

Fire Access Elevator

3007.6.2 Lobby enclosure.

- The fire service access elevator lobby shall be enclosed with a smoke barrier having a fire-resistance rating of not less than 1 hour, except that lobby doorways shall comply with Section 3007.6.3.
- Exception: Enclosed fire service access elevator lobbies are not required at the levels of exit discharge.

3007.6.3 Lobby doorways.

- Other than the door to the hoistway, each doorway to a fire service access elevator lobby shall be provided with a 3/4-hour fire door assembly complying with Section 716. The fire door assembly shall also comply with the smoke and draft control door assembly requirements of Section 716.2.2.1.1 with the UL 1784 test conducted without the artificial bottom seal.

3007.6.4 Lobby size.

- Each enclosed fire service access elevator lobby shall be not less than 150 square feet (14 m²) in an area with a minimum dimension of 8 feet (2440 mm).

ELEVATOR SEPARATION

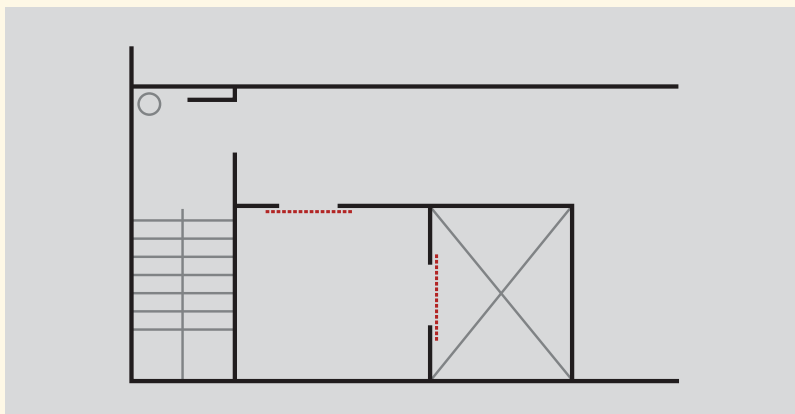
- **California** - *Regardless of any number of fire service access elevators served by the same elevator lobby, the enclosed fire service access lobby shall not be less than 150 square feet in an area with a dimension of not less than 8 feet.*

3007.9 Standpipe hose connection.

- A Class I standpipe hose connection in accordance with Section 905 shall be provided in the interior exit stairway and ramp having direct access from the fire service access elevator lobby.

3007.9.1 Access.

- The exit enclosure containing the standpipe shall have access to the floor without passing through the fire service access elevator lobby.



Sections 403 & 3008

Occupant Evacuation Elevators

403.5.2 Additional exit stairway. For buildings other than Group R-2 that are more than 420 feet in building height, one additional stairway ... shall be provided in addition to the number of exits required ...

3008.1.2 Additional exit stairway. Where an additional means of egress is required in accordance with Section 403.5.2, an additional exit stairway shall not be required to be installed in buildings with occupant evacuation elevators complying with Section 3008.1.

3008.6.1 Access to interior exit stairway or ramp. The occupant evacuation elevator lobby shall have direct access to an interior exit stairway or ramp.

3008.6 Occupant evacuation elevator lobby. The occupant evacuation elevator lobby shall be enclosed with a smoke barrier having a fire-resistance rating of not less than 1 hour, except that lobby doorways shall comply with Section 3008.6.3 (3/4 hour with vision panel)

Unlike typical passenger elevators, Fire Service Access elevators and Occupant Evacuation elevators cannot create lobbies with smoke rated materials only. The following bullet summary details much more rigid requirements indicating the level of building occupant safety that cannot be compromised:

- Protection placed at the point of access to the car cannot take the place of a lobby.
- Each lobby must be rated a minimum of 1 hour
- Lobby doors must be rated a minimum of 45 minutes
- Specific lobby sizes are required
- The above requirements will not allow the use of any rated materials that will not pass a hose stream test under UL 10B for complying opening protectives

Elevator Smoke & Draft

Section 3006.3

Elevator car doors are typically fire-rated but cannot comply with smoke and draft requirements. Added smoke & draft rated assemblies eliminate the passage of smoke and are usually located at the point of access to an elevator car as an alternative to the elevator lobby.

Fire & Life Safety Concerns

Elevator shafts commonly represent the majority of inter-connecting vertical shafts in multi-story buildings. These shafts become conduits for heat, smoke and other toxins between the fire floor(s) and additional floors. In buildings with more than three interconnected stories, the conventional elevator lobby is designed to stop the spread of fire and smoke before it reaches the elevator shaft enclosure doors. However, if the lobby is eliminated smoke could quickly penetrate the shaft at the point of access. Thus, all fire-rated assemblies used at the point of access must maintain a smoke and draft rating. (UL 1784)

Code Requirements

There are two primary provisions that drive the need for elevator protection in the IBC. First, Section 3006.2 requires protection where the elevator hoistway connects more than three stories and any of the following conditions apply:

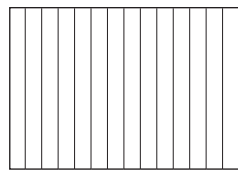
1. The building is not protected throughout with sprinklers ...
2. The building contains an I-1 Condition 2 occupancy
3. The building contains an I-2 occupancy
4. The building contains an I-3 occupancy
5. The building is a hi-rise ... more than 75 feet
6. The elevator hoistway door is located in the wall of a corridor required to be fire-resistance rated in accordance with Section 1020.1.

ELEVATOR SEPARATION

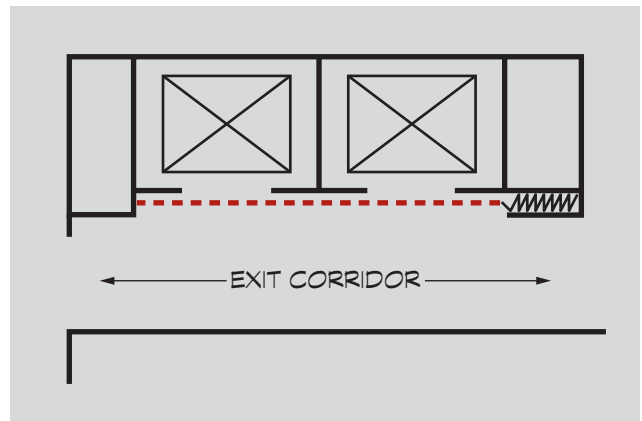
Section 3006.3, Item #3 allows the elimination of the lobby by placing a minimum UL 1784 (smoke) rated assembly at the point of access to the elevator hoistway door opening. Please note: All assemblies located at the point of access to an elevator car must be readily openable from the car side without a key, tool, special knowledge or effort. (3002.6)

Design Solutions

CASE 1: Side Acting Accordion with Power-assisted Egress

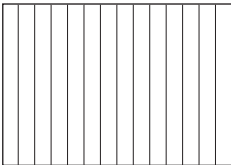


Due to the several configuration options of McKEON door assemblies multiple or single elevator openings can easily be protected. Egress can be placed at each elevator car door opening to accommodate conforming exit requirements.

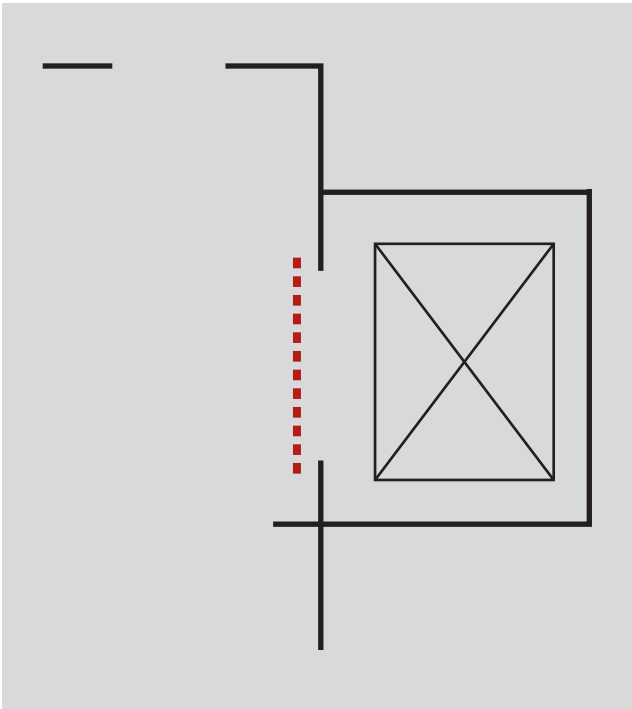


ELEVATOR SEPARATION

CASE 2: Side Acting Accordion with Manual Egress

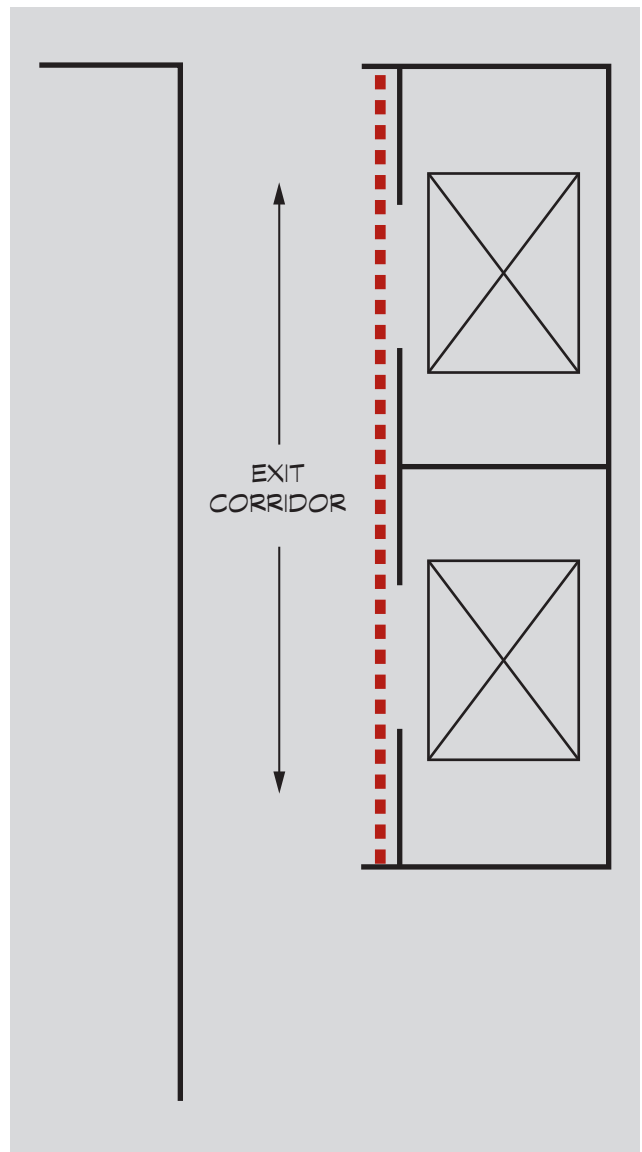
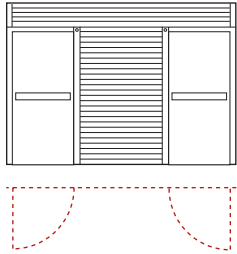


This simple, manually operated, bolt-up pre-fabricated unit can be installed at the point of access to any elevator car in a matter of hours. No pocket, stud or drywall construction is necessary. The door, held open by an electromagnet, is released at the command of a smoke detector and the fire and smoke rated assembly closes. Building occupants or first responders can pass through the opening as the door self-closes behind them.



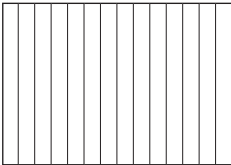
ELEVATOR SEPARATION

CASE 3: Vertical Coiling with Complying Swing Egress Door(s)

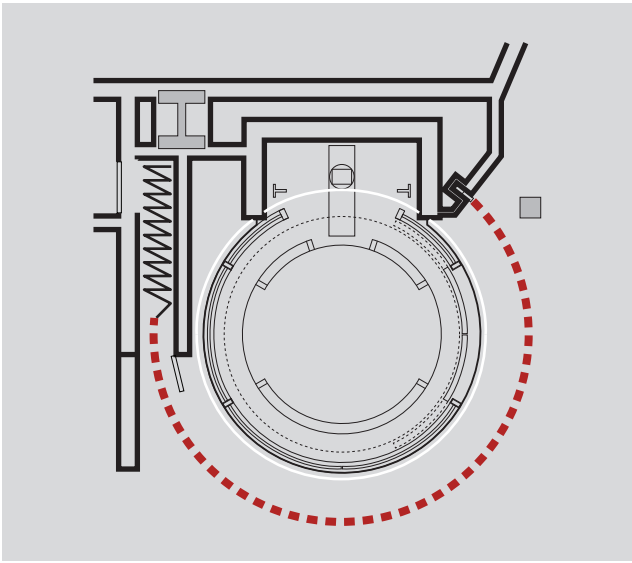


ELEVATOR SEPARATION

CASE 4: Side Acting Accordion with Power-assisted Egress

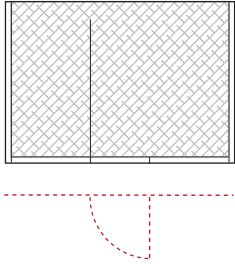


The single track 3-hour rated accordion will accommodate 18" radius to custom curves. Along with complying egress, McKEON resolved a very difficult challenge without life safety or design compromise.

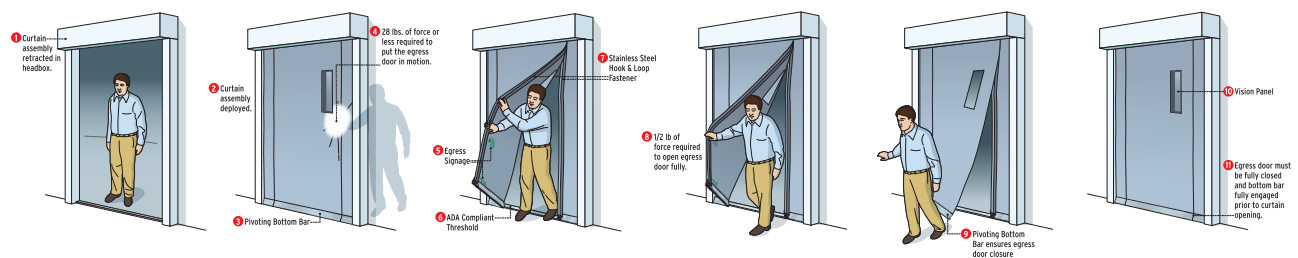
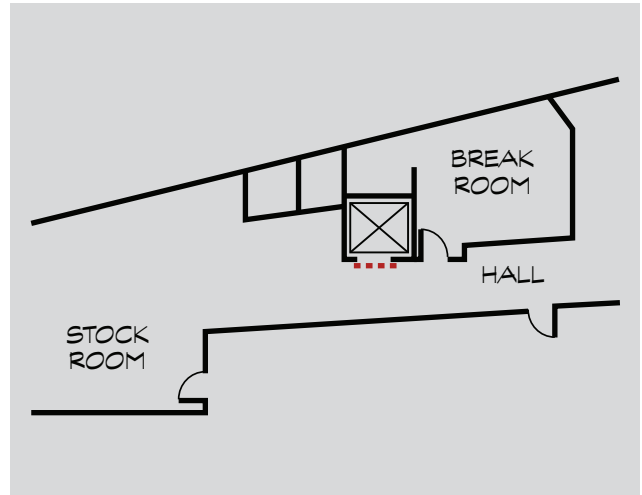


ELEVATOR SEPARATION

CASE 5: Vertical Acting with Egress with Complying Swing Egress Door(s)

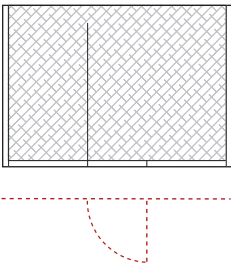


Typically, the elevator car or elevator shaft door is fire rated but does not carry a UL 1784 smoke rating. The SmokeFighter® D150E is a listed and labeled UL 1784 assembly with a complying egress feature. Located at the point of access to the elevator car, this assembly protects the opening mitigating smoke migration.

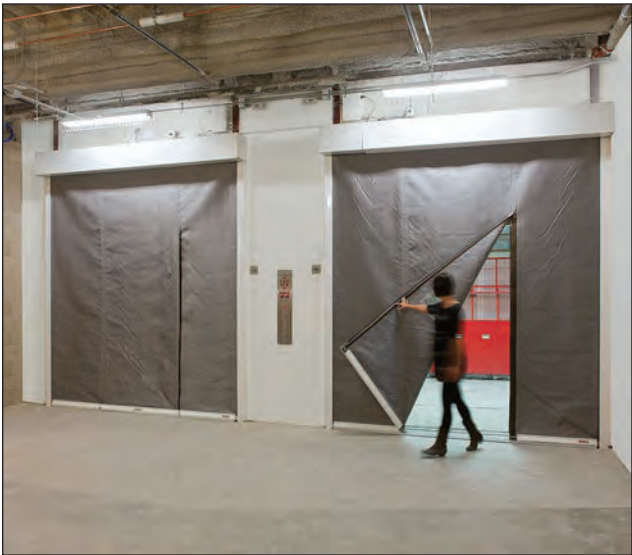
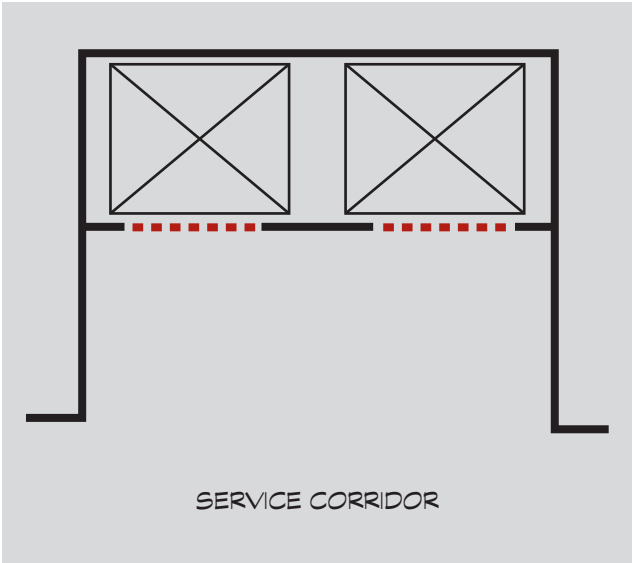


ELEVATOR SEPARATION

CASE 6: Vertical Acting with Egress with Complying Swing Egress Door(s)

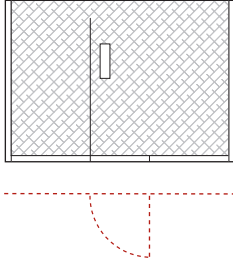


Similar to the previous case study, the elevator car or elevator shaft door is fire rated but does not carry a UL 1784 smoke rating. But on this project the design team elected to use the FireFighter® D200E which is listed and labeled as a 20-minute UL 10D & UL 1784 assembly with a complying egress feature. By applying the 20-minute fire-rated assembly in this design, McKEON provided redundancy in the fire-rated requirements. Located at the point of access to the elevator car, this assembly protects the opening mitigating smoke migration as well as fire and heat penetration.



ELEVATOR SEPARATION

CASE 7: Vertical Acting with Egress and Vision Panels



Where local jurisdictions have adopted the 2013 Edition or later of the Safety Code of Elevators and Escalators, ASME/ANSI A17.1, all assemblies placed at the point of an elevator car must incorporate vision panels.

McKEON manufacturers smoke protective curtains with vision panels for the Model D150E only.



ELEVATOR SEPARATION

Inquiry Discussion & Questions

Please consult the Inquiry Discussion & Question section of the Elevator Lobby case studies.

Notes:



2 | Exit Access Separation

Horizontal Exit

Exit Passageways

Pedestrian Walkways & Tunnels

Horizontal Exit

Section 1026

Horizontal exits are designed to move building occupants on a floor from any point in the exit access system to a fire and smoke protected area.

Fire & Life Safety Concerns

The horizontal exit differs fundamentally from the typical code-defined exit. The horizontal exit is meant to “defend in place” by creating an area of safe refuge for building occupants within the confines of the building structure. All other exits are designed to exit occupants out of and away from the building.

Code Requirements

Because building occupants are not being removed from the building when using the horizontal exit, specific precautionary requirements are based upon the following fundamental principles:

Principle #1: Separation. A 2-hour fire wall or fire barrier must be used to separate safe refuge areas connected with a horizontal exit (*Section 1026.2*). The determination between the use of a wall, fire barrier or horizontal assembly is the function of the wall as it relates to other code requirements.

Principle #2: Opening Protective. The opening within the horizontal exit must be protected with a self-closing or automatic closing fire door when activated by a smoke detector. The fire rating of the door must be a minimum of 90 minutes. (*Section 1026.3*)

Principle #3: Area of Refuge Capacity. Based on a net floor allowance of 3 square feet for each person with the following guidelines:

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 Section 407.5.3, 408.6.2, 420.6.1 and 422.3.2 as applicable. (*1026.4.1*)

Principle #4: Number of Exits. 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

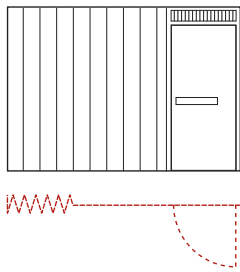
EXIT ACCESS SEPARATION

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.

Exception: The adjoining compartment shall not be required to have a stairway or door leading directly outside, provided the area of 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.

Design Solutions

CASE 1: Side Acting Accordion with Complying Swing Egress Door

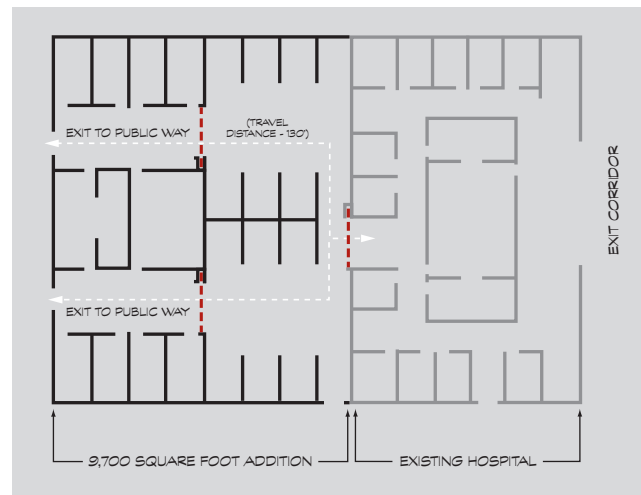


The intent is to add a 10,200 square foot critical care suite onto an existing I-2 (hospital). However code requirements come into play that affect the design dramatically:

- First, care suites of sleeping rooms cannot exceed 10,000 square feet in a sprinklered structure. In this case a 10,200 square foot suite is being added. (407.4.4.6.1)
- Second, there must be two exits from each suite. (407.4.4.6.2)
- Third, the travel distance between any point in a suite of sleeping rooms and an exit access exit door shall not exceed 100 feet with automatic smoke detection. (407.4.4.3)

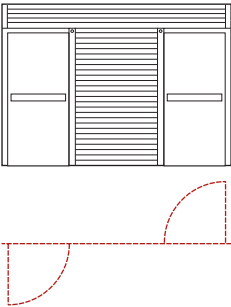
By utilizing the horizontal exit concept, the following will preserve the original design intent and provide code compliance:

- Separate the intended 10,200 square foot space into two suites, each less than 10,000 square feet.
- Provide a 2-hour fire barrier wall as the separation. (Section 1026.2)
- Provide a horizontal exit in the separation as one of two required exits from each space. (Section 407.4.4.6.2)
- Provide a 90-minute opening protective. [Table 716.1(2)]

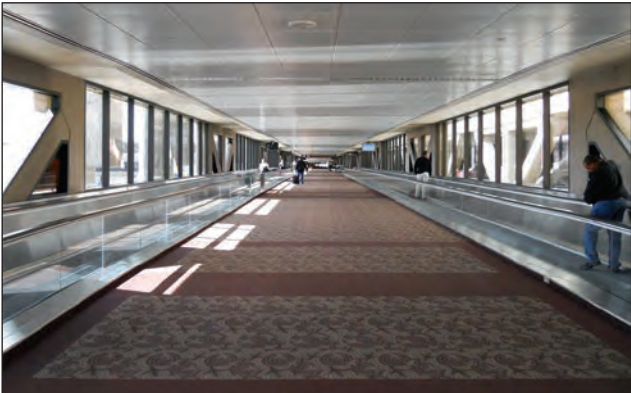
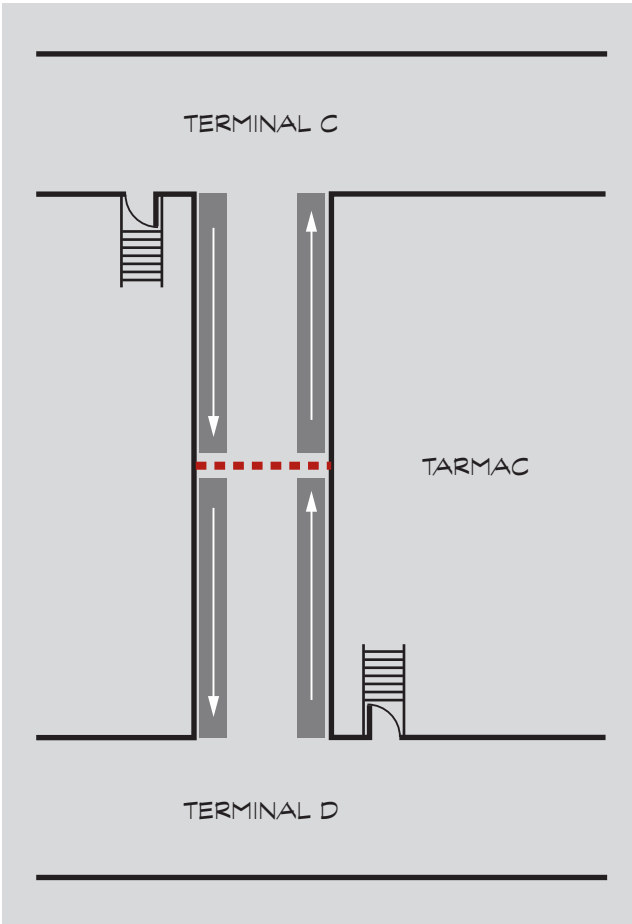


EXIT ACCESS SEPARATION

CASE 2: Vertical Coiling with Complying Swing Egress Door(s)



McKEON offers a particularly unique resolve for this airport design. Because the concourse is located above ground level and in a TSA secure area, it is not possible to provide exiting to the exterior. Also, there is not room for build-outs or pocket spaces, therefore unique to the T2500 technology a 90-minute opening protective is provided with no side room and as little as 26 inches of head-room with conforming dual egress doors. In essence each side of a long fire and smoke rated concourse forms one of two areas of refuge.



EXIT ACCESS SEPARATION

Inquiry Discussion and Questions

It has been said by many that the horizontal exit is probably one of the least understood and least utilized concepts of the building code. The following questions may be helpful in promoting awareness:

- Do you encounter travel distance problems as a horizontal exit?
in areas of the code other than the standard travel distance tables? (This case study for example.)

Notes:

Exit Passageways

Section 1024

An exit passageway provides the designer with an acceptable way of connecting a required exit stair to the exit discharge. Because the code requires an exit stair to open directly into an exit discharge to the exterior of the building, this provision will allow the stair to terminate at convenient locations away from the exterior walls. Also, the exit passageway can extend the path of travel when travel distances in the exit access system have been exceeded.

Fire & Life Safety Concerns

Extending the path of egress beyond the terminated travel distance or beyond the exit vestibule increases the potential for building occupants to be exposed to fire, smoke or hot and toxic gases. For these reasons exit passageways are designed with more strict provisions.

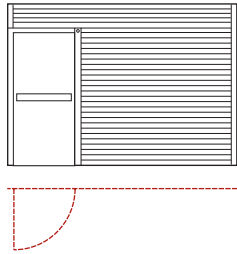
Code Requirements

1. An exit passageway shall not be used for any purpose other than as a means of egress. (1024.1)
2. Exit passageway enclosures shall have walls, floors and ceilings of not less than 1 hour and not be less than that required for any connecting interior exit stairway ... and be constructed as fire barriers or horizontal assemblies. (1024.3)
3. Elevators shall not open into an exit passageway. (1024.5)
4. Opening protectives shall comply with Section 716 ... and shall be limited to those necessary for exit access into the exit passageway from normally occupied spaces and for egress from the exit passageway. (1024.5)
5. 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. In other words, the interior exit stair must be separated from the exit passageway by a fire barrier wall equal in rating to the requirement for the interior exit stairway.

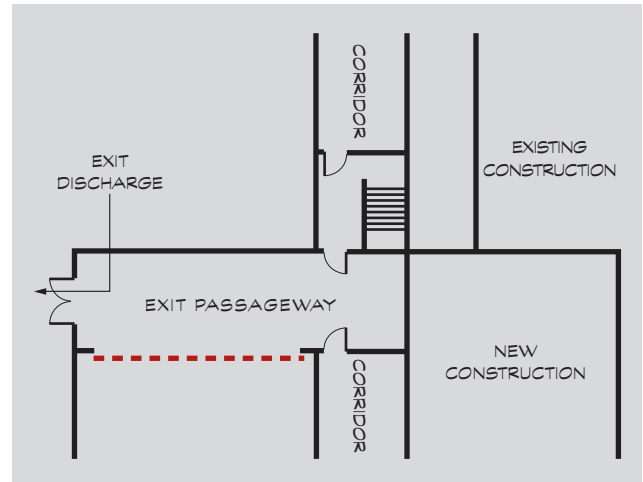
EXIT ACCESS SEPARATION

Design Solution

CASE 1: Vertical Coiling with Complying Swing Egress Door(s)



In this case study the required exit stair from the floors above terminated several feet from the exterior of the building. The McKEON opening protective forms the rated enclosure during a fire emergency, extending the exit path to exit discharge.



EXIT ACCESS SEPARATION

Inquiry Discussion and Questions

Because exit passageways are constructed under strict opening provisions, designs rarely incorporate them unless there is no other choice. With the use of the McKEON wide-span opening protectives, openings are not limited in size and little or no design compromise is noticed by building occupants. The following questions can be helpful in assisting the design professional to recognize new options:

- Have you ever desired to terminate a required exit enclosure on the interior of the building rather than at the exterior exit?

Notes:

Pedestrian Walkways & Tunnels

Section 3104

Walkways and tunnels are designed to provide connection between buildings. They can be located at, above or below grade level and are used as a means of travel by persons.

Fire & Life Safety Concerns

Buildings located across lot lines from each other are required to have fire-rated exterior walls to prevent fire and smoke from passing between them (705; Table 602). Walkways and tunnels that connect and penetrate these rated exterior walls compromise this protection, potentially allowing heat and smoke to pass from one building to another.

Code Requirements

Section 3104 details specific requirements to ensure building occupant safety based upon the following fundamental principles:

Principle #1: Separate Structures. Connected buildings shall be considered to be separate structures (3104.2). Unless the buildings are all on the same lot or exempt under specific accessibility requirements each building will be considered as a separate building when determining fire resistance, exterior wall ratings and egress.

Principle #2: Construction. The pedestrian walkway shall be of noncombustible construction (3104.3). Unless each building being connected is of combustible construction the connecting element must be noncombustible to minimize the travel of heat and smoke.

Principle #3: Fire Barriers. Once the rated exterior walls have been penetrated to accommodate a noncombustible connecting walkway, the interior of each building must be further protected with fire barriers of not less than 2-hour rated construction (3104.5.1). In order to avoid this requirement the following criteria must be met:

EXIT ACCESS SEPARATION

- A. Exterior walls - 2 hour rated, extend not less than 10' in every direction surrounding the perimeter of the pedestrian walkway.
- B. Openings in exterior walls of connected buildings - opening protectives not less than 3/4 hour.
- C. Supporting construction - See Section 707.5.1.

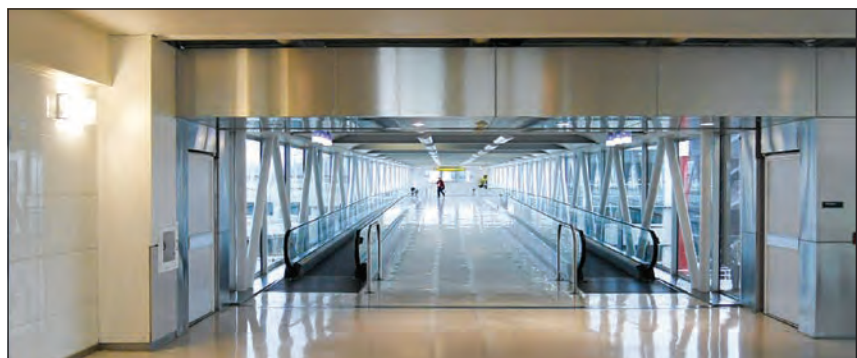
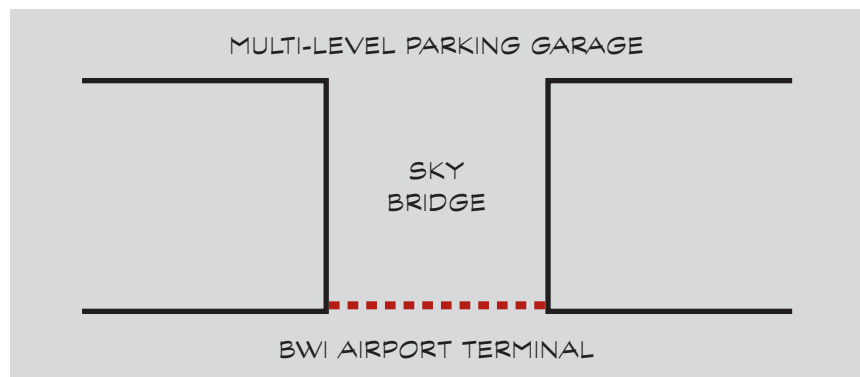
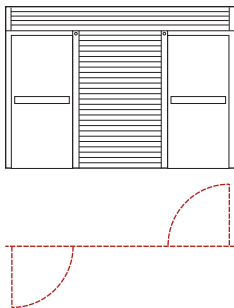
Principle #4: Alternative Separation (3104.5.2)

- A. Distance between connected buildings is more than 10 feet.
- B. Walkway and connected buildings fully sprinklered and the roof of the walkway is not more than 55 feet above grade connecting to the 5th, or lower, story above grade plane, of each building..
- C. The wall shall be capable of resisting smoke.
- D. The wall and doors can be constructed of wired or tempered glass that is protected with sprinklers. All glass in gasketed frames.

Design Solutions

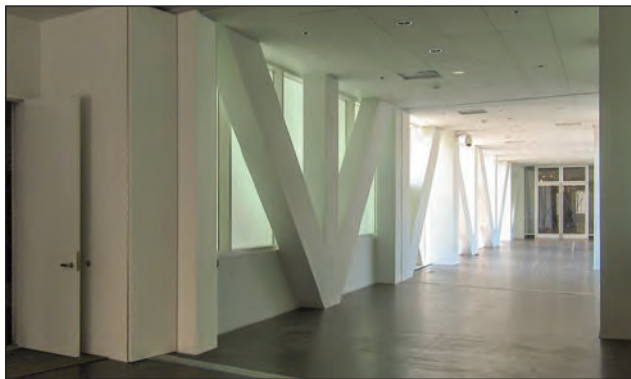
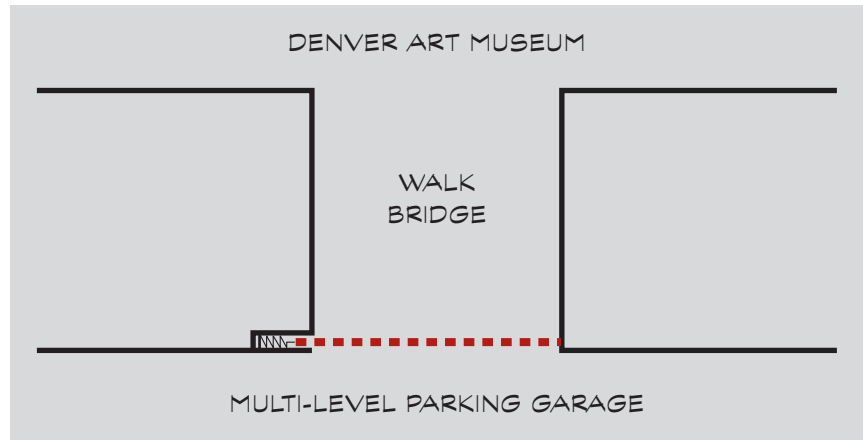
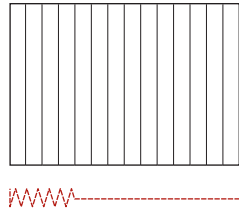
The alternatives to fire barrier separations as listed above are very costly. Complying with the 2-hour separation requirement in Section 3104.5 is the least expensive option. A listed and labeled wide span McKEON assembly will easily protect any size opening. In the following case studies, McKEON showcases three distinctly different technologies to resolve the same code application problem.

CASE 1: Vertical Coiling with Complying Swing Egress Door(s)

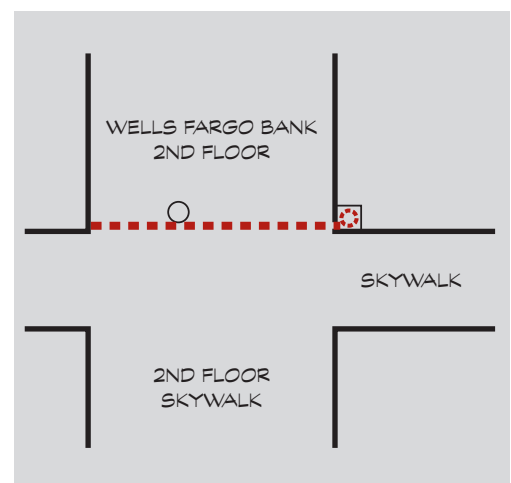
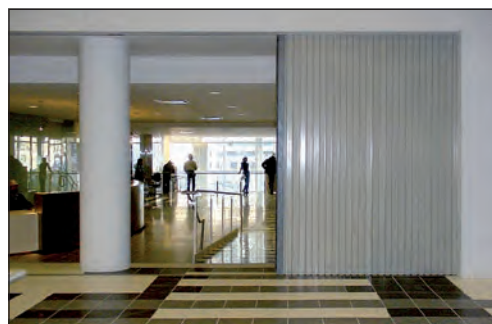
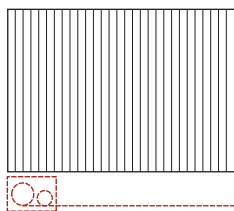


EXIT ACCESS SEPARATION

CASE 2: Side Acting Accordion with Power-assisted Egress



CASE 3: Side Coiling without Egress



EXIT ACCESS SEPARATION

Inquiry Discussion and Questions

Pedestrian walkways can be located overhead connecting two or more buildings or underground as tunnels connecting two or more buildings. This connecting construction is viewed as a definite threat to life safety. The code attempts to build in safety measures that are intended as substitutes for complete and optimum separation. These substitutes include extensive active wet sprinkler systems, open side walls, and tempered and/or wire glass components. It would certainly make more sense to use the "real thing" by easily providing rated barriers with wide-span opening protectives at each end eliminating any threat of fire and smoke entering the walkways.

The following questions may be helpful:

- Have you been able to run a cost comparison separating the building from the walkway as opposed to protecting the walkway?
- Even though a pedestrian walkway will most likely be constructed of non-combustible materials, would you like to avoid the cost of sprinklers, limiting interior design and costly tempered and/or wired glass components?

Notes:

3 | Vertical Opening Separation

Fundamental Guidelines

Vertical Compartmentation

Escalator Openings

Atriums

Exit Access Stairways

Interior Exit Stairways

Draft Curtains

VERTICAL OPENING SEPARATION

Fundamental Guidelines

Sections 404, 712, 713, 1019, 1023 & 1027

Vertical openings between multiple floors in multi-story buildings are consistently designed in many different shapes, heights and uses. These vertical space components of the building structure render multiple floors vulnerable. Protecting openings that connect multiple stories requires provisions specific to vertical migration. The building and fire codes require these vertical features to be enclosed or separated in order to prevent vertical migration of heat, smoke toxic fumes and gases during a building emergency. The common term in the fire & life safety codes for protecting the vertical spaces from the rest of the structure is the shaft enclosure.

Typically anytime two or more floors are open to each other a vertical opening or vertical shaft is created. The usual phrase describing this condition regardless of the number of floors or stories in the vertical configuration or combination thereof is, "floors are common with each other."

Historically, the building code addressed vertical spaces individually without specific reference to differences between types of vertical spaces. The seemingly logical place to start was to consider any vertical space a potential atrium. Through the process of deduction the code practitioner could eventually determine from several configurations of shaft enclosures whether or not their vertically designed space was an atrium or not. For example, a 3-story vertical space by definition is an atrium. However, if you insert an exit access stairway penetrating all three floors, the space is not an atrium in accordance with Section 404. It is now an exit access stairway in accordance with 1019.3.

Finally, beginning in the 2021 version of the IBC, the general statement in the atrium section of the code differentiates between atriums and other similar vertical spaces:

SECTION 404, ATRIUMS

404.1 General. 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.

Two fundamental principles drive the requirements of vertical opening protection. First, the migration of smoke, heat and toxic fumes and gases floor to floor by way of vertical floor pen-

VERTICAL OPENING SEPARATION

etration. Second, egress of building occupants from upper levels to a safe level of exit discharge.

The instructive diagrams, commentary and case studies in this section illustrate the balance between these two principles in the enforcement of fire & life safety provisions for building occupants in multi-story buildings.

Outline of Vertical Space Enclosures:

- Vertical Compartmentation (Combined Code Principles from IBC Chapters 4, 7 & 10)
- Shaft Enclosures (713)
- Escalator Openings (712.1.3)
- Atriums (712.1.7)
- Two-story openings (712.1.9)
- Exit access stairways (712.1.12)
- Interior Exit Stairways (1023)
- Elevators (3006)
- Draft Curtains & Closely Space Sprinklers (NFPA 13)

VERTICAL OPENING SEPARATION

Vertical Compartmentation

Combined Code Principles from Chapters 4, 7 & 10

Protecting openings that connect multiple floors are currently addressed by the building and fire codes by way of vertical type shaft enclosures, atrium provisions or requirements relative to small floor or roof hatch type openings. In the following case studies a new technology and product application will be discussed wherein vertical compartments can be created separating any number of stories from each other. This will be accomplished by coordinating in one application the intent of the provisions found in both atrium and shaft enclosure requirements.

Fire & Life Safety Concerns

As stated in the atrium case studies, vertical spaces that are interconnected and common with each other allow heat, smoke, and hot/toxic gases to migrate throughout an entire structure.

Code Requirements

Currently the code examines vertical opening conditions in Section 712, Vertical Openings and Section 713, Shaft Enclosures. In earlier editions of the code, all vertical openings were considered under the shaft enclosure provisions only. The older Section 708.2, Shaft Enclosure included 16 exceptions, or different ways of creating vertical spaces as shaft enclosures. The 2012 edition created a new Section 712 titled Vertical Openings, wherein the old 16 exceptions in Section 708.2 were moved and edited. These items, originally written as exceptions to the shaft requirements, became stand-alone provisions defining vertical opening conditions, rather than exceptions or re-writes to strict shaft enclosure requirements. Although the fundamental content did not change, placing the shaft provisions under the title of Vertical Openings significantly affects one's perspective regarding their intended purpose. Perhaps this paradigm shift, from shaft enclosure provisions to vertical opening provisions is, in fact, a monumental shift not seen in many years! However, none of these accepted methods specifically address the exclusive use of horizontal shutters to eliminate a vertical condition. Unless an escalator opening is being protected or a door-hatch assembly is used to protect small structural openings in floors and roof assemblies, the code is vague regarding protection of vertical openings in the creation of vertical compartments.

VERTICAL OPENING SEPARATION

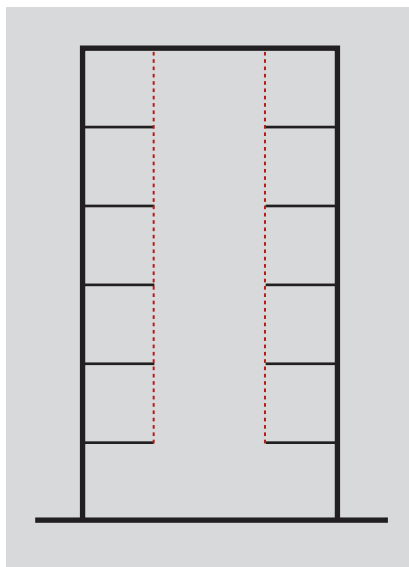


Figure 1

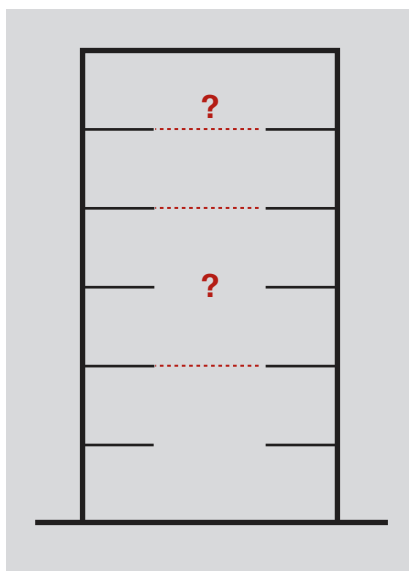


Figure 2

Figure 1, shown at the left, addresses a vertical opening condition complying with Sections 712 and 713 requirements to seal the space. Note, the atrium requirements are designed to essentially replicate this condition. By definition an atrium is a shaft enclosure.

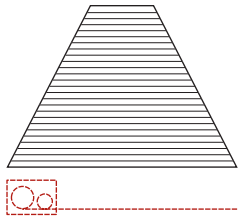
Within the current provisions set forth in Sections 712 and 713, the basic core and shell of this structure is still going to be a protected shaft. For example as shown in **Figure 2**, when one uses certain provisions of Section 404, by way of exception two floors can be common and the smoke evacuation can be eliminated from those two floors, while all the other vertical separation or atrium provisions are retained. Yet in other provisions of Sections 712 and 1019 the incorporation of an exit access stairway allows two unprotected floors common. In fact, the 2015 and 2018 editions separate exit access stairs into their own Section 1019 and in definitions in Section 202 declares exit access stairways as “a stairway within the exit access portion of the means of egress system.”

The question is, is it possible to eliminate the “vertical” open condition “horizontally” without a stair by protecting the vertical opening in the spirit of compartmentation since a structural floor was never in the original design as shown in **Figure 2**, and if so how many floors can be common? Exact code language is not found, however if the vertical opening is eliminated horizontally with a rated and hose-stream tested assembly, has the potential for migration of smoke, heat and hot/toxic gases been mitigated? The answer is a resounding yes with one important caveat. Since this configuration is defining a 2-story atrium it is critical to meet the atrium separation requirements. Section 404.6, Enclosure of atriums, specifically requires that atrium spaces be separated from adjacent spaces by 1-hour construction both vertically and horizontally. Therefore, defining atriums as 2-story spaces can be achieved with 1-hour construction only in accordance with Section 707 Fire Barrier walls in the vertical orientation and in accordance with Section 711, structural floor assemblies in the horizontal orientation. In other words, non-hose stream tested assemblies that are limited to 20-minute ratings under UL 10B, 10C or 10D cannot be used to define an atrium in either the vertical or horizontal orientation.

VERTICAL OPENING SEPARATION

Design Solutions

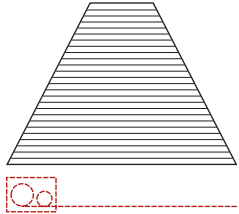
CASE 1: Horizontal Shutter



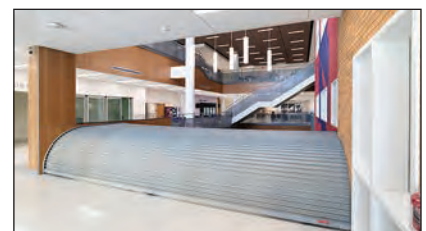
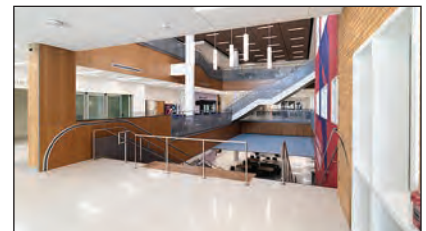
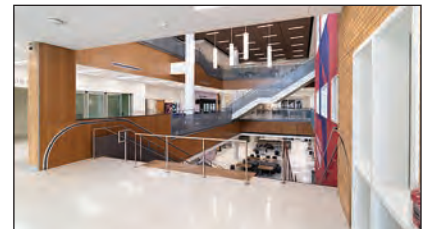
UL 10B 2-hour & UL 1784
"S" labeled, hose stream
tested assembly.

VERTICAL OPENING SEPARATION

Case 2: Horizontal Shutter

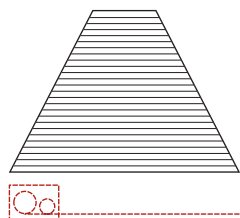


UL 10B 2-hour & UL 1784
"S" labeled, hose stream
tested assembly.

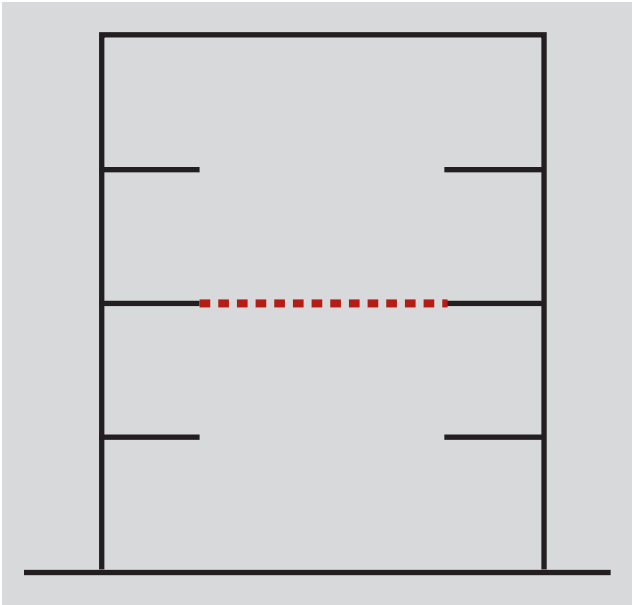


VERTICAL OPENING SEPARATION

CASE 3: Horizontal Shutter

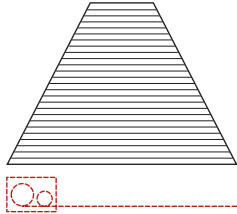


UL 10B 2-hour & UL 1784
"S" labeled, hose stream
tested assembly.

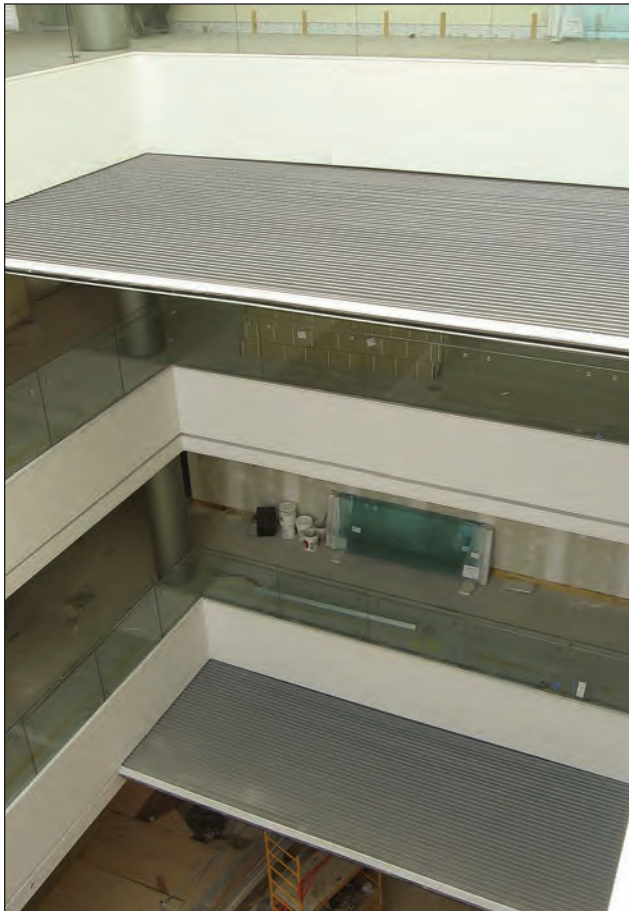
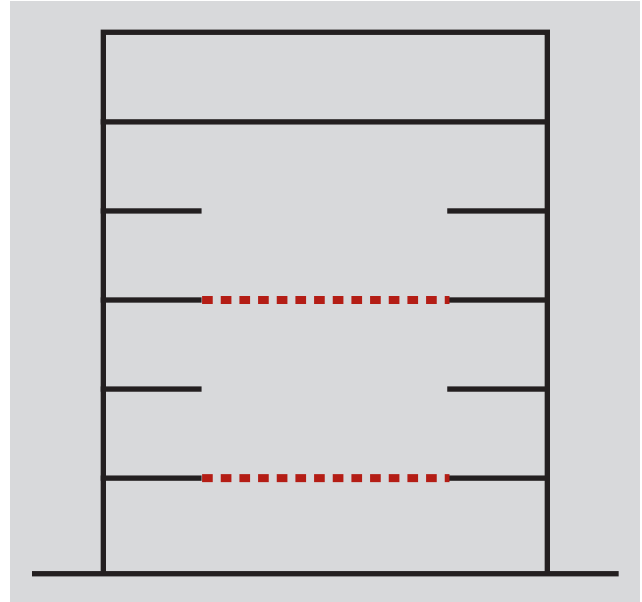


VERTICAL OPENING SEPARATION

CASE 4: Horizontal Shutter



UL 10B 2-hour & UL 1784
"S" labeled, hose stream
tested assembly.



VERTICAL OPENING SEPARATION

Escalator Openings

Section 712.1.3

An escalator provides convenient movement for building occupants communicating multiple floors. However, escalators are typically not a part of the required means of egress.

Fire & Life Safety Concerns

Openings through floors allow fire - or the products of fire (smoke, heat and hot toxic gases) - to spread to other floors. Enclosing these spaces in rated shaft enclosures is certainly the most proficient method of mitigating fire and smoke migration between floors. However, the code incorporates optional provisions as exceptions to the completely sealed vertical shaft.

Code Requirements

Where a building is equipped throughout with an automatic sprinkler system, one of the following options may be applied in lieu of an enclosed shaft (712.1.3)

OPTION #1 - Draft curtains and closely spaced sprinklers in accordance with the following conditions (712.1.3.1):

1. The area of the floor opening between stories does not exceed twice the horizontal area of the escalator.
2. The opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13.
3. In other than Groups B and M, this application is limited to openings that do not connect more than four stories.

OPTION #2 - Listed or approved automatic shutters in accordance with the following conditions (712.1.3.2):

1. The shutter shall be installed in accordance with the manufacturer's instructions.
2. The shutter shall be of non-combustible construction and have a fire-resistance rating of not less than 1.5 hours.
3. The shutter shall close immediately upon the actuation of a smoke detector installed in accordance with Section 907.3.
4. The shutter shall completely close off the vertical opening.
5. Escalators shall cease operation when the shutter begins to close.

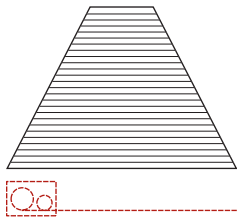
VERTICAL OPENING SEPARATION

6. The shutter shall operate at a speed of not more than 30 feet per minute (152.4 mm/s).
7. The shutter shall be equipped with a sensing leading edge to stop closure where in any contact with an obstacle, and continue to close when the obstacle is cleared.

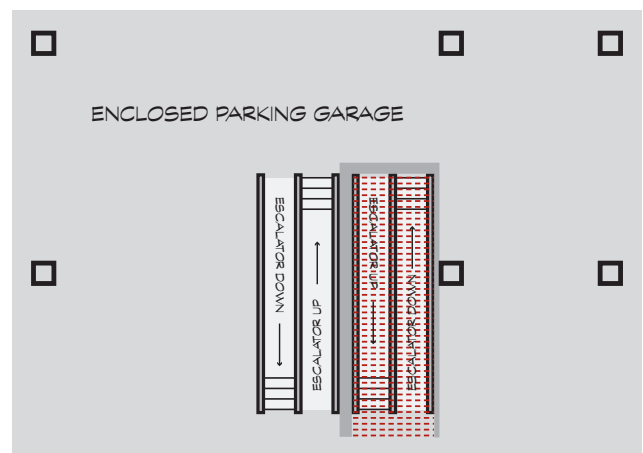
Note: For more detailed information regarding this option please see “Understanding Draft Curtains & Closely Spaces Sprinklers ...” in this document.

Design Solutions

CASE 1: L-Shape Horizontal Shutter

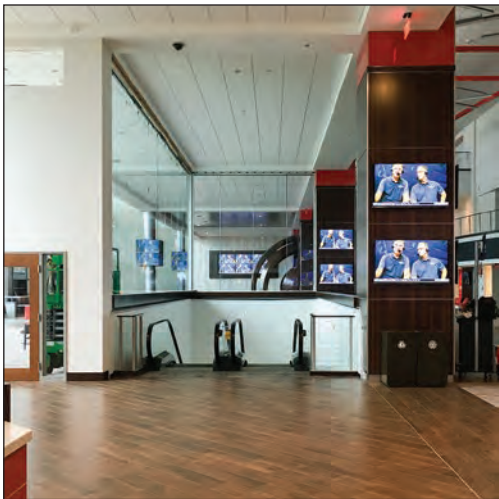
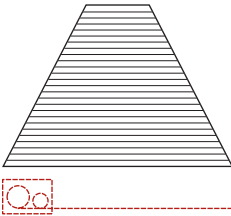


While a parking garage doesn't require an aesthetically pleasing solution, from a life safety perspective the need for fire and smoke protection is the same. A 2-hour rated horizontal shutter satisfies both the basic requirement of opening protection and enclosure of the escalator.

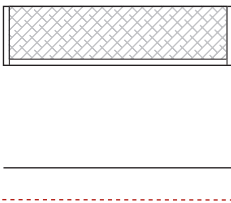


VERTICAL OPENING SEPARATION

CASE 2: L-Shape Horizontal Shutter



CASE 3: Deployable Draft Curtains & Closely Spaced Sprinklers



VERTICAL OPENING SEPARATION

Inquiry Discussion & Questions

Escalators, whether in high-profile locations or low-profile parking garages, cannot be limited to the design criteria as stated above and maintain the desired ambiance of the space.

The following questions may be helpful:

- Would you like to use the escalator as a required exit?

Notes:

VERTICAL OPENING SEPARATION

Atriums

Section 404

An atrium is a floor opening, or a series of floor openings, that connects the environment of adjacent stories. By code definition an atrium is a space within a building that extends vertically and connects two or more stories in I-2 and I-3 occupancies and three stories or more in all other occupancies with the exception of hazardous (Group H) structures. Atriums are designed to provide open and spacious vertical areas common with other building elements.

Fire & Life Safety Concerns

Unprotected vertical openings are often cited as the factor responsible for fire spread in incidents involving fire fatalities and/or extensive property damage. Section 404 addresses the need for protection of these specific building features in lieu of providing a complete floor and/or vertical shaft separation. In simple terms, the atrium provisions are extremely restrictive because a complying atrium is a shaft enclosure.

Code Requirements

Vertical common areas that comprise an atrium are not considered unprotected, rather the atrium is considered a protected space by means other than a conventional “walled-in” shaft enclosure. Listed below are the nine specific provisions allowing atriums to be open and spacious yet considered a conforming shaft enclosure:

1. The atrium floor area is permitted to be used only for low-hazard uses unless the individual space is provided with an automatic sprinkler system. (*Section 404.2*)
2. An approved automatic sprinkler system shall be installed throughout the entire building. (*Section 404.3*)
3. A fire alarm system shall be provided to include emergency voice communications systems in Group A, E & M occupancies.. (*Section 404.4*)
4. Engineered smoke control system - this system shall be installed in accordance with Section 909 when the atrium space exceeds more than two floors. (*Section 404.5*)
5. Atrium spaces shall be separated from adjacent spaces by 1-hour fire barrier construction unless at least one of the following exceptions are met: (*Section 404.6*)
6. Smoke control equipment must be on a standby power system. (*Section 404.7*)

VERTICAL OPENING SEPARATION

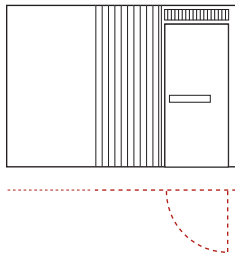
7. The atrium interior finish of walls and ceilings must be not less than Class B. (404.8)
8. Travel distance and travel path restrictions. (404.9; 404.11)
9. Limited to 50% of interior exit stairways to terminate at the floor of an atrium. (404.10)

Note: For additional understanding regarding the physical configuration of the atrium and taking advantage of the two-story exception for eliminating exhaust smoke control systems see “Vertical Compartmentation” in this document.

Design Solutions

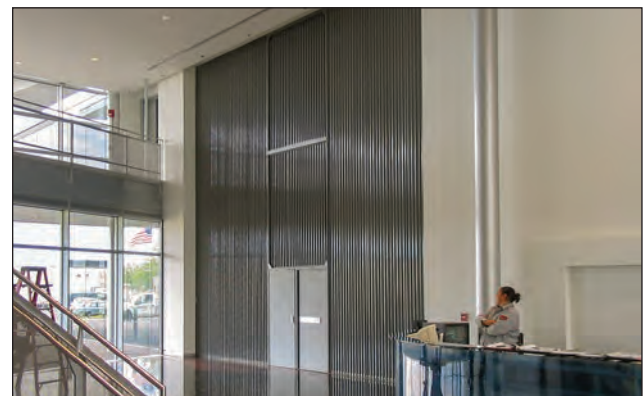
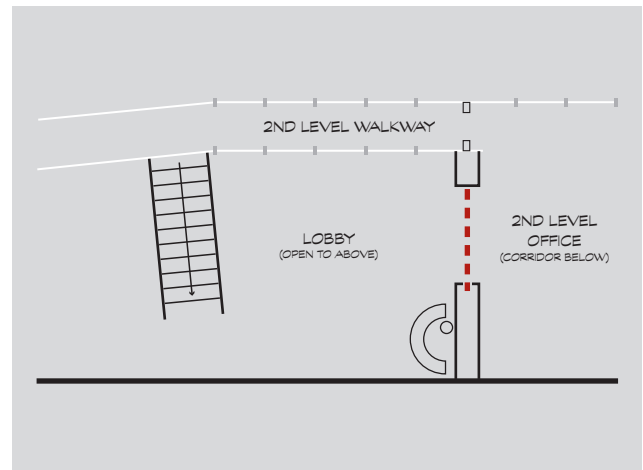
The use of deployable wide-span opening protectives in vertical atrium spaces, both vertically and horizontally, can significantly reduce construction and maintenance costs.

CASE 1: Side Acting with Complying Swing Egress Door(s)



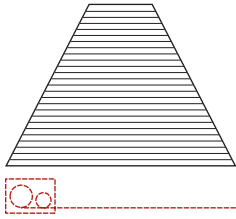
This unique case study features another McKEON product for resolving multiple design/code challenges simultaneously. The lower floor travel path is a required design feature for egress and - combined with the non-rated

second floor overlook - is certainly a very creative solution. However, without the side acting, extreme height and egress conforming McKEON assembly this would not be possible!

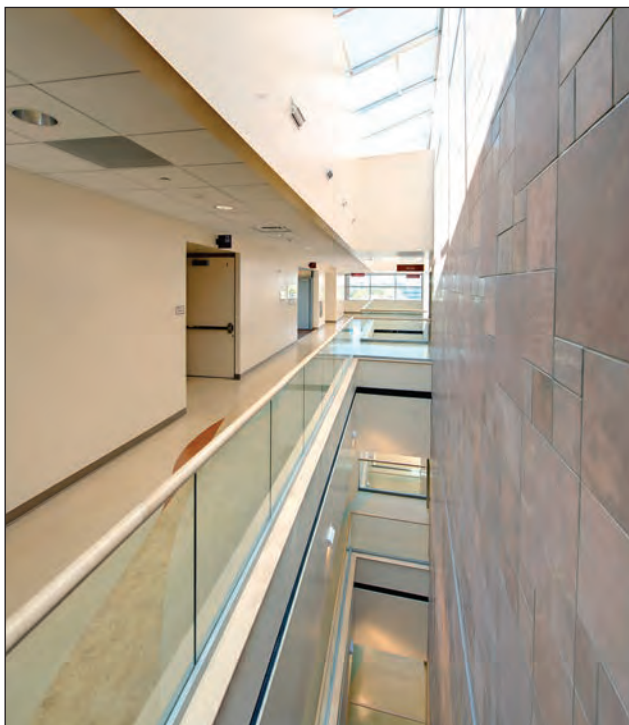
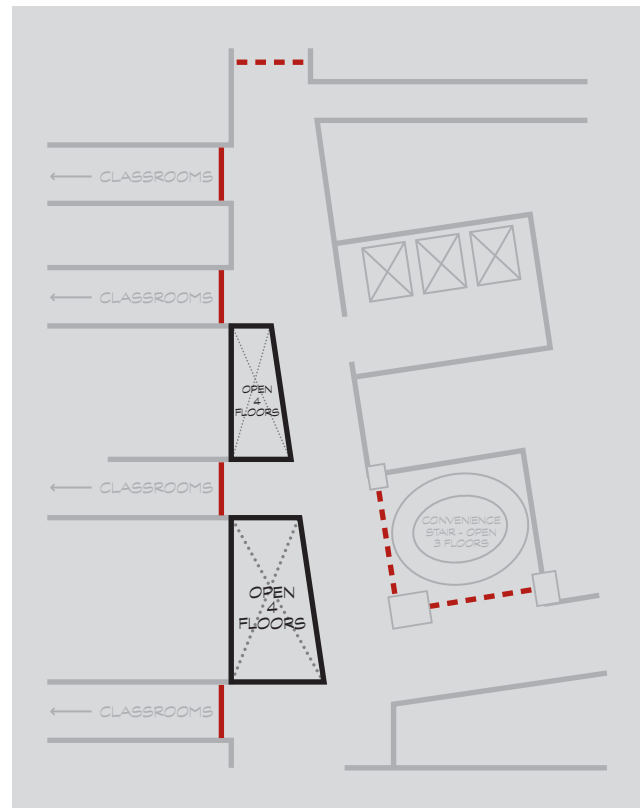


VERTICAL OPENING SEPARATION

CASE 2: Horizontal Shutter

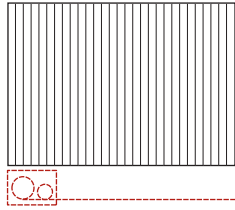


In this case study the atrium space is essentially converted to a vertical compartment separation using the McKEON horizontal shutter. Please refer to the “vertical compartmentation” case studies at the end of this section for more information. Note the absence of any smoke evacuation systems!

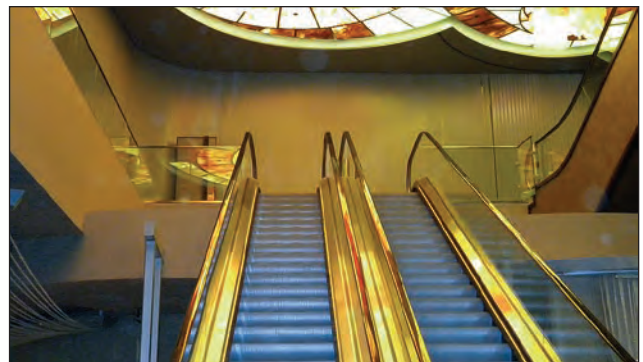
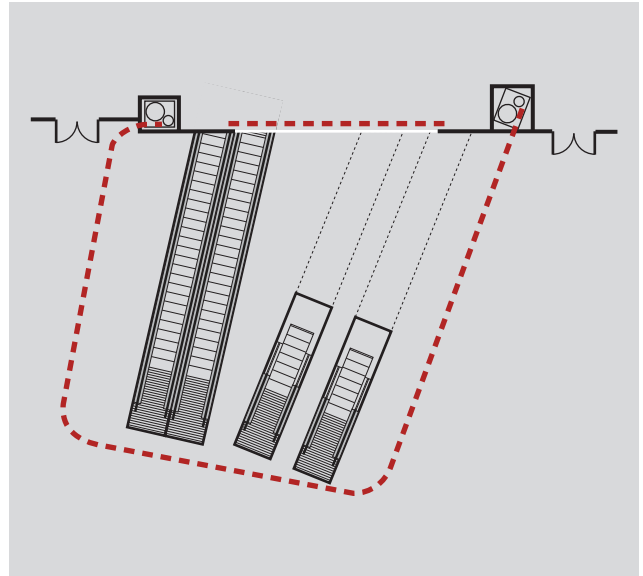


VERTICAL OPENING SEPARATION

CASE 3: Side Coiling without Egress



Even though this design incorporates an escalator, Item #2.1 under Exception #2 can only be applied if the area of the floor opening between stories does not exceed twice the horizontal projected area of the escalator. Since the area in this vertical open space is greater, the next option is to explore the possibility of creating a vertical shaft enclosure allowing no more than two floors common or interconnecting. With a 2.25" head-track design, 3-hour fire listing and unlimited width capacity, McKEON easily solved the problem with a triple curve, non-floor track 140' bi-part opening protective.



VERTICAL OPENING SEPARATION

Inquiry Discussion & Questions

The following questions may be helpful:

- The size of the smoke evacuation system is based upon the calculation of total cubic footage of not only the atrium space but all spaces that open into the atrium space. Can I help you minimize this system cost by reducing the cubic footage with wide-span opening protectives at critical locations in the atrium?

Notes:

VERTICAL OPENING SEPARATION

Exit Access Stairways

Sections 712, 1019

These case studies deal with a condition wherein several floors are common to each other. The floors are inter-connected with an interior exit access or communicating stairway. Previous editions of the code addressed these stair features as non-egress stairs. The code now defines Exit Access Stairways as a stairway within the exit access portion of the means of egress system. (202)

Fire & Life Safety Concerns

Multiple floors open to each other is perhaps one of the most vulnerable conditions to fire danger threats in any multi-story building. Fire suppression is concerned with confining a fire to the floor of origin and preventing the fire, or the products of the fire (smoke, heat and hot/toxic gases) from spreading to other levels. Such conditions are not conducive to defend in-place strategies. Rather, it is preferable that building occupants move quickly out of harm's way. These requirements expressly demonstrate the overlap between passive, active and egress fire & life safety provisions.

Code Requirements

In occupancies other than I-2 and I-3, floor openings containing exit access stairs that do not comply with one of the following ... shall be enclosed in a shaft enclosure. (1019.3)

- The exit access stairway must be included in the exit access travel distance measurement. (1017.3.1)
- Comply with the 2-story requirements of 712.1.9 (1019.3, Item #1)
- Options to open four stories or more than four stories using draft curtains and closely spaced sprinklers (see Section 1019.3, Item #4)

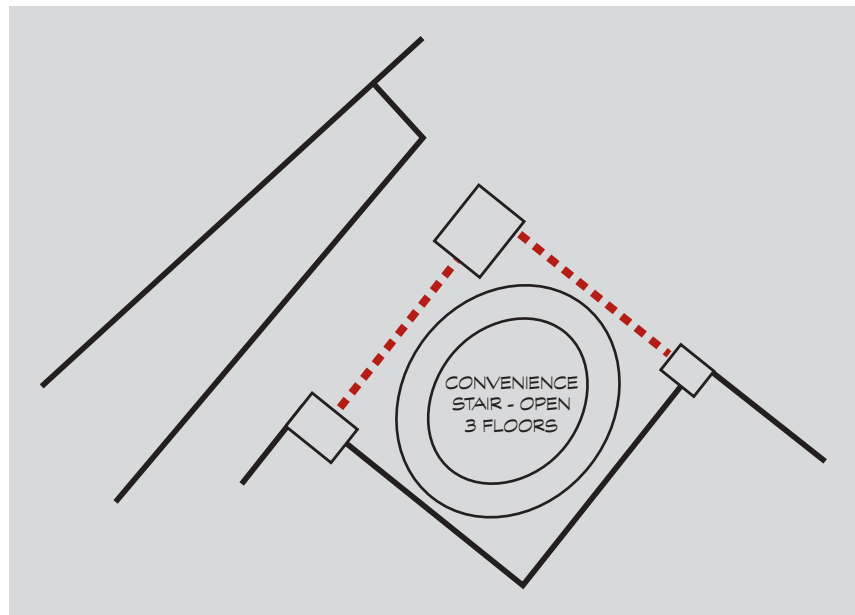
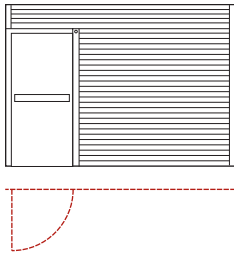
Note: Additional information regarding the provisions of 1019.3, Item #4 can be found in this document under the title of "Understanding Draft Curtains & Closely Spaced Sprinklers"

VERTICAL OPENING SEPARATION

Design Solutions

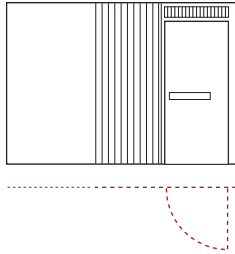
Because each space contains an exit access stair the code will allow two floors common. In the following case studies, McKEON offers different products for very diverse design needs, yet there is not a compromise in fire and life safety.

CASE 1: Vertical Coiling with Complying Swing Egress Door(s)



VERTICAL OPENING SEPARATION

CASE 2: Side Acting with Complying Egress Door(s)

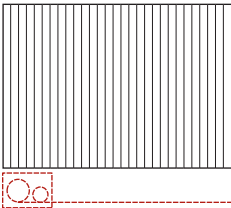


In the second case study a convenience stair within a university learning center is open to each floor it connects during normal school operation. When the building goes into alarm two McKEON 3-hour side acting assemblies, each with a conforming egress swing door and conventional fire exit hardware, combine to provide shaft enclosure protection.

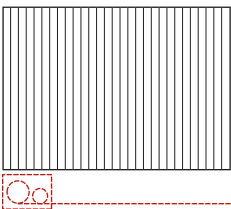


VERTICAL OPENING SEPARATION

CASE 3: Extreme Height & Width Side Coiling without Egress



CASE 4: Side Coiling without Egress

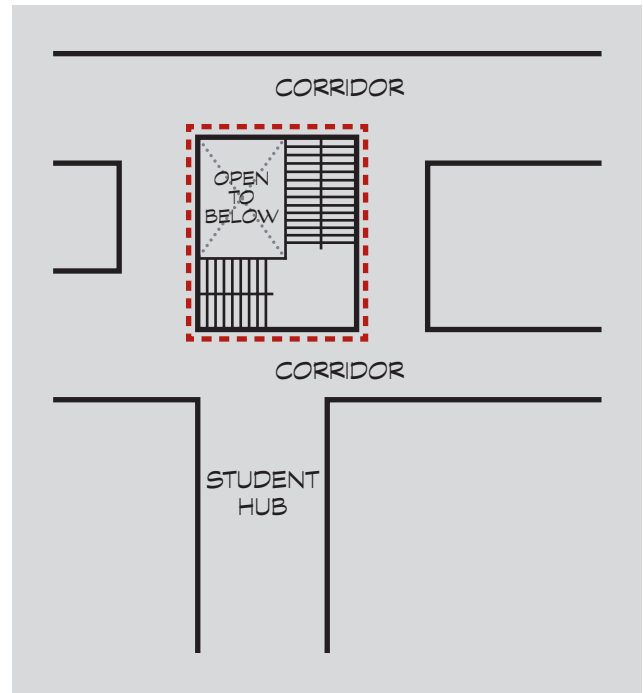


VERTICAL OPENING SEPARATION

CASE 5: Deployable Draft Curtains & Closely Spaced Sprinklers



The McKEON D100 draft curtains deploy when there is a fire emergency. During normal hours of building occupancy, unlike conventional fixed draft curtains, the ceiling space around the vertical opening is clear of any obstacles.



VERTICAL OPENING SEPARATION

Inquiry Discussion & Questions

Historically, there were three separate categories defining occupied open-style vertical spaces in the code. First, atriums; second, 2-story spaces; third, exit access stairways. However, since each had the possible appearance of an atrium, the code practitioner would have to consult different code sections for each vertical-space building component and by the process of elimination determine which provisions apply. As of the adoption of the 2024 edition of the IBC, significant clarification has been added in two locations to help solve this problem of determination by elimination. First, the atrium section (404), by exception, declares specifically that 2-story spaces and exit access stairways are not atriums. Second, exit access stairways must conform to both Section 1019 and Section 712.1.9 - 2-story spaces. With these new clarifications please note below, exit access stairways must conform to all the provisions listed in Section 712.1.9 for 2-story openings:

1. Does not connect more than two stories.
2. Does not penetrate a horizontal assembly that separates fire areas or smoke barriers that separate smoke compartments.
3. Is not concealed within the construction of a wall or floor/ceiling assembly.

4. Is not open to a corridor in Group I and R occupancies.
5. Is not open to a corridor on nonsprinklered floors.
6. Is separated from floor openings and air transfer openings serving other floors by construction conforming to require shaft enclosures. (712.1.9)

The following questions may be helpful:

- Do you have clients who wish to occupy multiple floors with a vertical common area connecting all floors?
- Can I show you how interconnecting unenclosed stairs can be incorporated into the design without creating shaft enclosures or complying with atrium provisions?
- Have you been concerned attempting vertical space separation avoiding the closed-in shaft appearance?
- Did you know there is technology available to offer a wide-span opening protective to separate vertical spaces that can also serve as the required exit from unenclosed stairways?

Notes:

VERTICAL OPENING SEPARATION

Interior Exit Stairways

Section 1023

Exit enclosures extend vertically through the interior of multi-story buildings in order to ensure timely and safe evacuation of occupants during an emergency. These enclosures include exit stairs and exit ramps.

Fire & Life Safety Concerns

Because exit enclosures penetrate horizontal floor and ceiling assemblies, fire, heat, smoke and toxic gases can potentially penetrate into building spaces at each floor level. Therefore, enclosures become critical barriers of protection for building occupants. The protected enclosure will be a non-contaminated exit path for at least one hour in buildings less than four stories and two hours in buildings four stories or more.

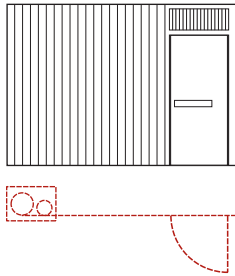
Code Requirements

1. Interior exit stairways shall be enclosed with fire barriers in accordance with Section 707 or horizontal assemblies in accordance with Section 711 or both. (1023.2)
2. Exit enclosures in buildings connecting four stories or more shall be rated at 2 hours; less than four stories at 1 hour. (1023.2)
3. Openings and penetrations shall be rated in accordance with Section 716. (1023.4)

VERTICAL OPENING SEPARATION

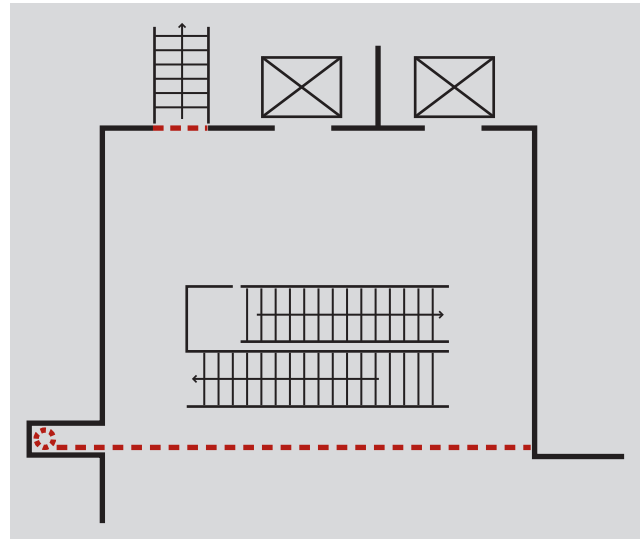
Design Solutions

CASE 1: Side Coiling with Complying Swing Egress Door(s)



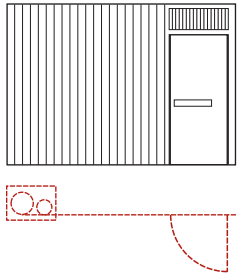
An absence of stacking space dictated use of a unique McKEON product to seal this exit enclosure. The side coiling assembly requires a small box-like space, projecting the 3-hour steel curtain with conventional egress door along a very narrow pocket entry point

and header slot path. When deployed, complete compliance with shaft enclosure opening protective requirements is achieved.

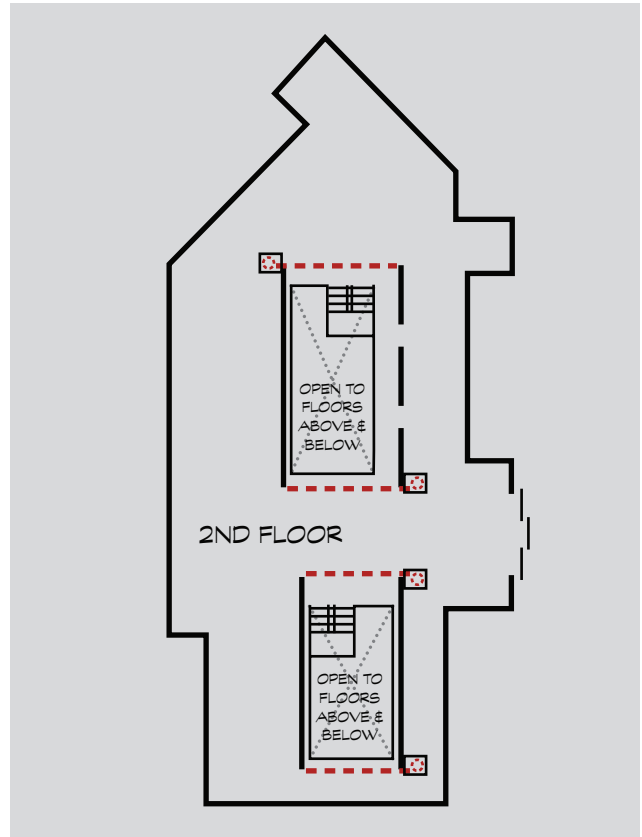


VERTICAL OPENING SEPARATION

CASE 2: Side Coiling with Egress

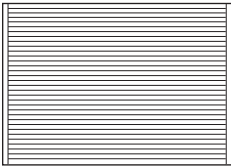


A fixed swing door within the parameters of a lengthy side coiling 3-hour assembly provides a simple resolve in a multi-floor challenge of vertical separation and egress.

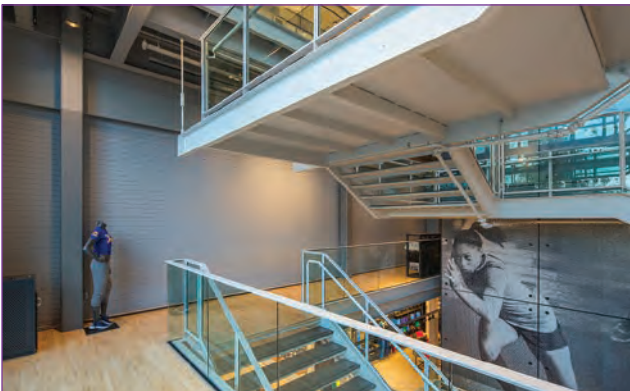
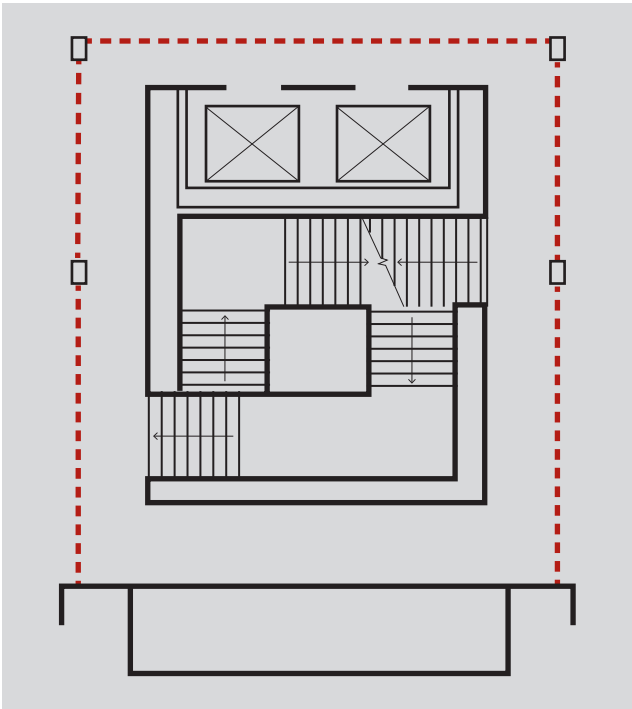


VERTICAL OPENING SEPARATION

CASE 3: Vertical Coiling without Egress



Shaft enclosures that protect a required means of egress are extremely critical to the life safety of building occupants. From a design perspective it is often challenging to incorporate opening protectives in hi-profile open spaces. This extreme width vertical coiling assembly fits narrow header lines, has inconspicuous side guides, and deploys with adequate separation only when the building goes into alarm.



Inquiry Discussion & Questions

The following questions may be helpful:

- Do you seek an open and spacious appearance at the landing area of vertical stair enclosures?
- Would you like to use a required vertical exit stair shaft as an aesthetically pleasing communicating stair by opening the enclosure area at each floor?

VERTICAL OPENING SEPARATION

Understanding Draft Curtains & Closely Spaced Sprinklers as Vertical Space Fire Protection Features

Sections 712.1.3.1 & 1019.3, #4

Draft curtains and closely spaced sprinklers, in accordance with NFPA 13, may be used in lieu of shaft enclosure construction in specific vertical opening applications.

Because of the chimney effect that can take place in vertical openings in multi-story structures, smoke, heat, toxic fumes and gases easily transfer throughout the structure. The optimum regulatory provision that prevents or mitigates this condition is the construction of solid fixed walls that are fire-rated as shaft enclosures separating vertical spaces from the remaining structure and floor areas. However, certain conditions allow the use of draft curtains in lieu of Fire Barrier walls.

Draft curtains are intended to accelerate the activation of sprinklers placed around the perimeter of vertical openings in order to provide an instant water barrier. This is a level of protection that can take the place of the rated wall construction and mitigate the transfer of smoke, heat, toxic fumes and gases which may be transferring vertically through the structure during a fire event.

The code addresses the use of draft curtains in two specific applications only. Both are penetrations through floor openings with the first being the escalator and the second, exit access stairways.

Escalator Openings

Section 712.1.3 Escalator openings. Where a building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, vertical openings for escalators shall be permitted where protected in accordance with Section 712.1.3.1 or 712.1.3.2.

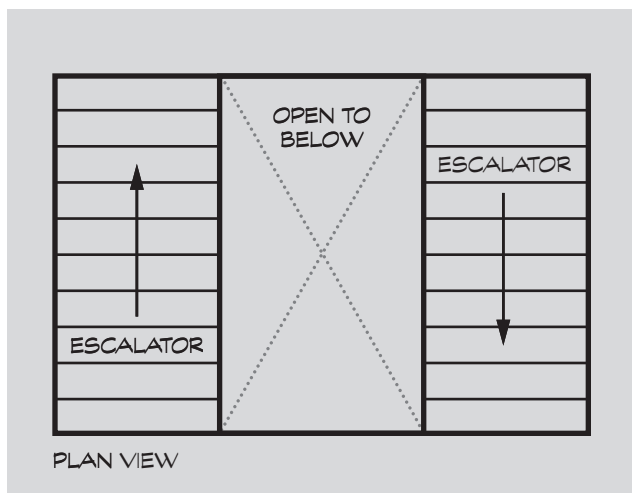
Section 712.1.3.1 Opening size. Protection by a draft curtain and closely spaced sprinklers in accordance with NFPA 13 shall be permitted where the area of the vertical opening between stories does not exceed twice the horizontal projected area of the escalator. In other than Groups B and M, this application is limited to openings that do

not connect more than four stories.

Section 712.1.3.2 Automatic shutters. (Please see the application study in this document titled, "Vertical Openings - Escalator.")

The use of the draft curtains with closely spaced sprinklers in escalator openings as outlined in the aforementioned code language only applies when the area of the escalator itself obstructs at least half of the area of the opening being penetrated. The following diagram illustrates a compliant application of this criteria. It is important to remember, this condition is acceptable only when the building is fully sprinklered.

VERTICAL OPENING SEPARATION



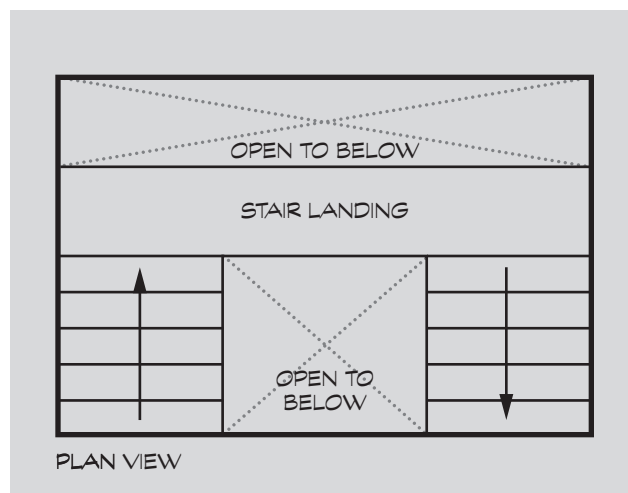
Exit Access Stairway Openings

Section 1019.3 Occupancies other than I-2 and I-3. In other than Group I-2 and I-3 occupancies, floor openings containing exit access stairways or ramps that do not comply with one of the conditions listed in this section shall be enclosed with a shaft enclosure constructed in accordance with Section 713.

Condition 4. Exit access stairways and ramps in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, where the area of the vertical opening between stories does not exceed twice the horizontal projected area of the stairway or ramp and the opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13. In other than Group B and M occupancies, this provision is limited to openings that do not connect more than four stories.

Using language similar to the escalator provisions, the use of draft curtains with closely spaced sprinklers in exit access stairway openings only applies when the area of the stair, to include any landings, obstructs at least half of the area of the opening being penetrated. The diagram below illustrates a compliant applica-

tion of this criteria. It is important to remember, this condition is acceptable only when the building is fully sprinklered.



A Code Discussion for Clarification

The design and code provisions governing the application and use of draft curtains do not require side-guide components or fire endurance testing and do not parallel typical opening protective acceptance criteria. Since the adoption and development of the *2015 edition of the International Building Code (IBC)*, the use of draft curtains in any project are for the sole purpose of creating barriers to force heat to activate sprinkler heads in vertical openings such as escalators and exit access stairways. Draft curtains are not intended to prevent smoke from migrating floor to floor, rather their purpose is to assist in immediate activation of the closely spaced sprinklers, associated with them, which are intended to mitigate the migration of smoke and/or heat floor to floor.

Background

In the legacy model building codes and all editions of the IBC prior to the published 2015 edi-

VERTICAL OPENING SEPARATION

tion, draft curtains were a requirement in two separate areas of the code with criteria and detailed definition in one area only. First, we will explore the use where these criteria and definitions occurred, Factory and Storage occupancies, as defined in *Chapter 9, Fire Protection Systems*. *Section 910.3.5.1* stated: *Construction. Draft curtains shall be constructed of sheet metal, lath and plaster, gypsum board or other approved materials which provide equivalent performance to resist the passage of smoke. Joints and connections shall be smoke tight.* In essence, draft curtains could be constructed of cardboard and duct tape ... as long as they channeled smoke.

This code language was written around the stringent requirements of Group F-1 and S-1 occupancies as indicated in *Table 910.3*. In these hi-pile storage occupancies there was no requirement for draft curtains to be fire rated, only that they “resist the passage of smoke.” Achieving smoke tight joints and connections were critical due to exceptions in the code section that allowed the reduction of smoke vents, their sizes and placement with the use of draft curtains. In other words, this specific language was confined to these two aforementioned occupancy types. Incidentally, this code requirement was eliminated in the 2015 edition of the IBC, the term draft curtain no longer exists for F-1 and S-1 occupancies. These particular smoke removal systems no longer require draft curtains for directing smoke.

Current Provisions

Section 712 Vertical Openings, 712.1.3.2 allows unprotected escalator openings that are protected by draft curtains. *Section 1019* addresses *Exit Access Stairways* allowing draft curtains to protect vertical openings. However, these two code sections (applications) did not reference *Section 910* prior to 2015 confirming separate and dis-

tinct uses of the provision. However, both the escalator and exit access stairway applications include a pointer to *NFPA 13* as the standard for the use of this building feature. *Section 712.1.3.1* *Opening size* at the escalator opening and *Section 1091.3, Item #4* at the exit access stairway opening state the following: “... protection[ed] by a draft curtain and closely spaced sprinklers in accordance with *NFPA 13* ...”

Please note, there are no other definitions or criteria for the term draft curtain in the model building codes with exception of the reference to *NFPA 13*. Yet, the term draft curtain is called out in both aforementioned code sections. Further to confuse the issue the term Draft Stop is found in *IBC Section 202*. After reading this definition, clearly it is addressing a building feature located in “... concealed areas of building components such as crawl spaces, floor/ceiling assemblies, roof/ceiling assemblies and attics.”

As if the issue is not confusing enough, *NFPA 13* addresses vertical openings such as escalator openings and stair openings with regard to this level of protection as Draft Stops rather than using the term Draft Curtain. Please note:

NFPA 13, Section 8.15.4 Vertical Openings

8.15.4.1 General. Unless the requirements of 8.15.4.4 are met, where moving stairways, staircases, or similar floor openings are unenclosed and where sprinkler protection is serving as the alternative to enclosure of the vertical opening, the floor openings involved shall be protected by closely spaced sprinklers in combination with draft stops in accordance with 8.15.4.2 and 8.15.4.3.

8.15.4.2 Draft Stops. Draft stops shall meet all of the following criteria:

- 1. The draft stops shall be located immediately adjacent to the opening.*

VERTICAL OPENING SEPARATION

2. *The draft stops shall be at least 18 in. (457 mm) deep.*
3. *The draft stops shall be of noncombustible or limited combustible material that will stay in place before and during sprinkler operation.*

The term draft curtain does appear in *NFPA 13*, however, only in reference to the old method of channeling smoke to smoke and heat vents in “F” & “S” occupancies. Therefore, the use of draft curtains in our current model building codes is limited to escalator and exit access stairway openings only. Since *NFPA 13* criteria for use of draft curtains in vertical openings does not require the channeling of smoke, rather to simply force heat and smoke against the sprinkler heads for immediate activation, the criteria does not include large depths of drop beyond 18 inches nor does it require smoke sealed corners or joints in the curtain installation.

If we examine this concept from a more pragmatic view we can see that the criteria makes sense. As mentioned above, the maximum drop in the draft stop criteria for these applications is 18 inches. If the intent of the draft curtain application was to stop the transfer of smoke or heat to other floors, this depth would have to be much greater. At some point, very quickly upon contact the smoke will easily pass over these draft curtains and the curtains become academic at that point. Hence, draft curtain applications in escalators and stairs always have gaps at the

joints, are typically constructed of polymethyl methacrylates which by trade-name are better known as clear acrylics or Plexiglass. These or other materials are usually not continuous or installed in a fashion to actually prevent smoke from migrating floor to floor ... their only purpose is to force enough heat against the sprinkler heads to activate them.

For this reason there is not a test standard or criteria for testing draft curtains. *NFPA 13* simply requires, “*The draft stops shall be of noncombustible or limited combustible material ...*” The D100 technology significantly exceeds these basic requirements. The McKEON SmokeFighter® Model D100 is manufactured from fabric that has been tested and certified for a 3-hour UL 10D fire label. This material has also been tested and certified for a 20 minute UL 10B fire label. Both labels certify use to span unlimited widths and heights. The test criteria included side-guide components in order to maintain full integrity opening protective hose stream performance.

The D100 technology exceeds the minimum requirements, creating a substantial fire and smoke barrier to expeditiously activate the closely spaced sprinklers surrounding the vertical opening. Sprinkler activation at the unprotected shaft opening mitigates the migration of heat, smoke, toxic fumes and gases from traveling throughout the structure.

4 | Occupancy Separation

Fundamental Guidelines

Mixed Occupancy - Accessory Use

**Mixed Occupancy Use -
Non-Separated vs. Separated**

Fundamental Guidelines

Table 508

Most buildings are designed for multiple uses that will typically result in more than one occupancy classification. The code provides three basic options for mixed occupancies in Section 508:

- 1. Accessory occupancies: Section 508.2**
- 2. Non-separated occupancies: Section 508.3**
- 3. Separated occupancies: Section 508.4**

Chapter 3 of the building code specifically classifies a building according to its use and occupancy. The level of fire hazard varies with specific uses and occupancies in a building. However, this level of hazard and its potential affect on the building occupants is determined not only by the use and occupancy classification by construction type, height and area size, but also the use of passive and active fire protection systems. Chapter 5 combines fire-resistance levels, construction types and occupancy types to determine size and height limitations as well as separation requirements.

Increased fire resistance of the structural members of the building along with increased active and passive fire protection systems permits greater height and area allowances. Notwithstanding, the use and occupancy of the structure will become a determining factor regarding the extent of separation and compartmentation required. For example, a “B” (business occupancy) is allowed occupant load floor area to be calculated at 100 gross sq. ft. per occupant. However, a group “I-2” occupancy (hospital) which is a similar occupant load as far as quantity of people, is required to be calculated at 240 gross sq. ft. per occupant, more than double that of a “B” occupancy. The difference between these requirements is the use of the facility. Occupants in a hospital need better protection for a greater amount of time because they are non-ambulatory and most are dependent upon others for mobility or even life support. Therefore, the fire and life safety requirements designed to help protect building occupants are very different for each of these occupancies.

OCCUPANCY SEPARATION

When buildings are designed as mixed occupancies there is a concern because basic fire and life safety requirements are being mixed within the same structure. Three basic options to eliminate confusion and ensure building occupant safety are outlined as follows:

Accessory Occupancy:

1. Accessory occupancies are those which are different from the main occupancy but ancillary to or a portion thereof. (508.2)
2. Aggregate accessory occupancies shall not occupy more than 10% of the area of the story. (508.2.3)
3. Aggregate accessory occupancies shall not exceed the tabular values in Table 506.2 without height and area increases. (508.2.3)
4. Accessory occupancies shall be individually classified in accordance with Section 302.1. (508.2.1)

Non-Separated Use:

To consider spaces under the Non-Separated Use requirements, the following must be met allowing NO separation between occupancies:

1. Each occupancy use shall be individually classified. (508.3.1)
2. Code requirements shall apply to each portion of the building based upon the occupancy classification of the space under consideration. (508.3.1)
3. The most restrictive applicable provisions of Section 403 and Chapter 9 shall apply to the building or portion thereof in which the non-separated occupancies are located, Section 403 in hi-rise and Chapter 9 in all others.
4. The allowable building area and height of the

building or portion thereof shall be based on the most restrictive allowances for the occupancy groups under consideration for the type of construction of the building in accordance with Section 503.1. (508.3.2)

Separated Use:

The following requirements under the provisions of Separated Occupancies will bring these spaces into compliance without compromising design if separated with fire barrier walls according to Table 508.4:

1. Separated occupancies shall be classified in accordance with Section 302.1. (508.4.1)
2. Each separated space shall comply with the code based upon the occupancy classification of that portion of the building. (508.4.1)
3. In each story, the building area shall be such that the sum of the ratios of the actual building area of each separated occupancy divided by the allowable building area of each separated occupancy shall not exceed 1. (508.4.2)
4. Each separated occupancy shall comply with the building height limitations based on the type of construction of the building in accordance with Section 503.1. (508.4.3)

OCCUPANCY SEPARATION

Mixed Occupancy – Accessory Use

Section 508.2

Post grade 12 educational occupancies are typically classified as “B” occupancies and usually incorporate mixed occupancies that are often considered accessory – full service kitchens and cafeterias (A-2), assembly areas (A), and dormitories (R-2) occupancies. Even though these spaces are ancillary to and a functional portion of the original larger occupancy they must be separated when they exceed the 10% rule.

Fire and Life Safety Concerns

In this case study we will examine the potential fire and life safety threats posed due to the use of open flames, combustible gases and solids, and exhaust hood extinguishing systems. These kitchens (A-2) are often common with other areas (B or R-2) in the facility potentially exposing large groups of building occupants to the associated hazards. In these cases and similar situations, where the spaces are greater than 10%, separation is required.

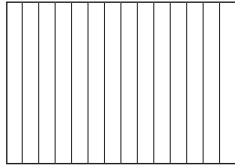
Code Requirements

Table 508.4 in Chapter 5 provides the requirements for separation of occupancy types. Should an accessory occupancy exceed the 10% rule, this table becomes the determining factor. Since the separation must be a fire barrier wall (508.4.4.1), Table 508.4 requires a 1-hour separation between an “A” and “B” occupancy or “R” and “B” occupancy when the building is fully sprinklered and 2-hour in non-sprinklered buildings.

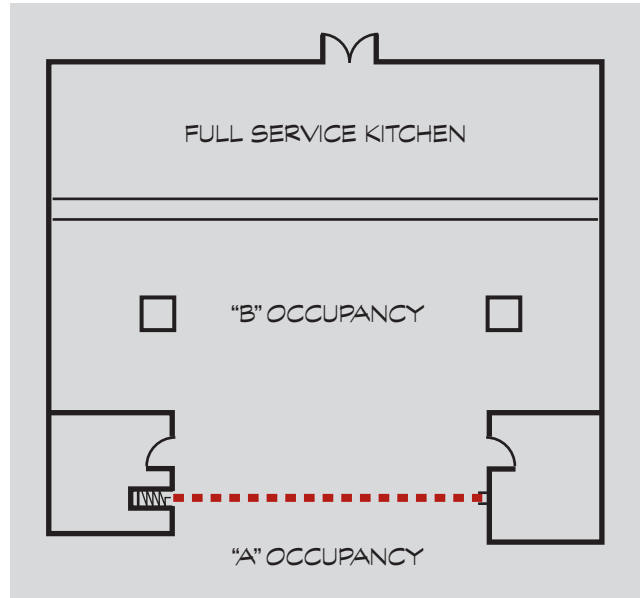
OCCUPANCY SEPARATION

Design Solutions

CASE 1: Side Acting Accordion with Power-assisted Egress

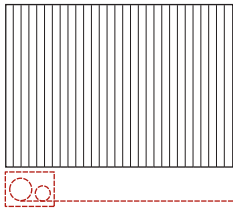


This first case study examines the use of the McKEON Side Acting Accordion fire door. The assembly is hidden from view unless there is a fire when it is activated by the smoke detector. Egress is accomplished by compliance to 1010.3.3.



OCCUPANCY SEPARATION

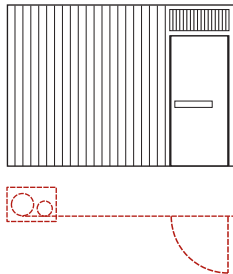
CASE 2: Side Coiling without Egress



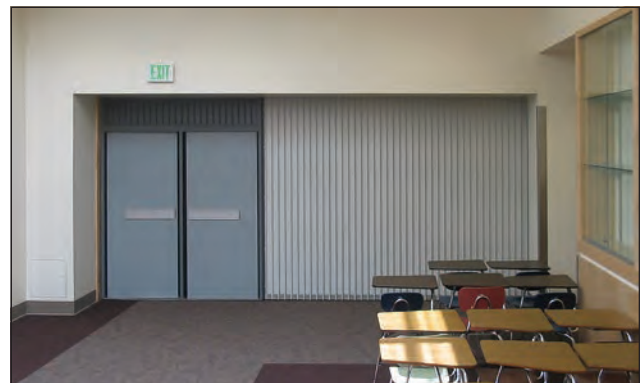
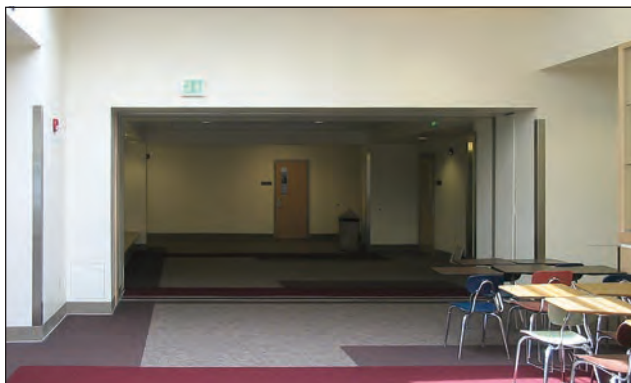
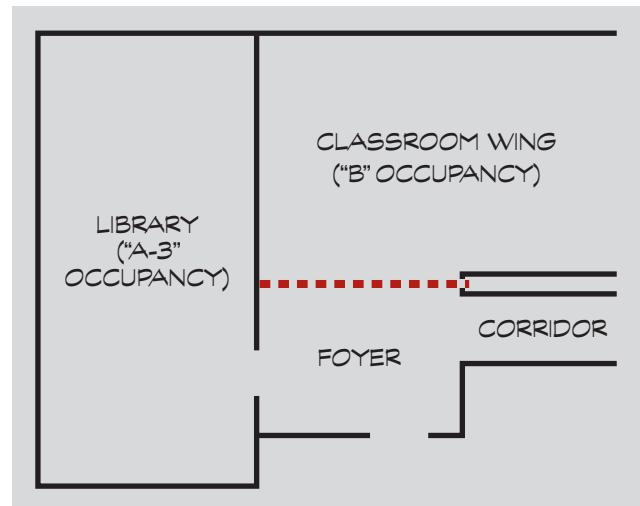
This case study is very similar to the previous application with the exception of an egress requirement. The McKEON side coiler without egress became the most economical solution without compromising life safety.



CASE 3: Side Coiling with Complying Swing Egress Door(s)



This third case study features a different product under the same code premise, the requirement to separate an "A-3" occupancy (library) from the rest of the "B" occupancy, school. The feature product is the Side Coiling with Conventional Egress Assembly due to limited width of pocket space.



OCCUPANCY SEPARATION

Mixed Occupancy Use - Non-Separated vs. Separated

Section 508; Table 508.4

Complying with Table 508.4 and providing fire barrier walls to separate occupancies can be limiting to the design. Also, using non-separated provisions to eliminate restrictive fire barrier walls becomes extremely costly due to added fire and life safety requirements that affect the entire structure.

Fire & Life Safety Concerns

Building structures are classified based on their occupancy and use. The purpose for classifying structures is to configure optimum safety requirements commensurate to the need as dictated by each individual use. These areas of concern are general building limitations, means of egress, fire protection systems and interior finishes. The challenge comes when buildings contain rooms or spaces that are different than the original building occupancy classification thereby creating a mixed use or mixed occupancy structure.

Code Requirements

In this case study the Conference/Training room is 1,188 square feet with an occupant load of 79. It is classified as an A-3 occupancy located in a 5-story Group B office building of Type IIIA construction. The conference room is classified as an A-3 because it is used for gathering a large number of people for assembly purposes (Section 303.1). It cannot be considered an accessory space because it exceeds both occupant load and area square footage of the accessory use exceptions.

First, let's look at the requirements imposed if we attempt to eliminate all separations as indicated in Table 508.4, in other words non-separated use.

Non-Separated Use:

1. Each use shall be individually classified. (508.3.1)
 - The entire building is classified as a "B" occupancy. The space under consideration (Conference/Training room) is an A-3 occupancy.
2. The allowable building area and height of the building or

OCCUPANCY SEPARATION

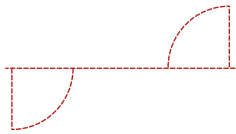
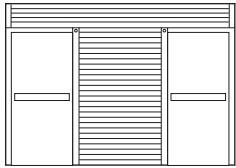
portion thereof shall be based on the most restrictive allowances for the occupancy groups under consideration ... (508.3.2)

3. The most restrictive applicable provisions of Section 403 and Chapter 9 shall apply to the entire building or portion thereof. (508.3.1)
 - Section 403 encompasses the requirements for hi-rise construction and Chapter 9 include the provisions for fire protection systems. In other words, the building will have to incorporate the most protective and restrictive requirements of these chapters. For example:
 - Standpipe system (403.4.3)
 - Smoke detection (403.4.1)
 - Fire Alarm systems (403.4.2)
 - Emergency voice/alarm communication system (403.4.4)
 - Fire command (403.4.6)
 - Smoke removal (403.4.7)
 - Emergency responder radio coverage (403.4.5)
 - Standby power (403.4.8)
 - Emergency power systems (403.4.8.4)
4. The allowable height and area of the building or portion thereof shall be based on the MOST RESTRICTIVE allowances for the occupancy group under consideration for the types of construction of the building in accordance with Section 503.1. (508.3.2)
 - The height and area allowances for this requirement would not allow the building to be five stories. Most likely only three at best.

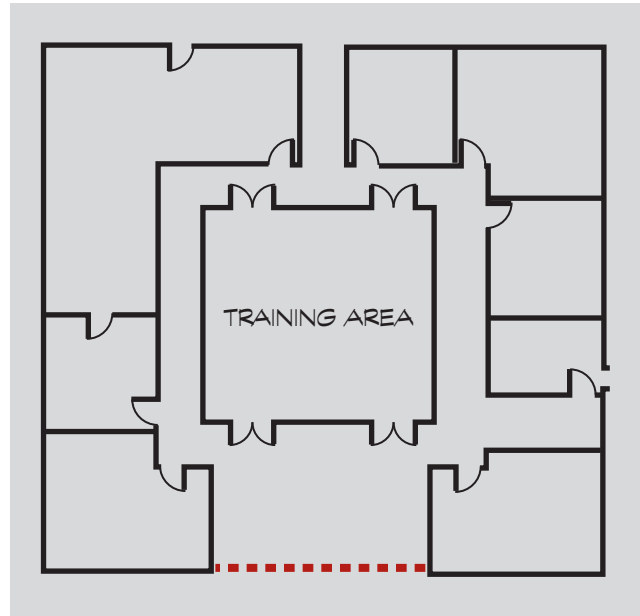
OCCUPANCY SEPARATION

Design Solutions

CASE 1: Vertical Coiling with Complying Swing Egress Door(s)

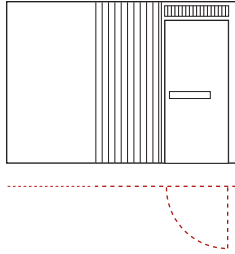


The use of wide span opening protectives enables occupancy separation without compromising open and spacious design. In this case study a simple deployable separation prevents the overall structure from being subject to the most restrictive provisions of non-separated use.



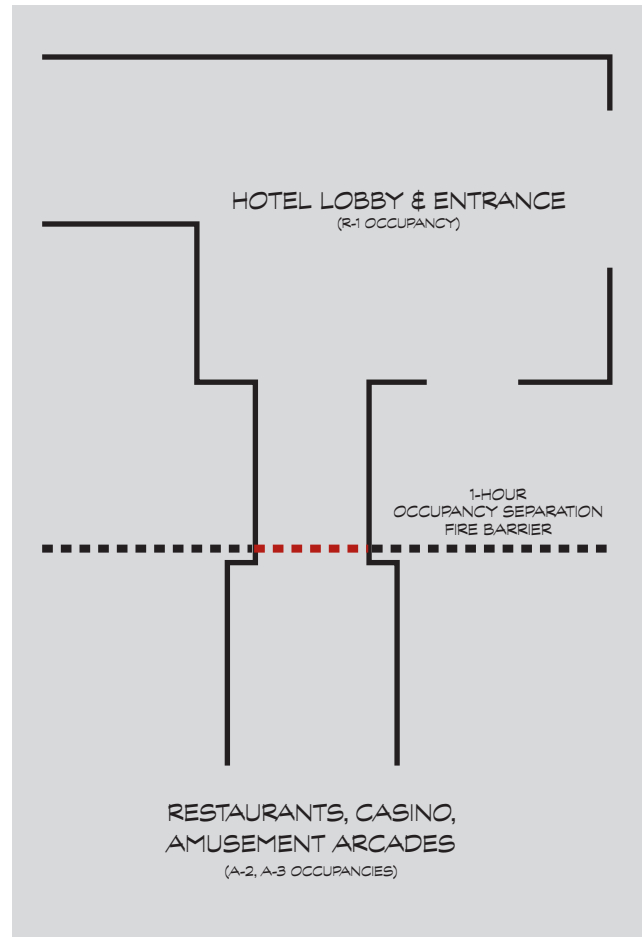
OCCUPANCY SEPARATION

CASE 2: Side Acting with Complying Swing Egress Door(s)



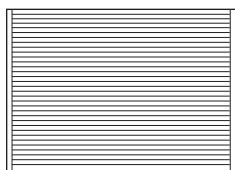
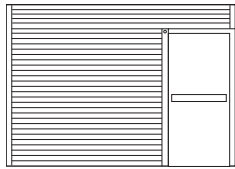
This case study is a text book example of occupancy separation, but is very unique in product application problem-solving from an architectural perspective. Pocket space was limited in width, but not depth, and headroom was extremely limited. Given the ambiance of the space, conventional swing doors on

magnetic hold-opens were not an option. McKEON provided the S7000 series which requires only a 7" pocket width and no more than a 2 1/4" reveal in the ceiling for the head track. With patented side acting technology the entire assembly, incorporating four conventional swing doors, fits into a narrow space parallel to the fire barrier wall. Upon command of the smoke detector the 3-hour assembly slides into place providing occupancy separation and conforming egress.

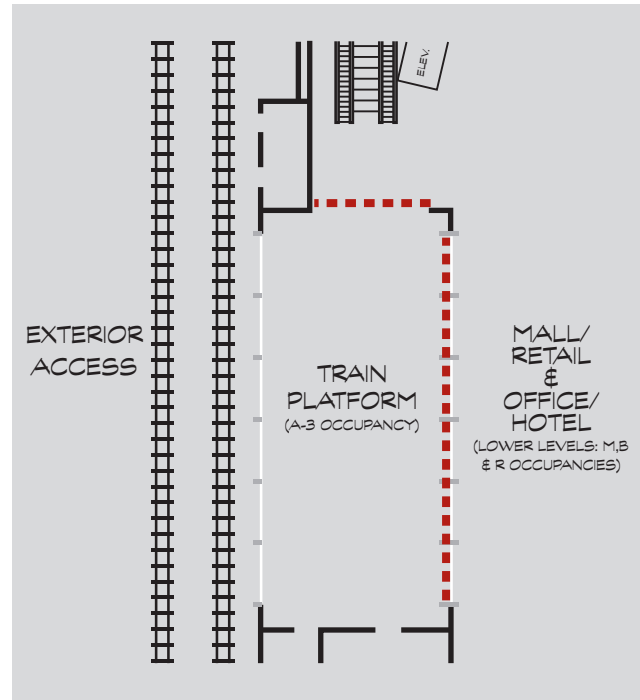


OCCUPANCY SEPARATION

CASE 3: Vertical Coiling with Complying Swing Egress Door(s) & Vertical Coiling without Egress

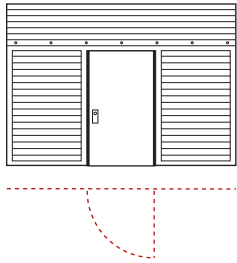


In this case study McKEON offers a solution to a difficult challenge by providing two different products within the same space. A combination of six fire-rated vertical rolling shutters installed on a diagonal path of travel and one vertical coiling assembly with conventional egress for exiting from the space. This solution preserves the beauty of the space without compromising mixed occupancy separation requirements.

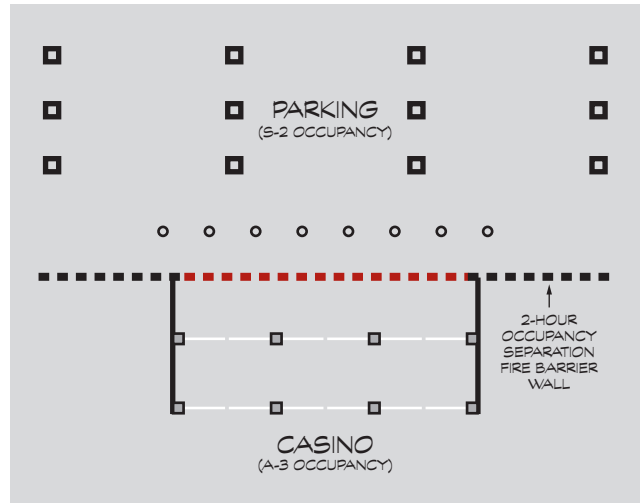


OCCUPANCY SEPARATION

CASE 4: Vertical Acting with Complying Swing Egress Door(s)



This application illustrates McKEON's capacity to provide 3-hour separation, conforming to a large occupant load exit width without occupying side stacking space. Deploying only in case of fire or emergency, both egress and fire separation requirements are satisfied without compromising design.



OCCUPANCY SEPARATION

Inquiry Discussion and Questions

Fundamentally, separating the interior of buildings with fire barriers wherever occupancies change as required in Table 508.4 is simple and straightforward. However when designs promote mixed occupancies without separation, the code is left to create alternate means of protection to compensate for the loss of fixed barriers. Hence, in the absence of passive redundant systems, code enforcement becomes a tremendous challenge and the non-separated use provisions govern. These provisions are extremely costly.

The following questions may be helpful:

- Are you frustrated because open design is difficult when incorporating fire barrier walls as occupancy separations?

- Can I show you how wide-span opening protectives can eliminate the need to design non-separated structures?
- Have you considered the additional cost incurred by conforming to the non-separated use requirements?
- Do you really want to impose the most restrictive requirements of Chapter 4, Section 403 hi-rise provisions as well as the most restrictive requirements of Chapter 9 on the entire building?

Notes:



5 | Area Separation

Allowable Area

AREA SEPARATION

Allowable Area

Section 706; Tables 504.3, 504.4, 506.2

The allowable height and area of a building structure is determined largely by two basic factors; first, the combustibility of its structural materials and second, occupancy type or use and purpose of the building.

When a building design exceeds the established values, the intent of the code is to create another separate building structure to incorporate the increase. Since this is not always desirable, the code will allow interior fire walls to serve as separations sufficient to consider each space a separate structure within the tabular value allowance. In essence multiple compliant buildings can be created within the same structure and under a common roof.

Fire & Life Safety Concerns

Building height and area are calculated to accommodate three fundamentals principles in fire and life safety. First, the structural elements, rated or non-rated, are intended to maintain structural integrity during fire and other life threatening emergencies. This means the greater the protection of the structural elements, the larger the height and area. Second, additional height and area are allowed when active fire suppression systems such as sprinklers are used. Finally, passive redundant elements are used to compartmentalize the area and provide protection for building occupants as they egress the structure. Rated construction protects the structural elements, sprinklers protect the building contents, and egress protects building occupants by removing them from harm's way. All three principles overlap and work together to ensure a building occupant has adequate time to safely exit the structure. The reduction or absence of any of these components can compromise the safety of building occupants and cause property damage.

Another concern is the size of openings allowed in the passive redundant system, particularly in fire walls that are crucial to the area limitations. Opening size limitations are imposed to maintain the integrity of the wall during fire conditions. Opening protectives inherently accommodate strict requirements to adequately protect and maintain the integrity of the openings. The structural integrity of the fire wall must be maintained regardless of the wall opening size or its opening protective. It is critical to remember; the opening protective protecting an opening in a fire wall is not required to conform to structural integrity provisions. The opening protective is protecting the opening - NOT the wall. A fire wall used for area separation is allowed openings and opening protectives, however, a fire wall used as a party wall cannot have openings.

Code Requirements

1. The above referenced tables of Chapter 5 indicate the tabular height and area allowances for specific building construction types and occupancies.
2. Each portion of a building separated by one or more fire walls shall be considered a separate building. (503.1)
3. Openings in fire walls are subject to the following criteria (706.8):

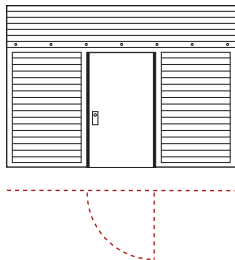
Non-sprinklered buildings - Openings shall not exceed 156 square feet and the aggregate width of openings at any floor shall not exceed 25 percent of the length of the wall.

Sprinklered buildings - Openings shall not be limited to 156 square feet and the aggregate width of openings at any floor shall not exceed 25 percent of the length of the wall.

AREA SEPARATION

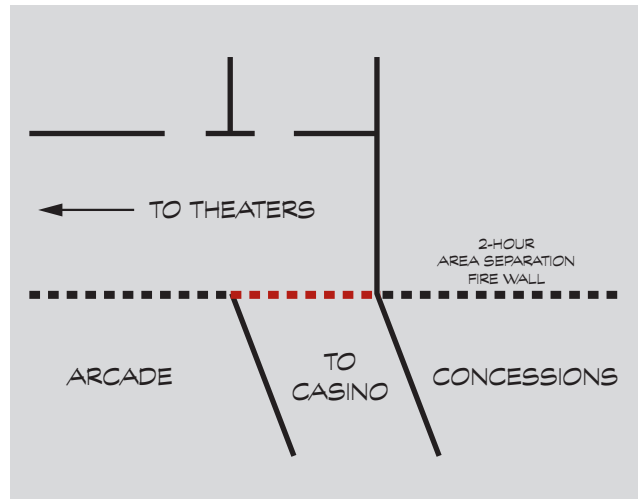
Design Solutions

CASE 1: Vertical Acting with Complying Swing Egress Door(s)



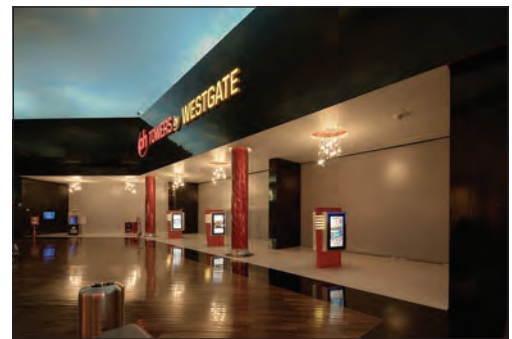
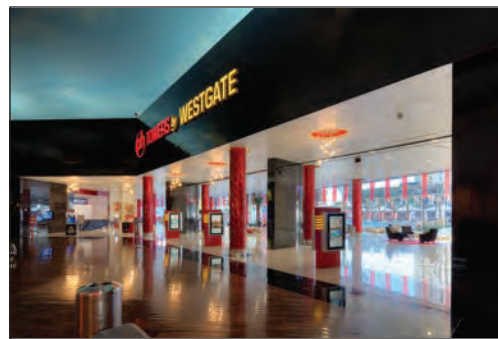
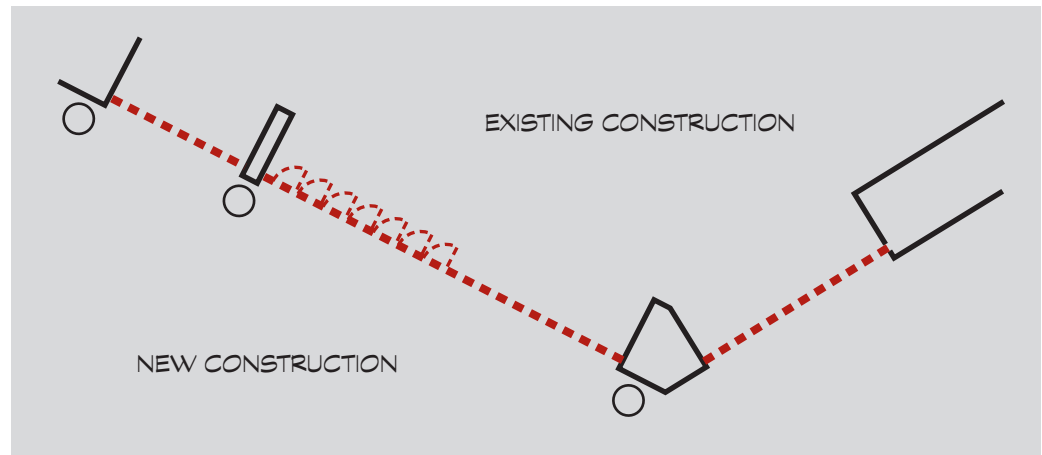
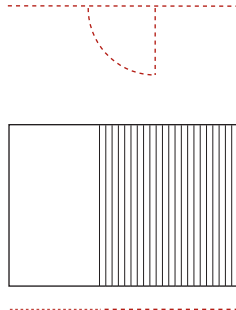
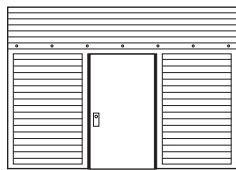
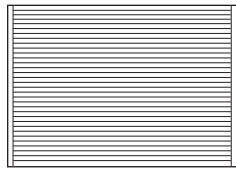
In this application McKEON resolved two significant design code compliance problems without sacrificing wide span open appearance. First, nearly the entire opening was necessary to meet the exit width requirements located in the

primary means of egress system in an "A" occupancy. Using the McKEON accordion assembly would not comply because of a) the large distance to be covered and b) the length of time required to open wide enough to allow for immediate egress. Second, there was not sufficient stacking space for any of the McKEON side acting models. However, because headroom was plentiful and large occupant load egress was a necessity, the T5000 series incorporating six egress conventional swings doors, three doors set in each direction to accommodate dual egress, was the perfect fit and the only viable solution.



AREA SEPARATION

CASE 2: Vertical Coiling without Egress, Vertical Acting with Complying Swing Egress Door(s) & Side Acting without Egress



AREA SEPARATION

Inquiry Discussion and Questions

The decision to use the area separation strategy is determined early in the conceptual design phase of the project.

Resistance to incorporate fire walls may be due to the following:

- Limited understanding of the code allowances for considering one structure as multiple buildings.
- The structural integrity of the fire wall design appears costly and overwhelming compared to the basic design; i.e. parapets, return exterior walls, etc.
- Limited understanding of diverse wide-span opening protectives. Conventionally, openings in any wall seem to follow the swing door model, largely due to the perception that complying egress is limited to these kinds of

doors and mullions. This traditional way of traversing throughout the building is very limiting and simply prohibitive to open design.

The following questions may be helpful:

- Have you ever been frustrated designing a structure because you exceeded the area allowances and were pushed to increase the construction type?
- When you are required to change a construction type to accommodate additional area, what is the increase in cost? How does your client feel about the increase?
- Are you hesitant to consider an area separation wall because of the limitations for openings as implied with conventional swing doors?

Notes:

6 | Corridor Separation

Fundamental Guidelines

I-2 Occupancies - Hospitals

- Smoke Protection
- Smoke & Fire Protection

I-1 and R Occupancies

B Occupancies - to Include NFPA 101 Provisions

Fundamental Guidelines

Sections 202, 407, 716, 712, 1016 & 1020

In Section 202, Definitions, of the IBC we find the following description for a corridor regardless of building construction type or occupancy: “An enclosed exit access component that defines and provides a path of egress travel.” Further in the definitions section we find the term, Open-Ended Corridor described as: “An interior corridor that is open on each end and connects to an exterior stairway or ramp at each end with no intervening doors or separation from the corridor.” Corridor applications can vary from rated to no rating at all. In this section we will explore the diverse protection features that regulate corridors and their applications.

Corridors typically fall within the Exit Access portion of the 3-part means of egress system. Corridors provide building occupants a protected environment when traveling from any point on a given floor-plate to an exit. This designated path, exit access, is considered a primary feature of the 3-part means of egress system. Therefore, corridors can be fire or smoke rated, or both ensuring that patrons within the structure will have a certain level of protection as they traverse through corridors and enter conforming exits. Eventually they will enter exit discharge, the final portion of the Means of Egress system, which provides escape away from the building, out of harm's way.

Section 1020, Corridors, explains when corridors serve as an exit access component in a means of egress system, they shall comply with all the requirements outlined in Section 1020. Section 1020.2, Construction, clearly defines any corridor wall required to be fire-resistance rated as complying with Section 708, Fire Partitions. However, there are specific exceptions to the fire rating of the Fire Partition in varied applications. An abbreviated list of circumstances where rated corridors are not required follows:

- Group E occupancies at ground level if not less than one door opens directly to the exterior and in assembly applications at least one half of the required egress doors open to the exterior.
- Groups I-1 and R when contained within a dwelling unit or sleeping unit.
- Open parking garages.
- Group B with only one required exit.
- Corridors adjacent to the exterior unrated walls of buildings as outlined in Tables 705.5 and 705.9.

CORRIDOR SEPARATION

Additional exceptions and guidance regarding corridor ratings can be found on Table 1020.2:

TABLE 1020.2 - CORRIDOR FIRE-RESISTANCE RATING

OCCUPANCY	OCCUPANT LOAD SERVED BY CORRIDOR	REQUIRED FIRE-RESISTANCE RATING (Hours)	
		Without automatic sprinkler system	With automatic sprinkler system
H-1, H-2, H-3	All	Not Permitted	1 ^c
H-4, H-5	Greater than 30	Not Permitted	1 ^c
A, B, E, F, M, S, U	Greater than 30	1	0
R	Greater than 10	Not Permitted	0.5 ^c /1 ^d
I-2 ^a	All	Not Permitted	0
I-1, I-3	All	Not Permitted	1 ^{b, c}
I-4	All	1	0

a. For requirements for occupancies in Group I-2, see Sections 407.2 and 407.3.
 b. For a reduction in the fire-resistance rating for occupancies in Group I-3, see Section 408.8.
 c. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 where allowed.
 d. Group R-3 and R-4 buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3. See Section 903.2.8 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.3.

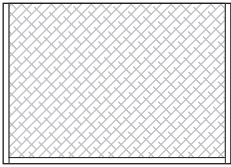
In essence, regardless of the fire, smoke, or non-rating of a corridor, it becomes the path of egress travel for building occupants egressing the structure. Due to this important function corridors are guided by additional requirements beyond ratings. Section 1020, Corridors, details the following:

- Width and capacity, 1020.3
- Obstruction, 1020.4
- Dead ends, 1020.5
- Air movement, 1020.6
- Corridor ceiling, 1020.6.1
- Corridor continuity, 1020.7

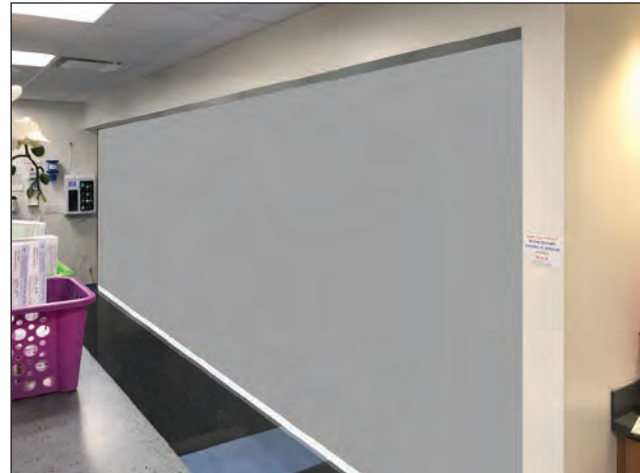
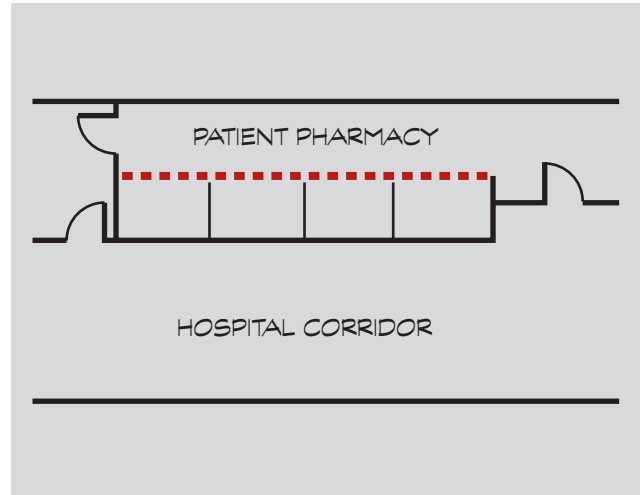
Since corridor requirements vary significantly in their use and application the differing McKEON wide-span opening protectives have become viable solutions to corridor design challenges. In this section please review the case studies, arranged by occupancy types, to better understand the design issues and potential solutions.

I-2 OCCUPANCIES - HOSPITALS/SMOKE PROTECTION

CASE 1: Vertical Acting without Egress



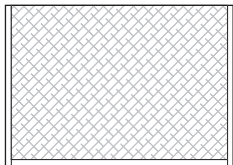
In I-2 occupancies corridor walls are required to be smoke rated only (Section 407.3). The SmokeFighter® D150 is an excellent resolve to minimal headroom space allowances. This hospital patient pharmacy is easily separated from the corridor with one of the latest fabric technologies offered by McKEON.



SIMULATION

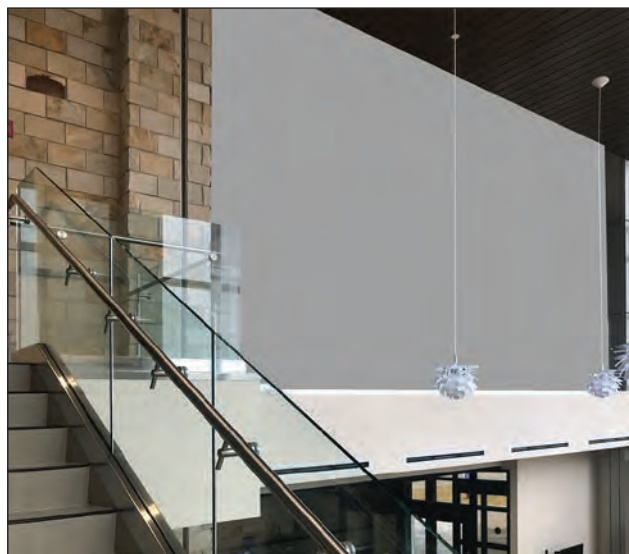
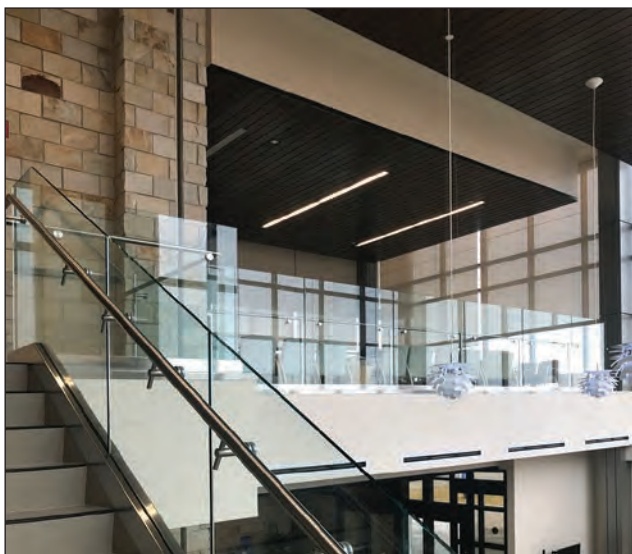
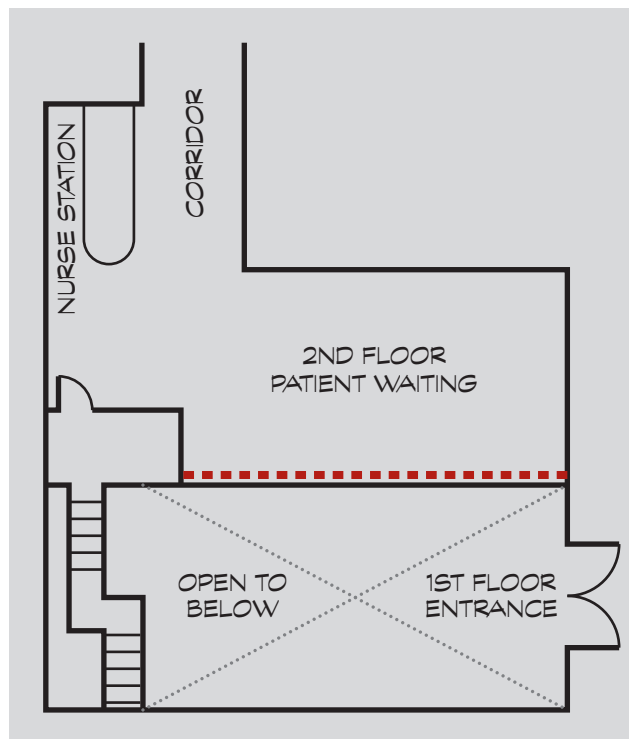
I-2 OCCUPANCIES - HOSPITALS/SMOKE PROTECTION

CASE 2: Vertical Acting without Egress



This case study presents two code challenges in one application. First, I-2 occupancies are not allowed to have two floors common unprotected, therefore, a complying shaft enclosure

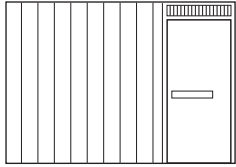
must be provided (Section 712.1.9). Second, the first floor area is considered the corridor serving in the means of egress and must be separated from the patient waiting area. McKEON provides a unique solution for this challenge with the FireFighter Model D400. This smoke and fire rated rolling curtain shutter is deployable and will only close when the building goes into emergency alarm. During normal business hours the entire 2-story space is free of any visual obstacles.



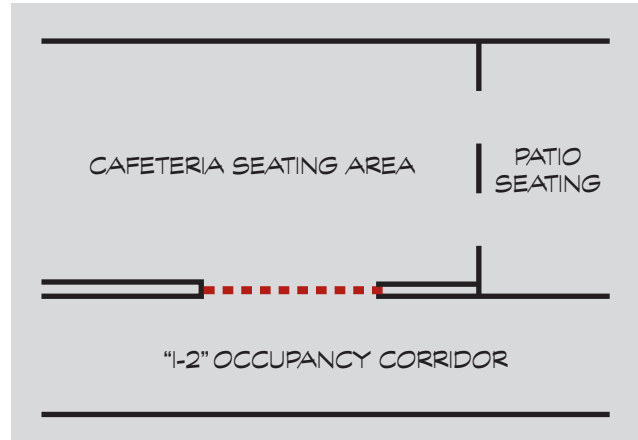
SIMULATION

I-2 OCCUPANCIES - HOSPITALS/SMOKE & FIRE PROTECTION

CASE 3: Side Acting Accordion with Complying Swing Egress Door

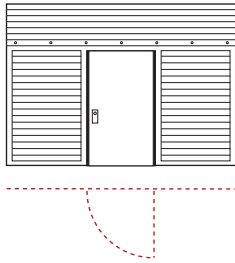


Due to local building code amendments, this application in a hospital corridor required a fire and smoke rated opening protective with conventional swing door egress. In the off hours this accordion can be closed to secure the cafeteria. Authorized access is possible through the swing door with cylinder lock.

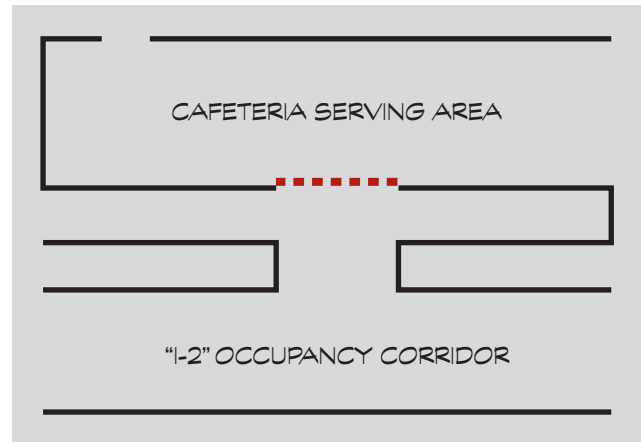


I-2 OCCUPANCIES - HOSPITALS/SMOKE & FIRE PROTECTION

CASE 4: Vertical Acting with Complying Swing Egress Door(s)

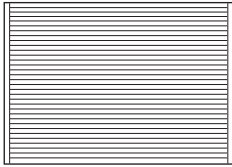


In this unique application, the McKEON T5000 technology, with integral code complying conventional egress doors, descends from the overhead space when the building goes into alarm. During normal business hours cafeteria patrons easily traverse the space from the corridor without obstruction.



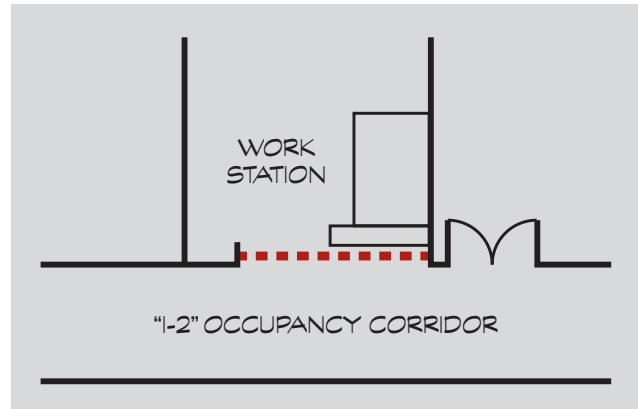
I-2 OCCUPANCIES - HOSPITALS/SMOKE & FIRE PROTECTION

CASE 5: Vertical Coiling without Egress



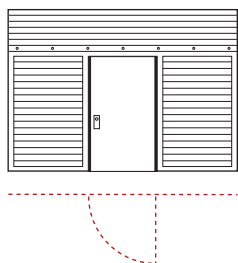
Egress is not required but a 2-hour fire rating is. This work station is left open during normal business hours. The protective assembly is easily lowered and locked after hours. Completely automated,

whether in fire or security mode, any building occupant can operate the assembly.

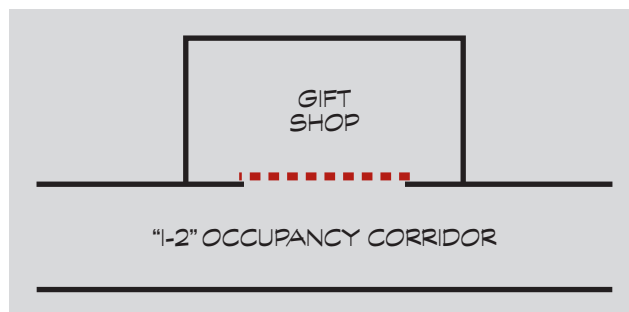


I-2 OCCUPANCIES - HOSPITALS/SMOKE & FIRE PROTECTION

CASE 6: Vertical Acting with Complying Swing Egress Door(s)



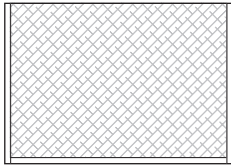
Incorporating the McKEON T5000 technology, the egress doors are completely concealed in the vertical space above, to close only in case of fire.



Gift shops are allowed to be open to the corridor where the total square footage does not exceed 500 square feet. (407.2.4) Areas larger must be protected from the corridor with 1-hour fire barrier construction. Gift shops and their associated storage offer a particular threat because of the potential fuel load created by large quantities of merchandise. The smaller the shop the lesser the threat of contents that are burning during a fire emergency. The code requires no separation at the corridor opening of a gift shop if the square footage is 500 square feet or less.

I-1 AND R OCCUPANCIES

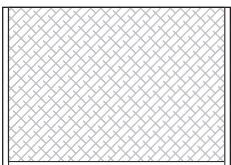
CASE 7: Vertical Acting without Egress



In this case study we will examine the requirements of the R-2 occupancy (congregate living facility with more than 16 occupants) pertaining to corridor rating and vertical space allowances. All corridors are required to be constructed of fire rated walls with a minimum rating of 30 minutes (1020.1). Also, these “R” occupancies cannot have unprotected 2-story openings (712.1.9, #4). These requirements can be challenging when spacious open designs are desired. Because the opening protectives for these walls can be rated 20-minutes (716.5.3), the McKEON FireFighter® D200 is the perfect solution. Take a look, too, at CASE 8. It is right across the hall!

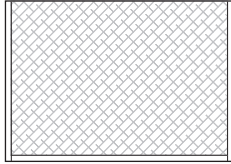


CASE 8: Vertical Acting without Egress

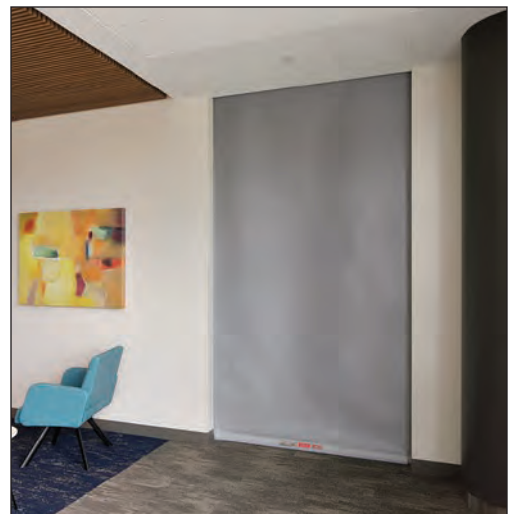


I-1 AND R OCCUPANCIES

CASE 9: Vertical Acting without Egress

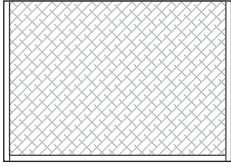


In this case study we will examine the requirements of the R-2 occupancy (congregate living facility with more than 16 occupants) pertaining to corridor rating and vertical space allowances. All corridors are required to be constructed of fire rated walls with a minimum rating of 30 minutes (1020.1). Also, these “R” occupancies cannot have unprotected 2-story openings (712.1.9, #4). These requirements can be challenging when spacious open designs are desired. Because the opening protectives for these walls can be rated 20-minutes (716.2.2.1), the McKEON FireFighter® D200 is the perfect solution.



B OCCUPANICES - to Include NFPA 101 Provisions

CASE 10: Vertical Acting without Egress



The photos at the right show a two-story convenience opening in a healthcare clinic which is classified as a 'B' or Business occupancy. Within the provisions of the IBC two floors can be common without separation and in this case

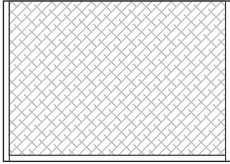
be considered an exit access stairway. However, this project was plan-checked and permitted using both the IBC and NFPA 101. Since NFPA 101 was more restrictive, additional separation was required.

NFPA 101, Section 8.6.6(4)(a) requires that all communicating spaces, beyond one story, be separated from the rest of the building. In sprinklered structures the separation can be smoke only. The design team chose to protect multiple floor openings with our wide-span SmokeFighter D150 smoke assemblies, closing only in case of fire.



B OCCUPANICES - to Include NFPA 101 Provisions

CASE 11: Vertical Acting without Egress



These photos feature a multi-story communicating space in the same facility as CASE 10, a healthcare clinic which is classified as a 'B' or Business occupancy. Within the provisions of the IBC two floors can be, under specific conditions, common without separation. However, this project was plan-checked and permitted using both the IBC and NFPA 101. Since NFPA 101 was more restrictive, additional separation was required.

NFPA 101, Section 8.6.9.1 requires that such openings shall not connect more than two adjacent stories (one floor pierced only) and be separated from the rest of the building. In sprinklered structures the separation can be a smoke partition (8.6.9.1(5)). The design team chose to protect the floor openings with our wide-span FireFighter D500S smoke assemblies, closing only in case of fire. The absence of mullions and posts was an attractive feature of this smoke partition.





7 | Smoke Compartmentation

Smoke Compartments - Healthcare

Smoke Barriers - Healthcare

Smoke Compartments – Healthcare

Section 407

The compartmentation requirements in these case studies are unique to hospital occupancies and are driven, for the most part, by means of egress provisions.

Fire & Life Safety Concerns

The code allows patient rooms to be arranged in open suites. However, this type of arrangement supposes a low patient-to-staff ratio where the staff is directly responsible for the safety of the patients in the event of a fire. To ensure safety, small smoke compartments with short-distance egress to protected exits become critical.

Code Requirements

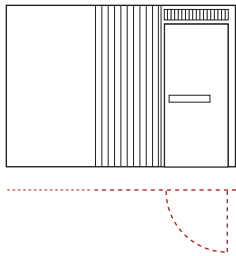
1. Habitable rooms or suites in Group I-2 occupancies shall have an exit access door leading directly to a corridor. (407.4.1)
2. Care suites containing patient sleeping rooms shall not exceed 7,500 square feet, sprinklered areas with automatic smoke detection, 10,000 square feet. (407.4.4.6.1)
3. Care suites containing other than patient sleeping rooms shall not exceed 12,500 square feet, sprinklered 15,000 square feet. (407.4.4.7.1)
4. Any patient sleeping room, or any care suite that includes patient sleeping rooms, of more than 1,000 square feet shall have at least two exit access doors remotely located from each other. (407.4.4.6.2)
5. Any room or suite of rooms other than patient sleeping rooms of more than 2,500 square feet shall have at least two access doors remotely located from each other. (407.4.4.7.2)

SMOKE COMPARTMENTATION

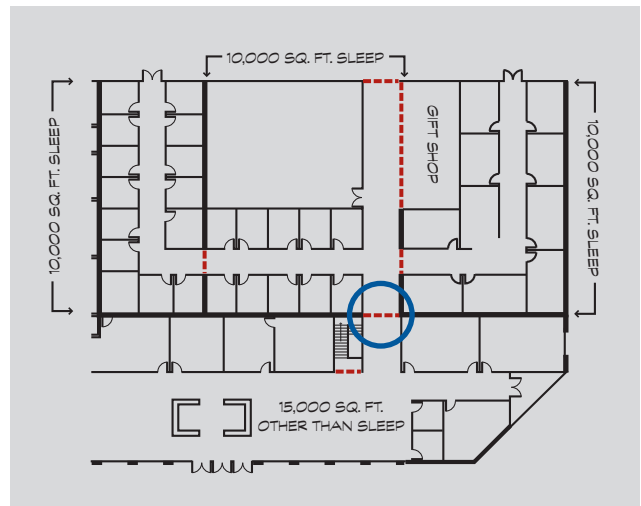
6. Travel distance between any point and an exit access door in a room not located in a care suite shall not exceed 50 feet. (407.4.2)
7. Travel distance between any point in a suite of sleeping rooms shall not exceed 100 feet, automatic smoke detection 125 feet. (407.4.4.3)
8. Vision panels are required in cross-corridor application of I-2 occupancies. (709.5.1)
9. Walls designed to create separate suites shall be construction as non-rated smoke partitions. (407.4.4.2)
10. Openings within smoke compartment walls that are not used to protect a vertical opening or an exit are not required to have a fire-rating but shall provide an effective barrier to limit the transfer of smoke. Also, these opening protectives do not have to be self-closing. (Section 407.3.1)

Design Solutions

CASE 1: Side Acting with Complying Swing Egress Door(s)

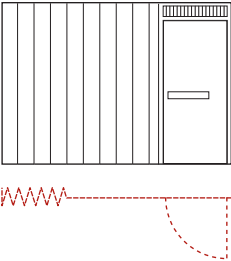


In this case study we find it difficult to maintain continuity with compartmentation when passing through corridors or other open areas with smoke partition walls. With the wide-span capabilities of the McKEON door assembly there is no compromise between building functionality and code compliance.

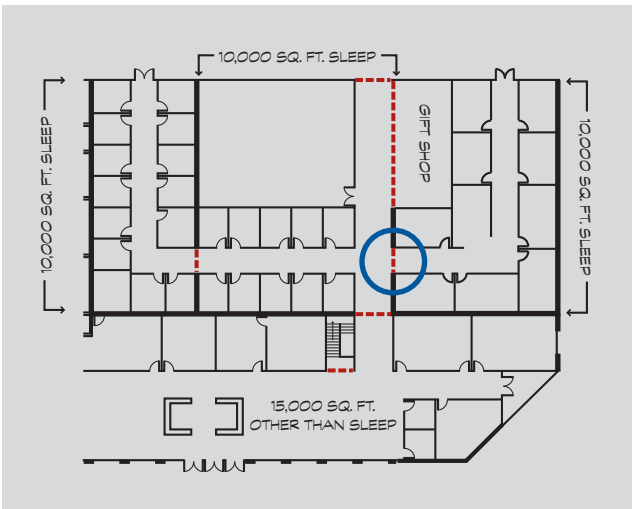


SMOKE COMPARTMENTATION

CASE 2: Side Acting Accordion with Complying Swing Egress Door

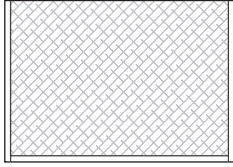


This side acting accordion offers conventional egress with a swing door attached to wide panels that provide a compact profile for less stack space.



SMOKE COMPARTMENTATION

CASE 3: Vertical Acting without Egress



Designing care suites, particularly critical units in large hospitals, can be challenging when complying with restrictive smoke compartment provisions. The maximum area limit in care suites containing patient sleeping rooms with sprinklers and automatic smoke detection is 10,000 square feet. This case study features a critical suite that far exceeds these limits. The SmokeFighter® D150 came to the rescue and provided necessary separation where head room was limited and side room would only allow for very discreet side guides.



SIMULATION

SMOKE COMPARTMENTATION

Inquiry Discussion and Questions

Often more desirable floor plans will be compromised to accommodate smoke compartmentation requirements. Rooms become smaller, corridors often inhibited with opening protectives, nurses stations altered, etc. to create life-saving smoke free spaces. Most often these adjustments become routine without an understanding of wide span opening protective technology.

The following questions may be helpful:

- May I show you how a smoke compartment separation can cross a corridor without compromising the space?

Notes:

Smoke Barriers - Healthcare

Section 709

Smoke barriers divide areas of a building into separate smoke compartments. These dividing walls allow building occupants time to be evacuated or relocated to other smoke compartments. In other words, smoke barriers separate portions of buildings into areas of refuge capable of resisting the passage of smoke and fire for 1 hour. (Section 709)

Fire & Life Safety Concerns

Smoke barriers are specifically required in I-2 (hospital) occupancies due to the non-ambulatory status of the building occupants (Section 407.5). Usually these occupants require assistance and care when being evacuated or relocated during an emergency. There must be a protected area where these patients can be placed until safely evacuated from the building. Smoke barriers in Group I-2 occupancies provide this defend-in-place mechanism.

Code Requirements

The following five requirements designate the use of smoke barriers in Group I-2 occupancies:

1. Group I-2 occupancies are required to subdivide every story into smoke compartments with an area not more than 22,500 square feet. (407.5)
2. Smoke compartments are to be divided using smoke barrier walls in accordance with Section 709. (407.5)
3. Smoke barriers are required to subdivide every story used by patients for sleeping or treatment with an occupant load of 50 or more persons into at least two compartments. (407.5)
4. Travel distance in smoke compartments shall not exceed 200 feet. (407.5.2)
5. Independent egress - A means of egress shall be provided from each smoke compartment created by smoke barriers without having to return through the smoke compartment from which means of egress originated. (Section 407.5.4)

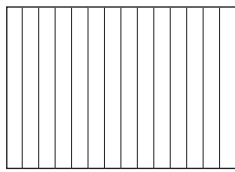
SMOKE COMPARTMENTATION

In order to accommodate an opening in a smoke barrier wall the following opening protective requirements must be met:

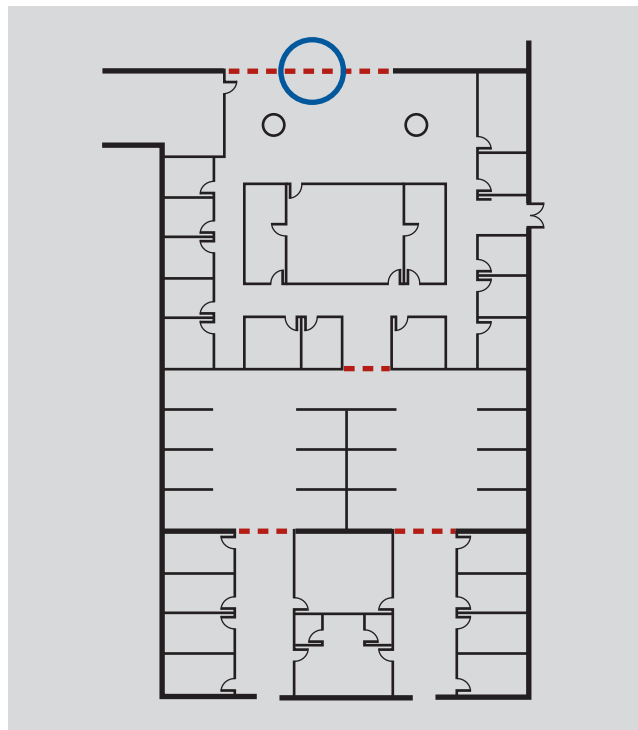
1. Minimum fire rating of 20 minutes. [Section 716.2.2.1 & Table 716.1(2)]
2. Vision panels. (709.5.1)

Design Solutions

CASE 1: Side Acting Accordion with Power-assisted Egress

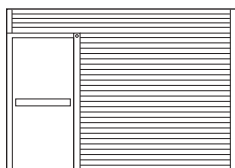


In this case study the intent is to add to an existing I-2 occupancy a 9,700 square foot Critical Care Suite. The existing building construction type is IIIA with 21,324 square feet and the desire is to have the new suite as open as possible to the existing hospital corridor system. The placement of a smoke barrier wall at this new addition connection is a specific code requirement in order to fall within the 22,500 square foot limitation. With the use of the McKEON wide-span labeled assembly approved for egress, the opening protective requirements are met without compromising the spacious clear open ambiance desired.

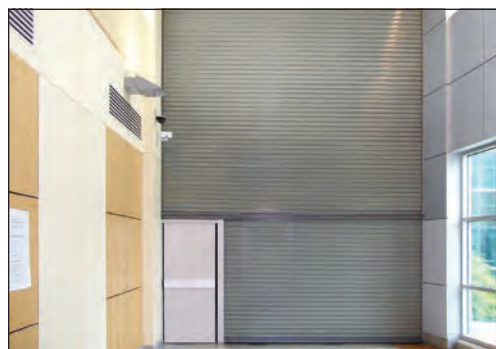
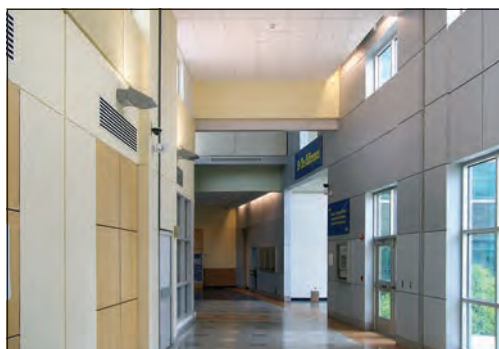


SMOKE COMPARTMENTATION

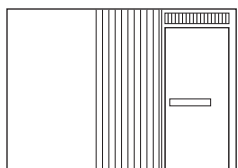
CASE 2: Vertical Coiling with Complying Swing Egress Door(s)



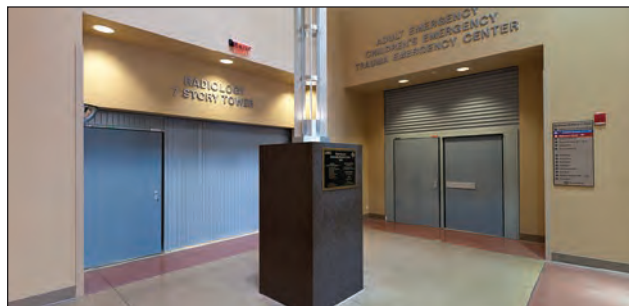
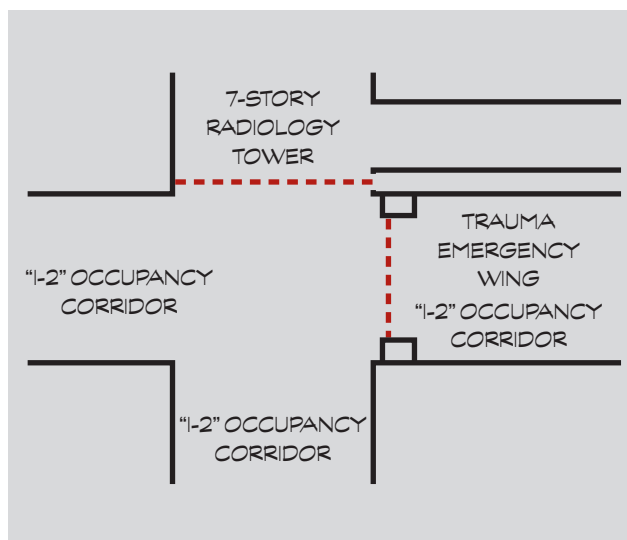
Regardless of the size of the space, smoke barriers must be maintained throughout the building. McKEON can easily protect these unusually large openings without compromising building ambiance.



CASE 3: Side Acting with Conventional Egress Door(s) & Vertical Acting with Complying Swing Egress Door(s)



These two very different technologies converge on the inside corner of the structure to complete the smoke barrier separation creating separate refuge area compartments. Operating as dual function assemblies they are also located to separate the corridors from additional spaces.



SMOKE COMPARTMENTATION

Inquiry Discussion & Questions

In principle, smoke compartmentation and smoke barrier separation are the same with minor differences. Smoke barriers are created using 1-hour rated walls (Table 716.5) and the separations are incurred at a minimum of 22,500 square feet. Smoke compartments are created using non-rated smoke partitions and the separations are incurred at a minimum of 10,000 square feet in suites of sleeping rooms and 15,000 square feet in non-patient room areas. Smoke compartment applications occur in Group I-2 occupancies/hospitals and smoke bar-

rier applications occur in Group I-2 and/or Group I-3 occupancies/prisons.

Helpful questions for smoke barrier applications can be found in the smoke compartmentation case study.

Notes:



8 | Resilient Construction

Storm Shelters

RESILIENT CONSTRUCTION

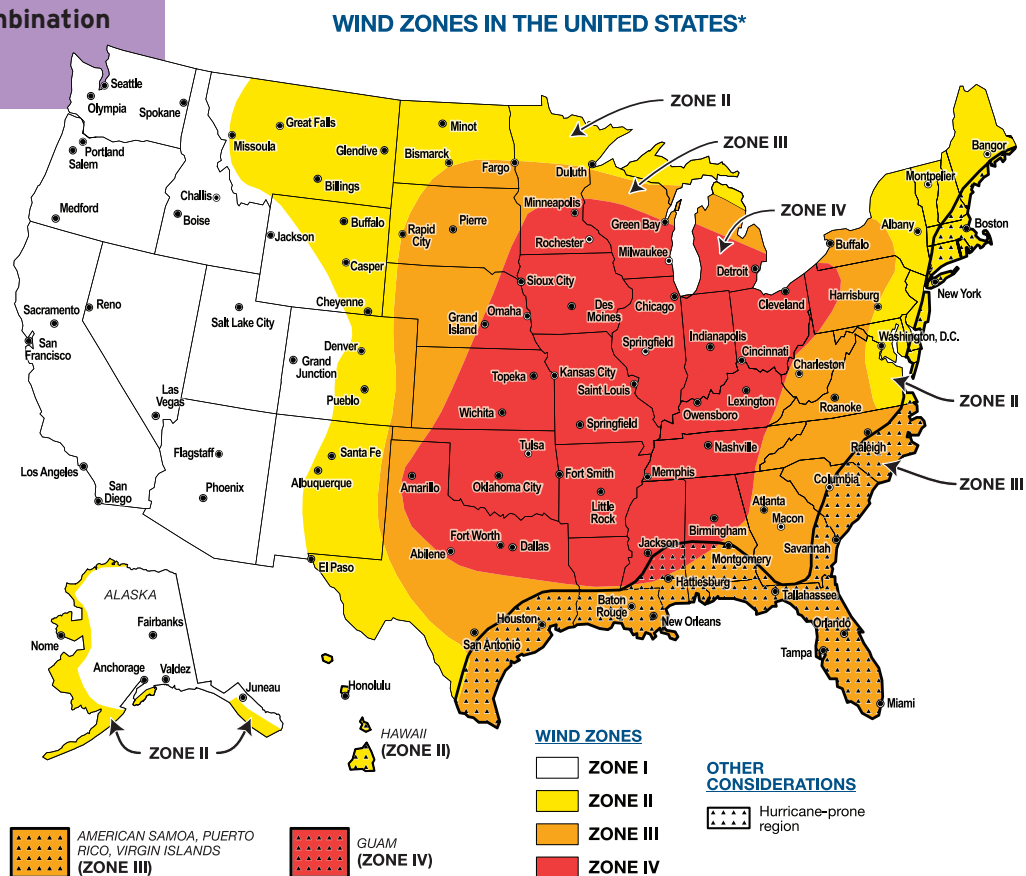
Storm Shelters

Section 423

Storm shelters can be constructed as separate detached buildings or as safe rooms within new or existing buildings. These types of structures are required to be designated hurricane shelters, tornado shelters or a combination thereof.

Fire & Life Safety Concerns

International Building Code committee staff worked closely with the Federal Emergency Management Agency (FEMA), in particular consulting the FEMA 361 Standard, when creating a formal ICC safety standard for buildings constructed in high-wind-load areas where tornadoes and hurricanes are a prevalent threat. The ICC 500 Standard has been adopted and incorporated into Section 423 of the code to provide safe areas of refuge from these storms.



* If you are uncertain of your location because of the level of detail and size of the map, or if you live on or near one of the delineation lines, use the highest adjacent wind zone.

RESILIENT CONSTRUCTION

Code Requirements

Section 423.3 Critical emergency operations. In areas where the shelter design wind speed for tornadoes in accordance with Figure 304.2(1) of ICC 500 is 250 MPH, 911 call stations, emergency operation center and fire, rescue, ambulance and police stations shall comply with Table 1604.5 as a Risk Category IV structure and shall be provided with a storm shelter constructed in accordance with ICC 500.

Section 423.4 Group E occupancies. In areas where the shelter design wind speed for tornadoes is 250 MPH in accordance with Figure 304.1(1) of ICC 500, all Group E occupancies with an aggregate occupant load of 50 or more shall have a storm shelter constructed in accordance with ICC 500.

Exceptions:

1. Group E day care facilities
2. Group E occupancies accessory to places of religious worship
3. Buildings meeting the requirements for shelter design in ICC 500

716.2.6 Fire door hardware and closers. Fire door hardware and closers shall be installed on fire door assemblies in accordance with the requirements of this section.

716.2.6.1 Door closing. Fire doors shall be latching and self- or automatic-closing in accordance with this section.

Exceptions:

3. Fire doors required solely for compliance with ICC 500 shall not be required to be self-closing or automatic-closing.



The SafeSpace 500 was subjected to both a positive and a negative wind load.



Missile impact test proves ability to withstand wind-borne debris from a hurricane or tornado.

RESILIENT CONSTRUCTION



SafeSpace™ Model 500X

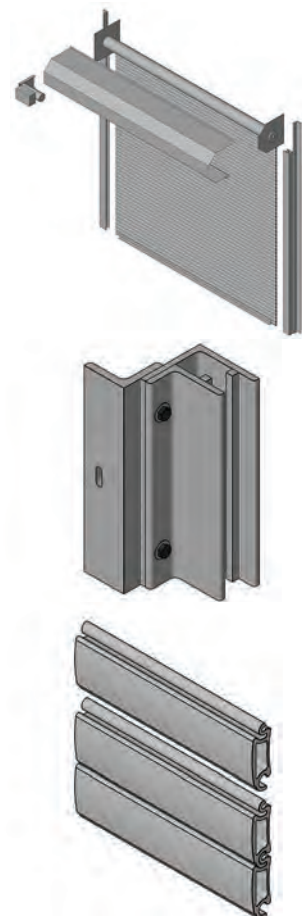
The SS500X is completely redesigned - without the use of conventional steel slats. It is the ideal vertical rolling tornado and hurricane resistant shutter.

- Larger maximum size and smaller minimum size
- Tested and labeled in compliance with the ICC500 2020 criteria
- Extruded from a lightweight alloy
- Carries a lower profile
- Made specifically for non-fire rated applications

Additional Protection Features

The SafeSpace™ 500X is a robust ICC 500 compliant assembly that also complies with the following criteria:

- Tested and listed for Forced Entry Resistant Door criteria of ASTM F3038 for 60 minutes
- Tested and listed for a Level 1 bullet resistance rating in accordance with UL 752.



RESILIENT CONSTRUCTION

Characteristics of the McKEON SafeSpace™ Models

	SafeSpace™ 500	SafeSpace™ 500F	SafeSpace™ 500X
ICC 500	2020	2020	2020
FIRE RATING	N/A	3 HOURS/UL10B	N/A
HURRICANE PSF	+201 / -201	+201 / -201	+201 / -201
TORNADO PSF	+252 / -252	+252 / -252	+252 / -252
HURRICANE IMPACT	15 LBS. @ 100 MPH	15 LBS. @ 100 MPH	15 LBS. @ 100 MPH
TORNADO IMPACT	15 LBS. @ 100 MPH	15 LBS. @ 100 MPH	15 LBS. @ 100 MPH
MINIMUM SIZE	4'-4" W x 4'-0" H	4'-4" W x 4'-0" H	2'-10" W x 3'-6" H
MAXIMUM SIZE	16'-4" W x 18'-0" H	16'-4" W x 18'-0" H	20'-3 1/2" W x 18'-0" H
SLAT CONSTRUCTION	STEEL	STEEL	LIGHT WEIGHT ALLOY
ASTM (Forced Entry Resistant)	N/A	N/A	1 HOUR
UL 752 (Bullet Resistant)	N/A	N/A	LEVEL 1

RESILIENT CONSTRUCTION

Resilient Door Operator

The FES-EP SafeSpace™ operator by McKEON is a multi-function system that can be set in the field. For example, it can be set for automatic self-closing or not depending upon the current provisions in the model building codes and standards. The ICC 500 Standard for the Design and Construction of Storm Shelters allows a room or area within a larger building to be designed as a storm shelter, and requires the walls separating the storm shelter from the remaining portions of the host building to be constructed as 2-hour fire barriers, even if the IBC does not require a 2-hour rating.

The 2020 edition of ICC 500 provided an exception to the requirement for door closers – in the situation where the fire-resistance rated wall is only required to separate a storm shelter from a host building. Any doors in the wall would still have to be fire-rated, but they would not have to include self or automatic closers. When large numbers of people need to enter the shelter quickly, such as for a tornado warning, exempting these doors from closers would allow for a constant flow of occupants seeking shelter without being interrupted by the door closing whenever someone releases the door.

Once people have entered the shelter, all openings can be secured from the inside by the personnel responsible for operating the shelter, or if necessary, by shelter occupants. Once the shelter doors are closed, the openings in the fire-resistance rated walls would be protected. When the storm is over, no closers would also allow for a smoother flow for egress.

ICC 500 Standard

603.1.1 Doors and shutters. *Fire doors and shutters in fire barriers required solely for compliance with Section 603.1 shall not be required to be self- or automatic-closing.*

IBC, 2024 Edition

716.2.6.1 Door closing. *Fire doors shall be latching and self- or automatic-closing in accordance with this section.*

Exceptions:

3. Fire doors required solely for compliance with ICC 500 shall not be required to be *self-closing* or automatic-closing.

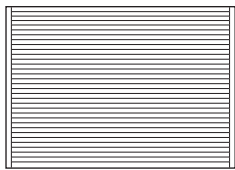


RESILIENT CONSTRUCTION

Design Solutions

In the case studies that follow the McKEON SafeSpace™ Models 500 and 500X are featured - opening protectives that comply with the stringent requirements of FEMA 361. Specifically passing the ASTM E1886 based missile impact test and withstanding wind pressures at 252 psf in accordance with ASTM E330, designers can now create large openings in exterior walls of ICC 500 compliant structures or compliant spaces within structures. Please note: When required the SafeSpace 500 can be labeled with a UL 10B 3-hour fire rating and UL 1784 smoke rating, the SafeSpace 500F model.

CASE 1: Vertical Coiling without Egress

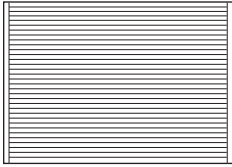


This elementary school cafeteria addition was required to comply with the FEMA 361/ ICC 500 provisions. Without the SafeSpace™ 500 the three large window openings in the front of the structure would not have been possible. The cafeteria entrances would have been limited to small swing door openings and the space would have had to be artificially lit. The casual observer would not know this addition is tornado safe, it looks like a typical school multi-purpose cafeteria!



RESILIENT CONSTRUCTION

CASE 2: Vertical Coiling without Egress

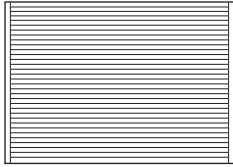


Located within the 250 MPH wind zone, a two-story summer camp facility turned the lower level into a storm shelter. With SafeSpace™ 500 technology the structure is compliant without sacrificing natural light and appearance.



RESILIENT CONSTRUCTION

CASE 3: Vertical Coiling without Egress



Similar to the previous cases, this beautiful library in the Ida Freeman Elementary School is also a tornado shelter. Thanks to SafeSpace™ 500 technology large windows and storefront doors let in plenty of daylight. It is easy to imagine that this area is simply a spacious, inviting area for reading and learning.



RESILIENT CONSTRUCTION

Inquiry Discussion and Questions

Often design teams struggle with creating storm shelters because the code seems to allow openings no larger than the typical ICC 500 rated swing doors. Rolling steel assemblies that are FEMA 361/ICC 500 compliant offer design flexibility and allow the space to meet the requirements of a resilient structure. When incorporating a storm shelter into a typical non-FEMA rated structure this same design flexibility is available with the SafeSpace™ technology because in most cases the separation walls are required to be fire and smoke rated as well.

The following questions may be helpful:

- Are you concerned the structure under design will look like a “prison” when the require-

ments of ICC 500 or FEMA 361 are a part of your design?

- Did you know that if your jurisdiction is the recipient of FEMA funding, it is possible that associated construction may have to follow the FEMA 361 guidelines?
- Do you know if the area wherein you are designing an E occupancy or emergency operations facility structure is under the provisions of FEMA 361 or ICC 500?
- Are there projects where there is a desire to have the SS500X provide multiple protections to include the forced entry and/or ballistics?

Notes:



Appendix

Definitions

Resources

DEFINITIONS

Fire Walls - Section 706

Definition

A fire-resistance-rated wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall. (202)

Fire Ratings: (Table 706.4)

2-hour

3-hour

4-hour

Opening Protection: (706.8)

Non-sprinklered buildings - Openings shall not exceed 156 square feet and the aggregate width of openings shall not exceed 25 percent of the length of the wall.

Sprinklered buildings - Openings may exceed 156 square feet but the aggregate width of all openings shall not exceed 25 percent of the length of the wall.

Design Notes

- Each portion of a building separated by one or more fire walls shall be considered a separate building. (503.1)
- 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. (706.1)
- Regardless of the rating of the opening protective, fire walls cannot have openings that exceed 25 percent of the length of the wall. (706.8)
- Fire walls constructed as party walls shall NOT have openings. (706.1.1)

Applications

- Exceeding area allowances (Tables 504.3, 504.4, 506.2)
- Horizontal Exits (1026)

DEFINITIONS

Fire Barriers - Section 707

Definition

A fire-resistance-rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained. (202)

Fire Ratings: (Tables 716.1(2); 707.3.10)

1-hour
2-hour
3-hour
4-hour

Opening Protection

Non-sprinklered Buildings - Openings shall be limited to a maximum aggregate width of 25 percent of the length of the wall, and the maximum area of any single opening shall not exceed 156 square feet. (707.6)

Sprinklered Buildings - Openings may exceed 156 square feet but must be limited to a maximum aggregate width of 25 percent of the length of the wall, unless the opening protective assembly has been tested in accordance with ASTM E119 and has a minimum fire-resistance rating not less than the fire-resistance rating of the wall. (707.6 Exceptions #1 & #3)

Design Notes

- A fire barrier may have an opening exceed the 25 percent rule if the building is sprinklered and the opening protective assembly is tested under the provisions of ASTM E-119. As seen below, most fire-rated walls used in building design will fall under Section 707, Fire Barrier Walls.

Applications

- Shaft Enclosures (713.4)
- Interior Exit Stairways (1023.1)
- Exit Passageways (1024.3)
- Horizontal Exits (1026.1)
- Atriums (404.6)
- Incidental Use Areas (Table 509)
- Control Areas (414.2.4)
- Separated Occupancies (Table 508.4)
- Fire Areas (Table 707.3.10)
- Enclosures for Exit Access Stairways (713.4; 1019.3)

DEFINITIONS

Fire Partitions - Section 708

Definition

A vertical assembly of materials designed to restrict the spread of fire in which openings are protected. (202)

Fire Ratings (708.3)

1-hour

1/2-hour (708.3, Exceptions #1 & #2)

Opening Protection

Opening protectives in fire partitions shall have a minimum fire rating of 20 minutes and a maximum of 45 minutes [Table 716.1.(2)] and shall be smoke tested under UL 1784. (716.2.2.1)

Design Notes

- Most rated corridor walls fall into this category. (708.1 and Table 1020.1)
- Typically corridor walls are not required to be rated unless the structure is non-sprinklered. (Table 1020.1)

Applications

- Separation walls as required by Section 420.2 for Groups I-1, R-1, R-2 and R-3 (708.1, Item #1)
- Egress balconies (708.1, Item #5)
- Walls separating tenant spaces in covered mall buildings as required by Section 402.4.2.1 (708.1, Item #2)
- Corridor walls as required by Section 1020.1 (708.1, Item #3)
- Elevator lobby separation as required by Section 3006.2 (708.1, Item #4)

DEFINITIONS

Smoke Barriers - Section 709

Definition

A continuous membrane, either vertical or horizontal, such as a wall, floor, or ceiling assembly that is designed and constructed to restrict the movement of smoke. (202)

Fire Ratings (709.3)

1-hour

Opening Protection

Opening protectives in smoke barriers shall have a minimum 20 minute fire rating and UL 1784 smoke test rating. [Table 716.1.(2)]

Design Notes

- Door assemblies in cross-corridor smoke barriers of I-2 Occupancies (Hospitals) shall have vision panels. (709.5.1)
- Smoke barriers constructed of minimum 0.10-inch-thick steel in I-3 Occupancies (Jails & Prisons) are not required to be 1-hour rated. (709.3)

Applications

In I-2 Occupancies (Hospitals) smoke barriers are required to subdivide every story used by patients for sleeping or treatment. (407.5) As per the following:

- 50 or more persons / minimum 2 smoke compartments
- Each compartment cannot exceed 22,500 square feet
- Travel distance shall not exceed 200 feet to a smoke barrier door

In I-3 Occupancies (Jails & Prisons) smoke barriers are required to divide every story occupied by residents for sleeping. (408.6) As per the following:

- 50 or more persons / minimum 2 smoke compartments
- Maximum number of residents in any smoke compartment is 200
- Travel distance to any exit access component shall not exceed 150 feet
- Travel distance to any smoke barrier door shall not exceed 200 feet

DEFINITIONS

Smoke Partitions - Section 710

Definition

A partition constructed to limit the transfer or passage of smoke. (710.4)

Fire Ratings

Non-rated (710.3)

Opening Protection

Door assemblies shall be UL 1784 tested and self closing by smoke detection. (710.5.2.2)

Design Notes

- Corridor walls in an I-2 Occupancy (Hospital) shall be constructed as Smoke Partitions. (407.3 & 710)

Applications

- Corridor walls of I-2 Occupancies (Hospitals) (407.3)
- Elevator Lobbies (3006.3, Item #2)
- Separation of care suites in Group I-2 Occupancies (407.4.4.2)

International Building Code, 2024

Means of Egress (AC8800 Series)

1010.1.2 Door Swing. Egress doors shall be side-hinged swinging.

Exceptions:

6. In other than Group H occupancies, horizontal sliding doors complying with Section 1010.3.3 are permitted in a means of egress.

1010.3.3 Special purpose horizontal sliding accordion or folding doors. In other than Group H occupancies, horizontal sliding doors permitted to be a component of a means of egress in accordance with Exception 6 to Section 1010.1.2 shall comply with all of the following criteria:

1. The doors shall be power operated and shall be capable of being operated manually in the event of power failure.
2. The door shall be openable by a simple method from both sides without special knowledge or effort.
3. The force required to operate the door shall not exceed 30 pounds (133 N) to set the door in motion and 15 pounds (67 N) to close the door or open it to the minimum required width.
4. The door shall be openable with a force not to exceed 15 pounds (67 N) when a force of 250 pounds (1100 N) is applied perpendicular to the door adjacent to the operating device.

5. The door assembly shall comply with the applicable fire protection rating and, where rated, shall be self-closing or automatic closing by smoke detection in accordance with Section 716.2.6.6 and shall be installed in accordance with NFPA 80 and shall comply with Section 716.
6. The door assembly shall have an integrated standby power supply.
7. The door assembly power supply shall be electrically supervised.
8. The door shall open to the minimum required width within 10 seconds after activation of the operating device.

NFPA 101 Life Safety Code, 2024

Means of Egress

7.2.1.4 Swing and Force to Open

7.2.1.4.1(4)(a), (b), (c) Special-purpose horizontally sliding accordion or folding door assemblies complying with 7.2.1.13 shall be permitted.

7.2.1.13 Special-Purpose Horizontally Sliding Accordion or Folding Door Assemblies.

Special-purpose horizontally sliding accordion or folding door assemblies shall be permitted in a means of egress, provided that the following criteria are met:

1. The door leaf is readily operable from either side without special knowledge or effort.
2. The force that, when applied to the operating device in the direction of egress, is required to operate the door leaf is not more than 15 lbf (67 N).
3. The force required to operate the door leaf in the direction of door travel is not more than 30 lbf (133 N) to set the leaf in motion and is not more than 15 lbf (67 N) to close the leaf or open it to the minimum required width.
4. The door leaf is operable using a force of not more than 50 lbf (222 N) when a force of 250 lbf (1100 N) is applied perpendicularly to the leaf adjacent to the operating device, unless the door is an existing special-purpose horizontally sliding accordion or folding exit access door assembly serving an area with an occupant load of fewer than 50.
5. The door assembly complies with the fire protection rating, if required, and, where rated, is self-closing or automatic-closing by means of smoke detection in accordance with 7.2.1.8 and is installed in accordance with *NFPA 80, Standard for Fire Doors and Fire Windows*.

INTERTEK Code Compliance Research Reports

CCRR 1086 Fire Doors and Fire Shutters

CCRR 0455 Smoke Curtains and Fire Curtains

CCRR 0500 Tornado and Hurricane Resistant Doors

For access to these reports:

- Download from the Intertek website: intertek.com/building/ccrr/
- Download from the McKEON website: McKeonDoor.com/regulatory-approvals/

International Building Code, 2021

202 Definitions, 716 Opening Protectives, Referenced Standards

The development and final vote of the following code sections have been completed and will be published in the 2021 edition of the IBC:

Section 202 Definitions

FIRE PROTECTIVE CURTAIN ASSEMBLY. An assembly consisting of a fabric curtain, bottom bar, guides, coil, operating and closing system.

Section 716 Opening Protectives

716.4 Fire protective curtain assembly. Approved fire protective curtain assemblies shall be constructed of any materials or assembly of component materials tested without hose stream in accordance with UL 10D, and shall comply with Sections 716.4.1 through 716.4.3.

716.4.1 Label. Fire protective curtain assemblies used as opening protectives in fire rated walls and smoke partitions shall be labeled in accordance with 716.2.9.

716.4.2 Smoke and draft control. Fire protective curtain assemblies used to protect openings where smoke and draft control assemblies are required shall comply with Section 716.2.1.4.

716.4.3 Installation. Fire protective curtain assemblies shall be installed in accordance with NFPA 80.

Referenced Standards

UL 10D-17, Standard for Fire Tests of Fire Protective Curtain Assemblies (shown below).

4

FIRE TESTS OF FIRE-PROTECTIVE CURTAIN ASSEMBLIES - UL 10D

SEPTEMBER 29, 2017

INTRODUCTION

1 Scope

1.1 These requirements cover the evaluation of fire-protective curtain assemblies intended to provide supplemental, passive fire protection as part of an engineered fire protection system. Fire-protective curtain assemblies are horizontally or vertically oriented. Horizontally or vertically oriented fire-protective curtain assemblies provide nonstructural separation only, and are not intended to be substituted for structural hourly rated partitions or opening protectives that have been tested for fire endurance and hose stream performance.

RESOURCES

McKEON Curtain Systems Egress Feature

All SmokeFire® and FireFighter® models that incorporate the egress feature are intended for conditional use in low occupant load applications. The smoke or smoke and fire rated swinging curtain door complies with all exit door requirements in IBC, Chapter 10, Means of Egress, with the exception of the 32/80 rule. In simple terms, a required exit door must open a minimum of 32 inches in width and 80 inches high. Consult the following page for details regarding opening widths and heights.

Code Requirements

Section 1010.1.2 Door Swing. Egress doors shall be of the pivoted or side-hinged swinging type.

The SmokeFighter and FireFighter egress doors include a hinged bottom bar located at 90 degrees to the fabric so that when the fabric is pushed to the open position both bottom bar and fabric easily swing providing complying egress width to allow building occupants to exit.

Section 1010.1.1 Size of doors. The required capacity of each



RESOURCES

door opening shall be sufficient for the occupant load thereof and shall provide a minimum clear opening width of 32 inches (813 mm) ... The minimum clear opening height of doors shall be not less than 80 inches (2032 mm).

The following photo/dimensions and table will help you determine compliance with this code requirement.



Product	Opening Height from Floor	Opening (swing) Force (LBF)	Opening Dimensions
Smoke and Fire Curtains	18"	Less than 1/2 lbf	36"
Smoke and Fire Curtains	36"	Less than 1/2 lbf	22 1/2"
Smoke and Fire Curtains	54"	Less than 1/2 lbf	20"
Smoke and Fire Curtains	72"	Less than 1/2 lbf	12"
Smoke and Fire Curtains	84"	Less than 1/2 lbf	6"

Section 1010.1.3 Door opening force ... the door latch shall release when subjected to a 15-pound (67 N) force. The door shall be set in motion when subjected to a 30-pound (133 N) force. The door shall swing to a full-open position when subjected to a 15-pound (67 N) force.

The following test data confirms that the SmokeFighter and FireFighter egress feature complies with these requirements.



Flexible Fabric Door Compliance Test

Force A (LBF) Opening force to set egress in motion, hook & loop ripped open	26
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Force B (LBF) Swing force to swing egress door to fully open position	0.5
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Force C (LBF) Force required to hold egress door in the fully open 90 position	4
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Height	34"
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ADA Notes:

- Doors designated as fire doors must have the minimum opening force allowed by the local authority.
- Interior accessible doors should require no more than 5 lbs. of force to open.
- Threshold cannot be higher than 1/2 inch at accessible doors.



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This edition of *Fire Door Systems, A Guide to Code Compliance* is based on the 2000 through 2024 editions of the IBC. Regardless of the edition currently adopted by your jurisdiction, the fundamental code principles discussed herein apply to all editions of the IBC through 2024.

