

McKEON DOOR COMPANY

Fire Door Systems

A Guide to Code Compliance



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McKeon Door Company

44 Sawgrass Drive • Bellport, NY 11713

Phone: 800-266-9392 • Fax: 631-803-3030

www.McKeonDoor.com • E-mail: info@mckeondoor.com

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Introduction

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 decade 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.

THE McKEON DOOR COMPANY develops and manufactures numerous fire and smoke 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.

Elevator Separation

- Elevator Lobby
- Elevator Smoke & Draft



Elevator Lobby

Section 713.14.1

The elevator lobby is designed to isolate the fire-rated elevator shaft enclosure and its doors from the remainder of the floor on which it opens. The building code does not require this separation until the elevator shaft enclosure connects more than three stories. (713.14.1)

Fire & Life Safety Concerns

Elevator shafts commonly represent the greater quantity of inter-connecting vertical shafts in multi-story buildings. These shafts become conduits for heat, smoke and other toxins from the fire floor(s) to additional floors.

Code Requirements

713.14.1 Elevator lobby. An elevator lobby shall be provided at each floor where a elevator shaft enclosure connects more than three stories. The lobby enclosure shall separate the elevator shaft enclosure doors from each floor by fire partitions. In addition ... doors protecting openings in the elevator lobby enclosure walls shall comply with Section 716.5.3 as required for corridor walls ...

Exception #1 – Not required at the street floor when the entire floor is sprinklered.

Exception #2 – Elevators that are not required to be located in a shaft in accordance with Section 712.1.

Exception #3 – Where additional doors are provided at the hoistway opening complying with UL 1784. In this case a swing door may be placed at the point of access to the car, however it is important to note that each opening must be protected individually.

Exception #4 – Lobbies are not required as long as the entire building is sprinklered. However, this exception does not apply to Group I-2, I-3 and in structures greater than 75 feet in height. Ironically, this is an exception within an exception.

Exception #5 – Smoke partitions (non-rated) can be used in lieu of fire partitions to create the lobby as long as the entire building is sprinklered.

Exception #6 – Not required when the hoistway is pressurized.

Exception #7 – Not required in open parking garages in accordance with Section 406.5.

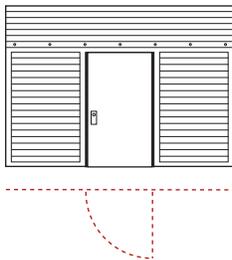
Design Solutions

The design of an elevator lobby is typically the least intrusive and least expensive option in multi-story buildings for separating the shaft enclosure from the floor upon which it opens. A diverse line-up of McKeon door assemblies can easily accommodate radius applications, wide-span openings and egress. The use of a wide-span opening protective eliminates the need for cased openings or jambs and allows for recessed installation in walls and ceilings.

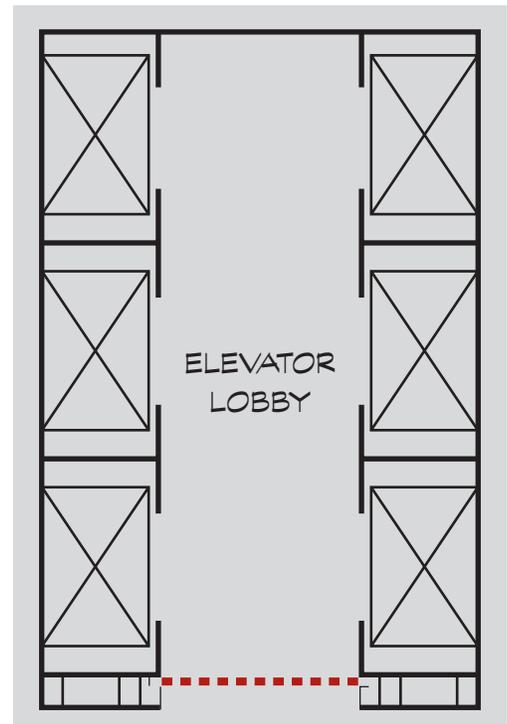
Whether protecting single or multiple openings, this technology allows a clear open appearance without sacrificing fire and life safety compliance. Conventional swing egress doors may be incorporated when required and offer the building occupant egress recognition when in panic mode during an emergency.

The following case studies feature multiple elevator car openings protected at the lobby entrance with a single opening protective. This solution is unobtrusive, saves money and provides the ultimate in fire and life safety – a lobby that functions as an area of refuge.

● Case Study 1: Vertical Acting with Complying Swing Egress Door(s)

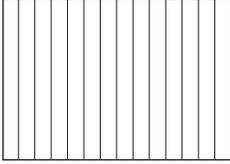


Our first case study features a vertical rolling steel door technology that incorporates a conventional egress door. Since head room was plentiful and side stacking room was not available, this vertical acting assembly was chosen.

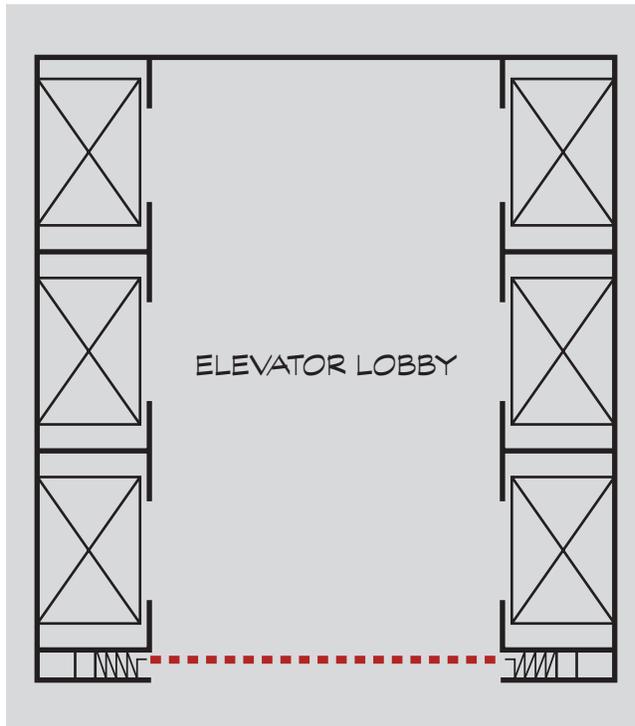


ELEVATOR SEPARATION

● Case Study 2: Side Acting Accordion with Power-assisted Egress

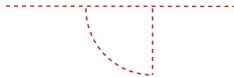
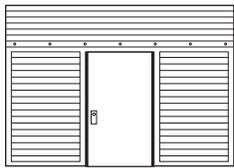
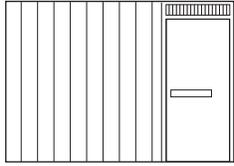


Unlike the previous case study, there is no headroom and side stacking space is limited. The McKeon bi-parting accordion fire door technology stepped up to meet the demand of hi-end design without compromising specific code requirements including conforming side acting accordion fire door egress acceptance.

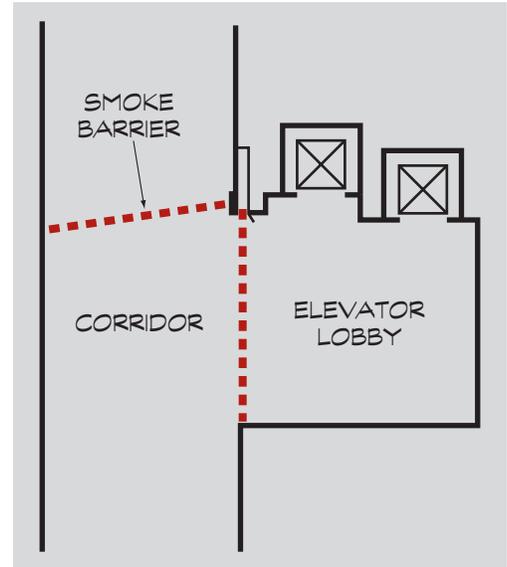


ELEVATOR SEPARATION

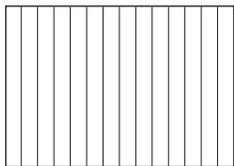
- **Case Study 3:** Side Acting Accordion with Complying Swing Egress Door & Vertical Acting with Complying Swing Egress Door(s)



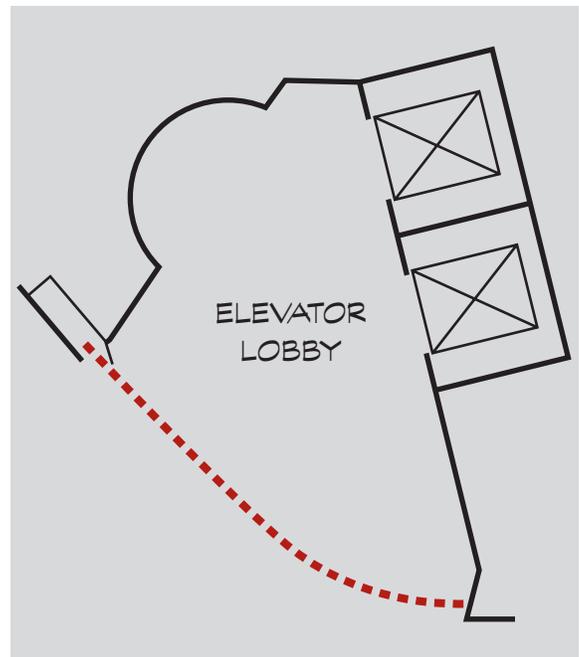
This case study includes both a side acting accordion with conventional egress elevator lobby separation and a vertical acting with conventional egress smoke barrier opening protective.



- **Case Study 4:** 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.



Inquiry Discussion & Questions

The charging language, as well as any one of the above listed seven exceptions will allow the designer to comply with the elevator shaft enclosure separation requirements. The seven options are a combined total of both active and passive systems. For example sprinkler systems or shaft pressurization systems are active systems that either move water or air as discussed in Exceptions #1 and #6. These are considered active systems because when there is an alarm these mechanical devices go into action and actually control the fire with water or move enough air in the elevator hoistway shaft to eliminate smoke from entering.

Passive systems are best illustrated by Exceptions #3 and #4. When the building goes into alarm enclosures are formed either around the elevator space or at the point of access to the car in order to stop smoke from spreading. Similar to fixed walls these enclosures are considered passive because they are non-mechanical and do nothing to control or eliminate fire and smoke, the enclosures simply block it from passage. Most often passive and active systems compliment each other as prescribed in Exception #5.

Along with fire and life safety concerns, the design professional must consider two additional critical areas – cost and appearance. The optimum circumstance is to have a non-obtrusive ambiance at minimal cost, regardless of the diverse individuality of each building design. Listed below are fundamental principles, as associated with several of the exceptions, combined with pertinent questions to address possible solutions:

- **Exception #3** allows protection at the point of access to the car without creating a lobby as long as the provisions of UL 1784 are met. This exception allowing the opening protective to be located at the point of access to the elevator car does not require the protective to be fire rated because the hoistway doors are fire rated. However, hoistway doors are not smoke rated, therefore, an opening protective at the point of access working in conjunction with the rated hoistway door functions as one assembly to meet both fire and smoke requirements. First, let's examine two potential technologies as solutions:

Individual side-hinged swing doors – From the cost perspective this is certainly a less expensive option. From the appearance and functionality of the space point of view this option is very difficult. The swing door must be held open on an electromagnetic catch that is mounted adjacent the hinged side of the door. This requires large areas of wall space to accommodate the width of the swing door which must be equal to the width of the elevator car door opening located

next to the car opening. This is nearly impossible to accomplish with multiple elevator door openings and elevator control buttons.

Also, the following language in the code presents challenges in minimum width corridors – rated or non-rated:

- (IBC) **1005.7.1 Door encroachment.** Doors opening into the path of egress travel shall not reduce the required width to less than one-half during the course of swing. When fully open, the door shall not project more than 7 inches (178 mm) into the required width.

In order for the elevator car opening to accommodate a side-hinged swinging door assembly the jamb must be framed and cased as well as electrical rough-in and hardware finish for the hold-open device installed. In multiple elevator car door applications it is questionable as to any significant cost savings. Obviously appearance is very undesirable whether in single or multiple applications.

- (IBC) **3002.6 Prohibited doors.** Doors, other than the hoistway doors and the elevator car door, shall be prohibited at the point of access to an elevator car unless such doors are readily openable from the car side without a key, tool, special knowledge or effort.

Vertical Rolling Barriers – Any vertical assembly placed at the point of access to a elevator car, regardless of composition of the materials, is prohibited unless it complies with Section 3002.6 as stated above (See Section 713.14.1, Exception #3). It must be noted that motor operated push-buttons that are battery operated would require special knowledge. The building occupant cannot be expected to wait until the vertical device lifts to the minimum 80-inch height before exiting. Should the battery not be charged it would require special effort that cannot be exerted by the disabled, handicapped, weak or small in stature building occupant. Also, to manually operate a vertical device at power failure would at the very least require special knowledge. Therefore, vertical rolling barriers that do not meet all the exiting criteria located in Chapter 10, Means of Egress are not approved by the building code as conforming exit doors in a means of egress.

Until recent acceptance of Accessibility provisions the elevator car was not a component of the means of egress system. Therefore an elevator car was not considered an occupied space in the building. This reasoning was based on the premise that when a building goes into fire alarm the elevators would lock-out (not be accessible from any other floor) and immediately return to the ground floor thereby disallowing any building occupant to ingress or egress the elevator

car until it was safely out of danger. Should the elevator malfunction and stop on an intermediate floor it would then be necessary to allow the elevator car occupant(s) to choose whether or not to exit the car. Any protection at the point of access to the elevator car at this juncture must comply with egress provisions.

However, the introduction of the International Building Code brought with it Accessibility provisions in Section 1007 specifically placing elevators as a component of the Exit and Exit Access portions of the Means of Egress system in buildings four stories or more in height. Therefore anything placed at the point of access to an elevator car must conform to the requirements of a required exit assembly. Additionally, in buildings with an occupied floor more than 120 feet above the lowest level of fire department access, two fire service access elevators are required (403.6.1).

In other than R-2 occupancies, buildings greater than 420 feet in height shall have one additional exit stairway, or, by exception, provide occupant evacuation elevators. These elevators are for any building occupant to use during a fire to exit the structure (403.5.2).

Each of the provisions cited require building occupants as well as fire service personnel to ingress into the elevator as well as egress from the elevator. Hence, the elevator has become a viable component in the Means of Egress system.

From a cost perspective, particularly in multiple elevator car applications, it is very expensive to separate individual openings. Overall, a full lobby created with concealed wide-span opening protectives is less expensive, does not compromise the design of the space, and perhaps most importantly provides areas of refuge for those waiting to ingress an elevator during an emergency. When a lobby is incorporated into the design, it must have at least one complying means of egress for exiting (713.14.1).

- **Exception #4** The charging language in Section 713.14.1 exempts structures three stories or less from having elevator separation provisions. It specifically requires all structures four stories or more to include lobbies. The reason for this charging language is that the elevator lobby provisions are calculated to defend-in-place building occupants until rescue help arrives because fire department truck rescue ladders cannot reach beyond 75 feet.

Nevertheless, this exception considers an entire sprinklered floor equal in task to an elevator lobby area of refuge. This exception does not apply to hospitals, prisons and hi-rise buildings.

ELEVATOR SEPARATION

- **Exception #5** provides an alternate means of construction of the walls creating an elevator lobby. Even though this provision allows non-rated construction with smoke partitions the opening protectives must remain UL1784 listed. The passage of smoke is still an issue and rated opening protectives are still required.
- **Exception #6** is a very expensive alternative when the building exceeds 5 or 6 stories. The greater the cubic footage of space to pressurize the greater the cost in mechanical equipment to do the job. Most designers have suggested this alternative is equitable in 5- and 6-story buildings as compared with passive redundancy. However all agree that beyond this 5th or 6th level passive redundant lobbies are the least expensive alternative in multi-story buildings to satisfy elevator separation requirements.

Elevator Smoke & Draft

Section 713.14.1, Exception #3

Elevator car doors are typically fire-rated but cannot comply with smoke and draft requirements. 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 greater quantity of inter-connecting vertical shafts in multi-story buildings. These shafts become conduits for heat, smoke and other toxins from the fire floor(s) to additional floors. In buildings that connect more than three stories, the conventional elevator lobby is designed to stop the spread of fire and smoke between the space in the story and the elevator shaft enclosure doors. However, if the lobby is eliminated there is concern that smoke can penetrate quickly at the point of access to the shaft. Therefore, all fire-rated assemblies used at the point of access must maintain a smoke and draft rating. *(UL 1784)*

Code Requirements

In the legacy codes elevator protection requirements were driven by rated corridor provisions. In other words, whenever an elevator opened to a rated corridor the threat of creating a “dirty” (smoke and heat filled) corridor was mitigated by providing protection at the point of access in lo-rise construction and a conforming lobby in hi-rise construction.

Currently in the IBC protection at the elevator is driven only by “where an elevator shaft connects more than three stories” (713.14.1). At first glance one would think a four story building less than 75 feet in height (lo-rise by definition) would require elevator protection. However, Exception #4, 713.14.1 allows buildings that are sprinklered to be exempt unless it is a High-Rise or a Group I-2 or I-3 occupancy.

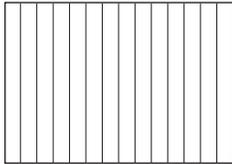
This application becomes a code requirement in rare cases when a building connects more than 3 stories, is less than 75 feet in height, and is not sprinklered.

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)*

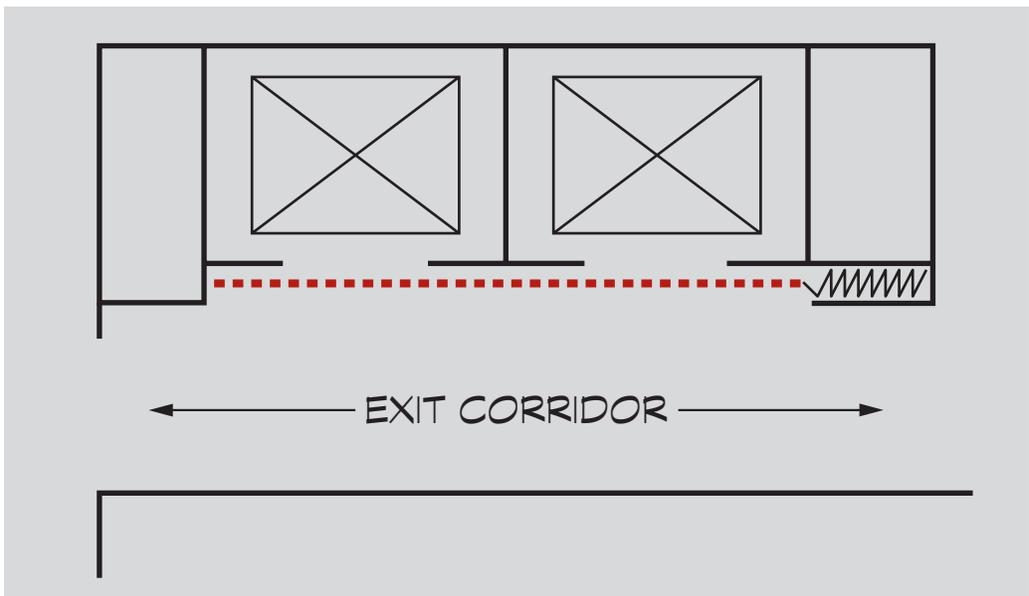
ELEVATOR SEPARATION

Design Solutions

● Case Study 1: Side Acting Accordion with Power-assisted Egress

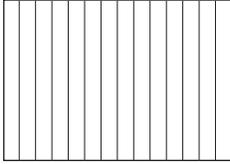


Due to the several configuration options of the McKeon door assemblies multiple or single elevator openings can easily be protected. Egress can be placed at each elevator car door opening to accommodate conforming exit requirements.

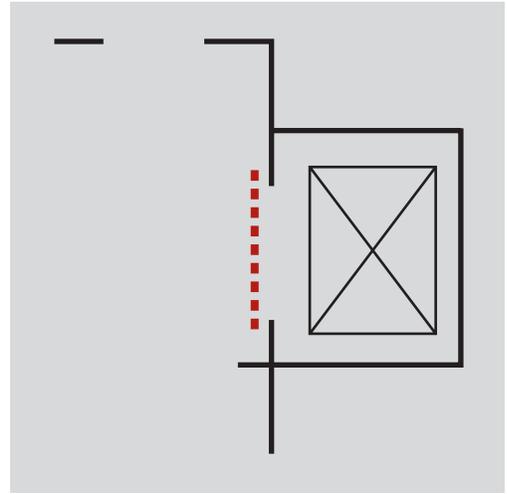


ELEVATOR SEPARATION

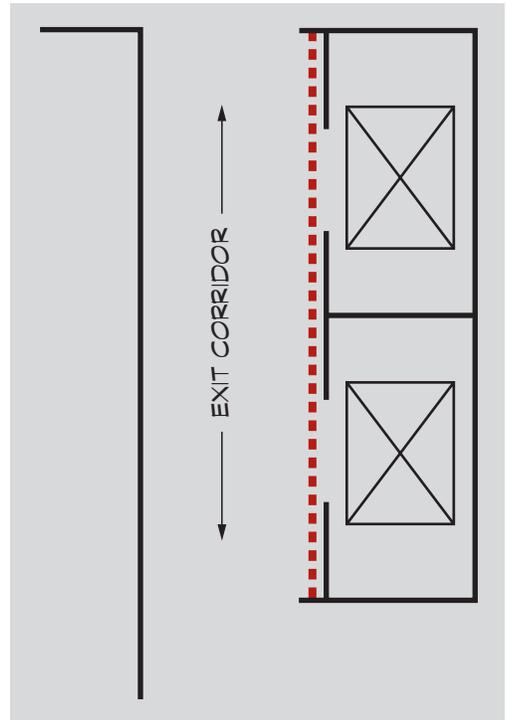
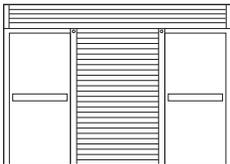
● Case Study 2: Side Acting Accordion with Manual Egress



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.

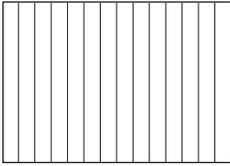


● Case Study 3: Vertical Coiling with Complying Swing Egress Door(s)

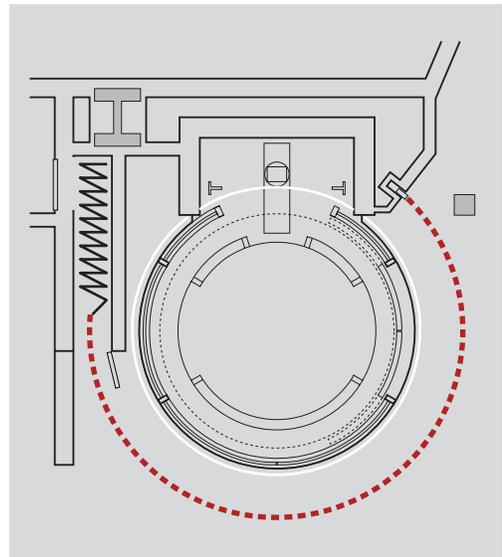


ELEVATOR SEPARATION

● Case Study 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.

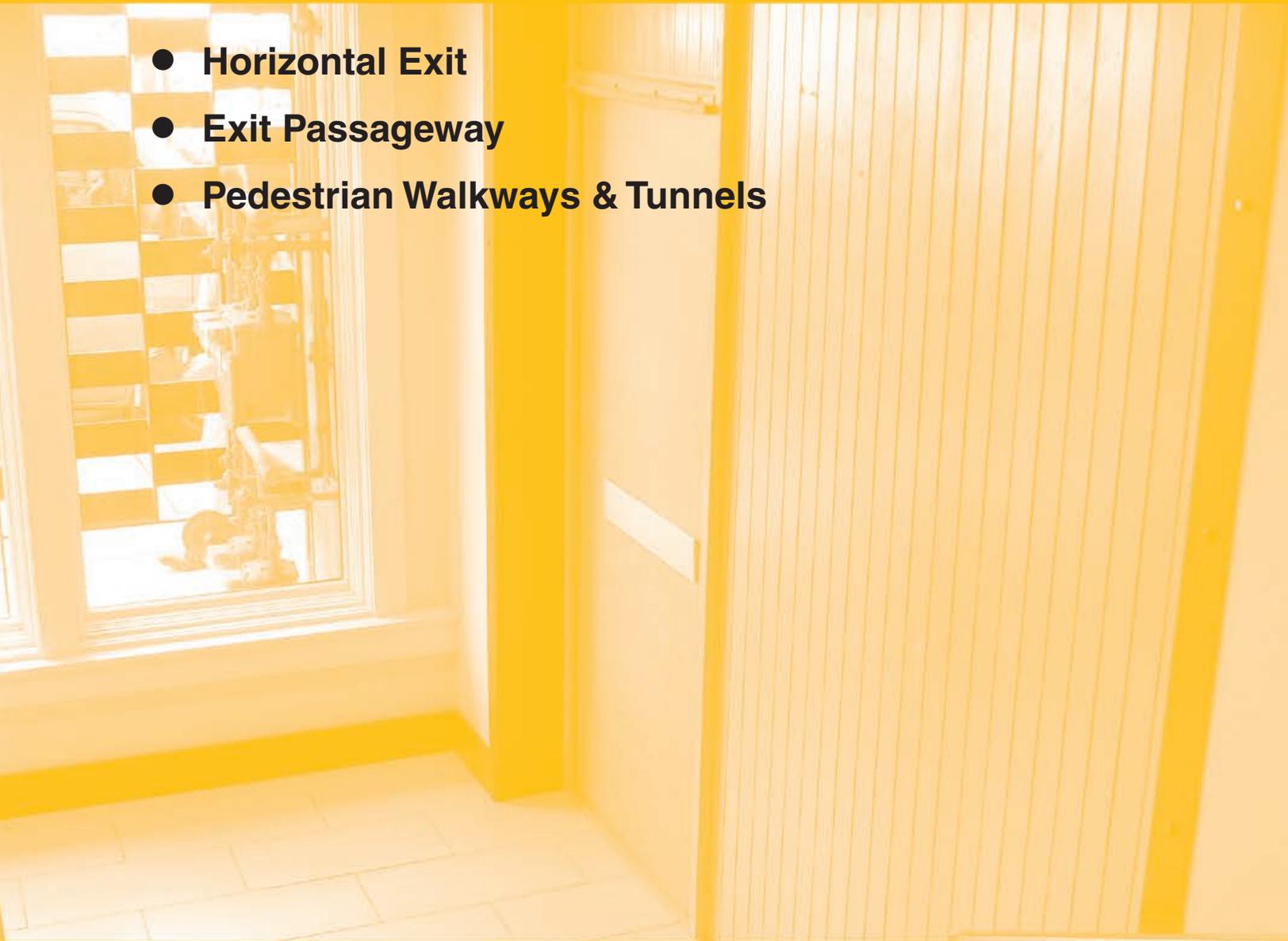


Inquiry Discussion & Questions

In hi-rise buildings this application is allowed under Section 713.14.1, Exception #3. Please consult the Inquiry Discussion & Question section of the Elevator Lobby case study.

Exit Access Separation

- **Horizontal Exit**
- **Exit Passageway**
- **Pedestrian Walkways & Tunnels**



Horizontal Exit

Section 1025

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

Fundamentally the horizontal exit differs from the typical code defined exit. The horizontal exit is calculated 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 utilizing the horizontal exit, specific precautionary requirements are based upon the following fundamental principles:

Principle #1 – A 2-hour fire wall or fire barrier must be used to separate safe refuge areas connected with a horizontal exit (*Section 1025.2*). 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 – 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. (*Sections 1025.2 & 1025.3*)

Principle #3 – A horizontal exit cannot serve as the only exit from the fire area. In cases where two or more exits are required, not more than one-half shall be horizontal exits (*1025.1*). In order to minimize this requirement the following criteria must be met:

Exception #1: In an I-2 (hospital) occupancy horizontal exits can comprise two-thirds of the required exits. (*Section 1025.1, Exception #1*)

Exception #2: In an I-3 (prison) occupancy horizontal exits can be the only and primary means of egress from the space. (*Section 1025.1, Exception #2*)

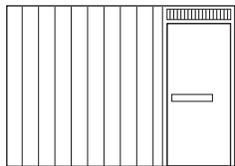
Principle #4 – The capacity of the refuge areas separated by a horizontal exit are calculated based upon the following:

EXIT ACCESS SEPARATION

1. The refuge area shall be occupied by the same tenant. (Section 1025.4)
2. The refuge area must be large enough to accommodate the original occupant load plus the occupant load anticipated from the adjoining fire area. (Section 1025.4)
3. The only exceptions to these rules are in I-2 and I-3 occupancies. (1025.4, Exceptions #1 through #3)

Design Solutions

● Case Study 1: Side Acting Accordion with Complying Swing Egress Door

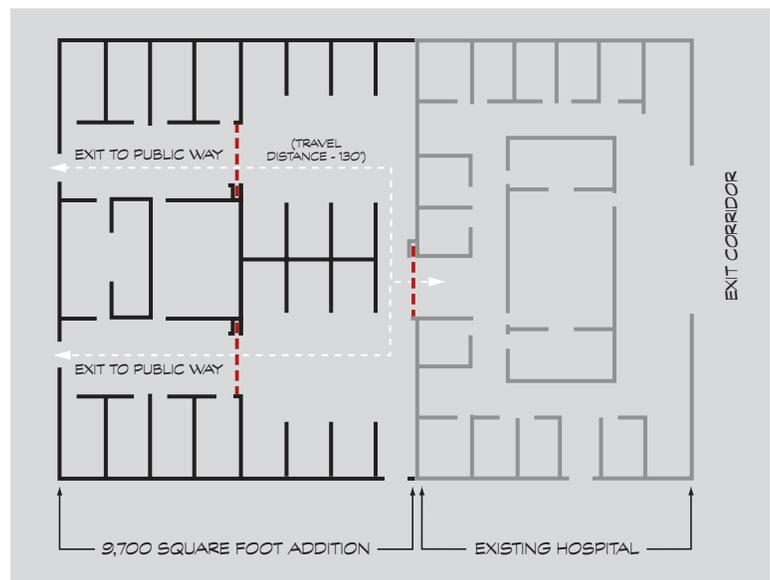


In this particular case study the intent is to add a 9,700 square foot critical care suite on an existing I-2 (hospital). However other code requirements come into play affecting the design dramatically:

- First, suites of sleeping rooms cannot exceed 5000 square feet and in this case a 9,700 square foot suite is being added. (407.4.3.5.1)
- Second, there must be two exits from each suite. (407.4.3.5.2)
- Third, the travel distance between any point in a suite of sleeping rooms and an exit access exit door shall not exceed 100 feet. (407.4.3.5.3)

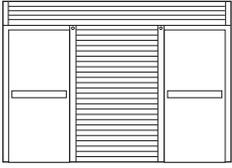
By utilizing the horizontal exit concept, the following will preserve the original design intent and provide code compliance:

- Separate the intended 9,700 square foot space into two suites, each less than 5,000 square feet.
- Provide a 2-hour fire barrier wall as the separation. (Section 1025.2)
- Provide a horizontal exit in the separation as one of two required exits from each space. (Section 407.4.3.5.2)
- Provide a 90-minute opening protective. (Table 716.5)

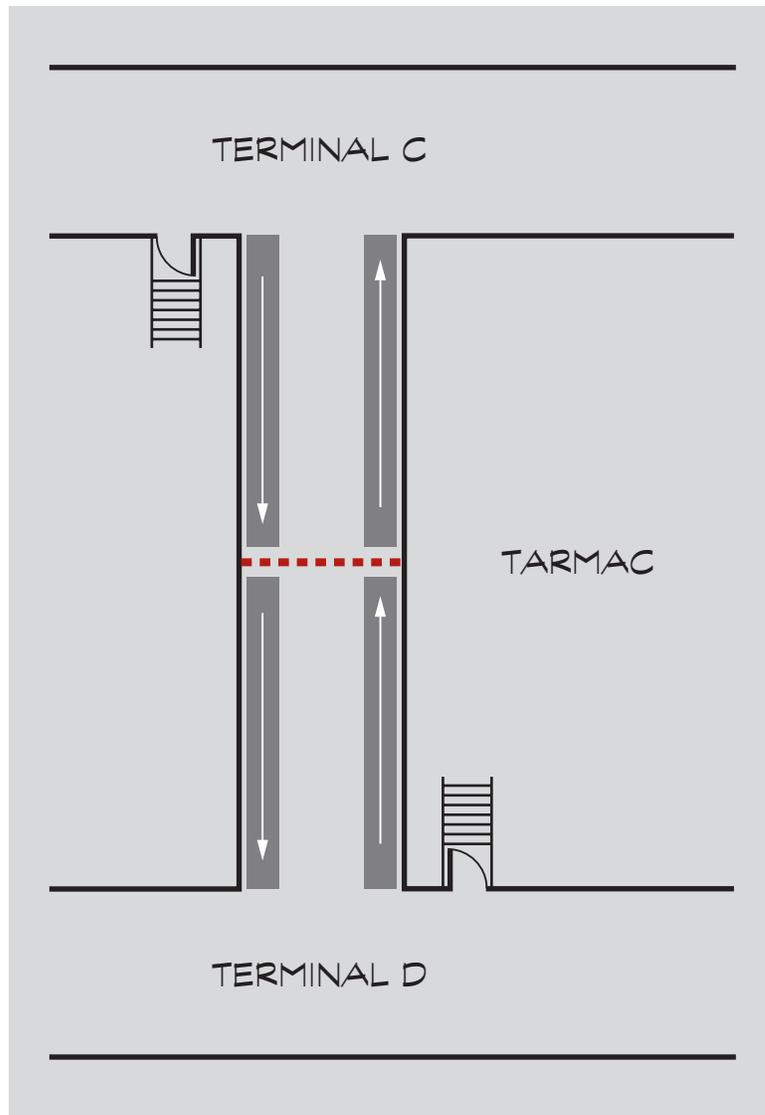
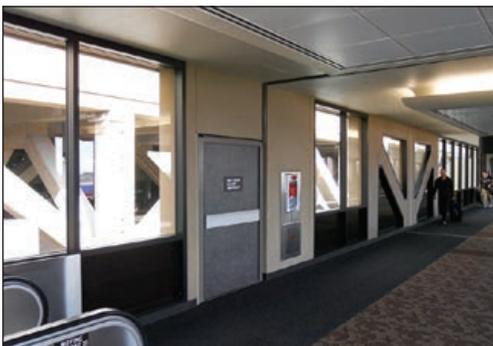
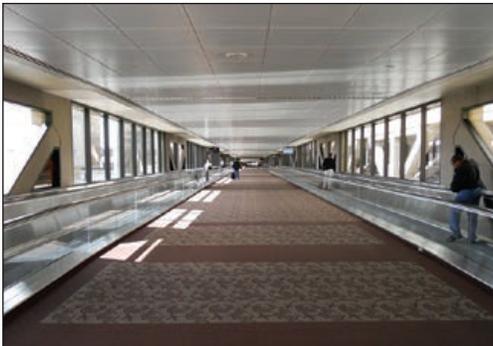
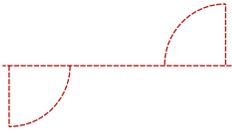


EXIT ACCESS SEPARATION

● Case Study 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 Passageway

Section 1023

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.

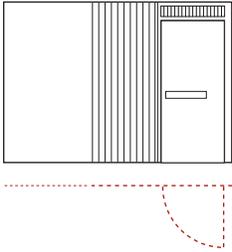
Code Requirements

1. An exit passageway shall not be used for any purpose other than as a means of egress. *(1023.1)*
2. Exit passageway enclosures shall have walls, floors and ceilings of not less than 1 hour ... and be constructed as fire barriers or horizontal assemblies. *(1023.3)*
3. Elevators shall not open into an exit passageway. *(1023.5)*
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. *(1023.5)*
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 1022.3.1. 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.

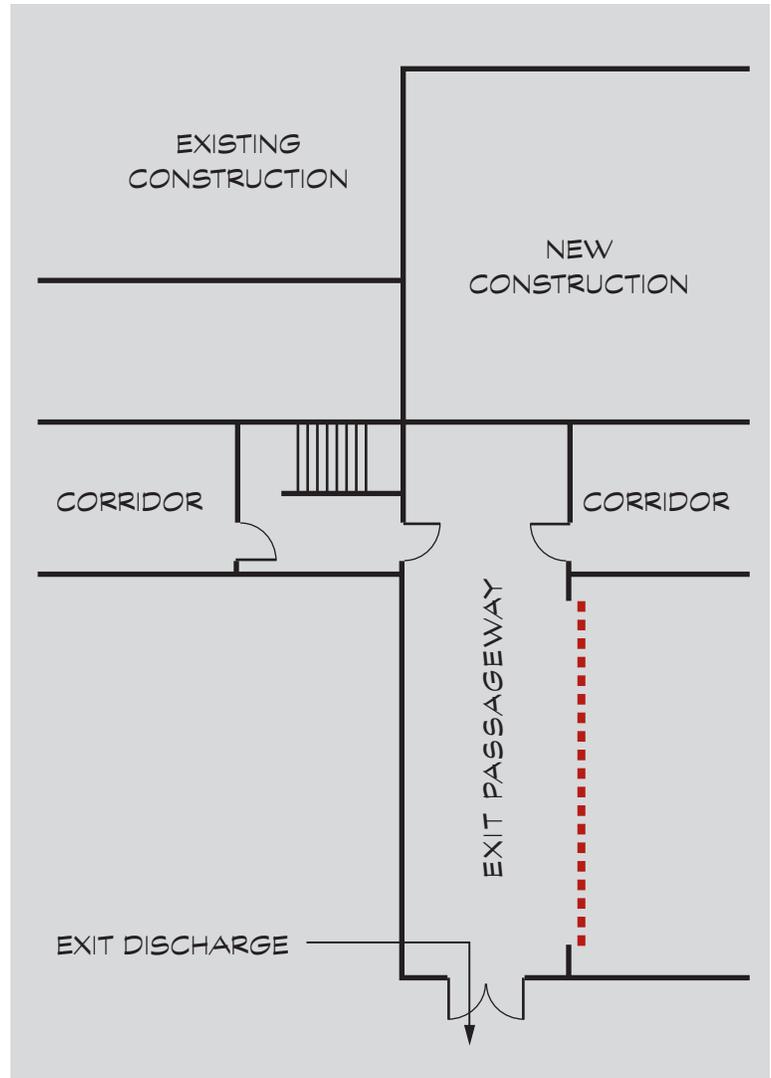
EXIT ACCESS SEPARATION

Design Solution

● Case Study: Side Acting 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. Because of the listed door label the McKeon opening protective left the space open between the stair and the exit discharge to the outside.



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 connect and penetrate these rated exterior walls compromising protection and potentially allowing heat and smoke to pass from one building to another.

Code Requirements

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

Principle #1 – 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 – 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 – 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). In order to avoid this requirement the following criteria must be met:

Exception #1 – The distance between the connected buildings is more than 10 feet ... the wall is constructed of a tempered, wired or laminated glass wall and doors subject to the following:

- 1.1. The glass protected with sprinklers in order to wet the entire surface of the interior glass.
- 1.2. Glass must be manufactured and installed in gasketed frames to avoid breakage with deflection from extreme heat.

EXIT ACCESS SEPARATION

1.3. Obstructions shall not be installed between the sprinkler heads and the glass.

Exception #2 – The distance between the connected buildings is more than 10 feet and the sidewalls of the glass are at least 50% open.

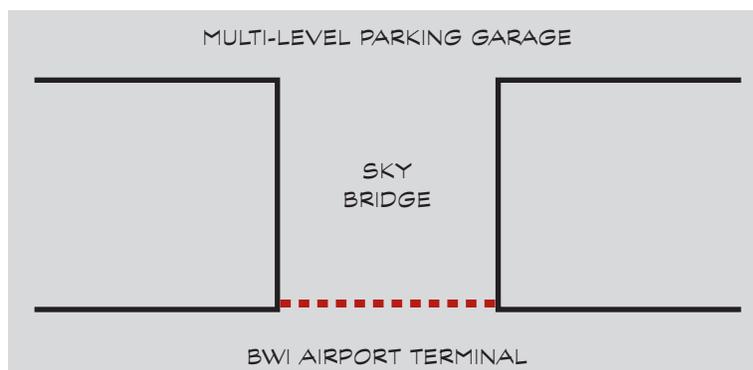
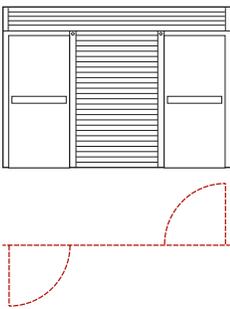
Exception #3 – Buildings are on the same lot.

Exception #4 – Where buildings are required by Section 705 to be rated more than 2 hours the walkway must be equipped with an NFPA 13 sprinkler system.

Design Solutions

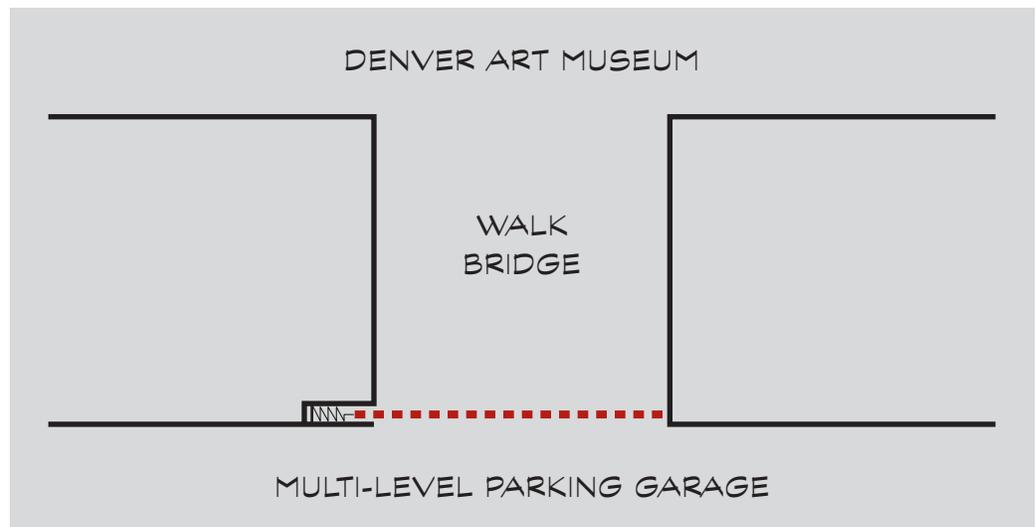
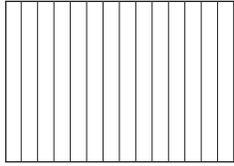
The alternatives to fire barrier separations as listed above are very costly. Complying with the 2-hour separation requirement in Section 3104.5 is the least expensive option. A listed and labeled wide span McKeon assembly will easily protect any size opening. In the following three case studies, McKeon Door Company showcases three distinctly different technologies to resolve the same code application problem. The diverse design requirements between the three applications was not a challenge for McKeon, simply routine applications of standard products.

● Case Study 1: Vertical Coiling with Complying Swing Egress Door(s)

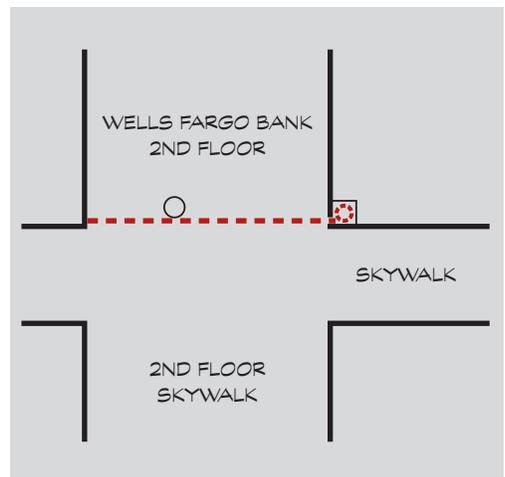
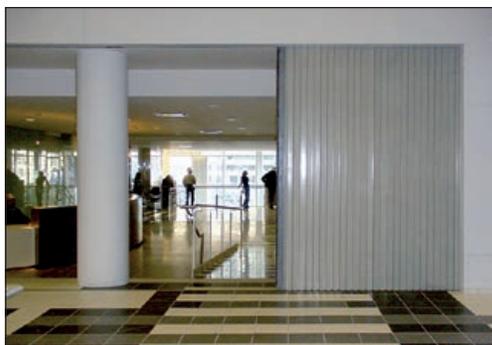
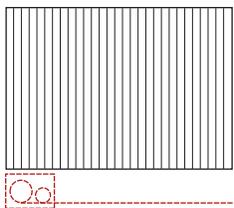


EXIT ACCESS SEPARATION

● Case Study 2: Side Acting Accordion with Power-assisted Egress



● Case Study 3: Side Coiling without Egress



Vertical Opening Separation

- **Fundamental Guidelines**
- **Exit Access Stairways**
- **Vertical Openings – Escalator**
- **Interior Exit Stairways**
- **Atriums**
- **Vertical Compartmentation**

Fundamental Guidelines

Sections 404, 712, 713 & 1009

Vertical openings between floors are designed consistently in multi-story buildings in many different shapes, heights and uses. For the purposes of code enforcement the following general categories are described in the building code:

1. **Shaft Enclosures (713)**
 - a. Escalators (712.1.3)
 - b. Mezzanines (712.1.10, 505)
 - c. Stairs or ramps (712.1.12, 1009, 1022, 1026)
 - d. Elevators & dumbwaiters (713.14.1)
2. **Atriums (404, 712.1.6)**
3. **Interior Exit Stairways and Ramps (Section 1022)**
4. **Exit Access Stairways (712, 1009)**

Usually anytime two or more floors are open to each other a vertical opening is created and the phrase “floors are common with each other” is used to characterize the condition.

Two tightly interwoven fundamental principles drive the requirements of vertical opening protection. First, the migration of smoke, heat and toxic gases floor to floor. Second, egress of building occupants from upper levels to a safe level of exit discharge.

The 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.

Exit Access Stairways

Sections 712, 1009

These case studies deal with a condition wherein several floors are common to each other. The floors are inter-connected with a interior exit access or communicating stairways. Previous editions of the code addressed these stair features as non-egress stairs. The 2012 edition of the code defines interior exit access stairways as interior stairways that are not required interior exit stairways. (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. For building occupants, these conditions are not conducive to defend in-place strategies – rather to egress quickly from harm’s way. Therefore, these requirements expressly demonstrate the overlap between passive, active and egress fire & life safety provisions.

Code Requirements

An exit enclosure is not required at an interior exit access stairway, in other than I-2 and I-3 occupancies, as long as the following conditions are met.

- The exit access stairway must be included in the exit access travel distance measurement. (1016.3.1)
- Serve or atmospherically communicate between only two stories (1009.3, Exception #1)

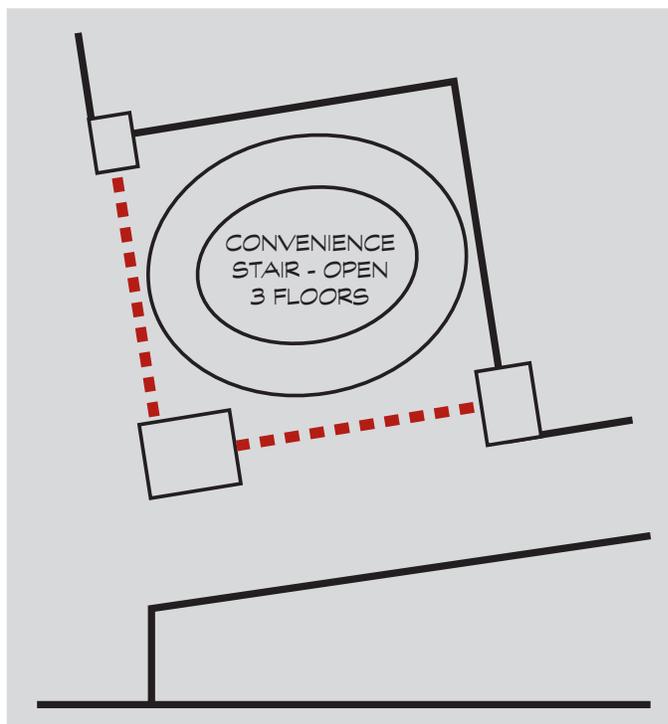
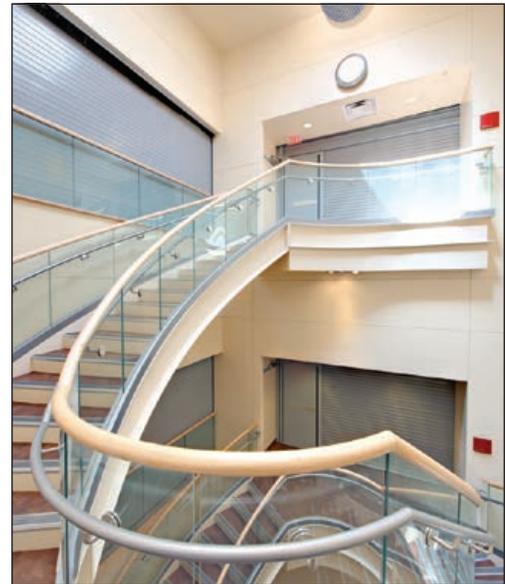
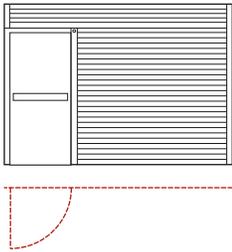
For additional code language and acceptance criteria for two-story openings please see “Inquiry Discussion & Questions” on pages 32-33 of this application study.

VERTICAL OPENING SEPARATION

Design Solutions

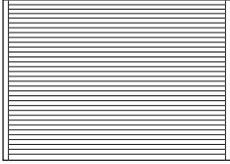
Since each space contains a stair the code will allow two floors common. In the following case studies, McKeon Door Company offers different products for very diverse design needs, yet there is not a compromise in fire & life safety.

● Case Study 1: Vertical Coiling with Complying Swing Egress Door(s)

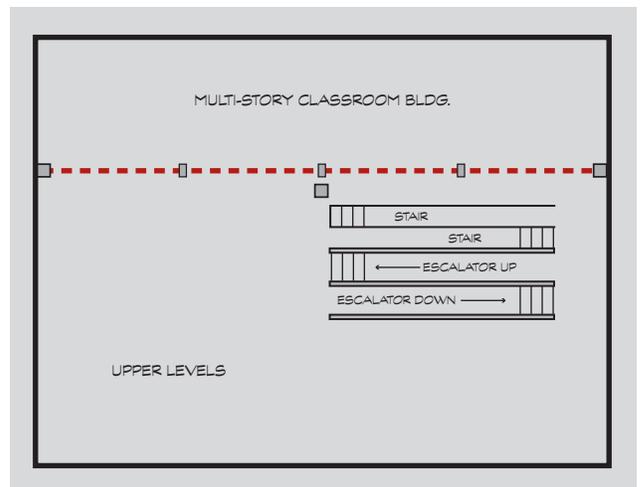
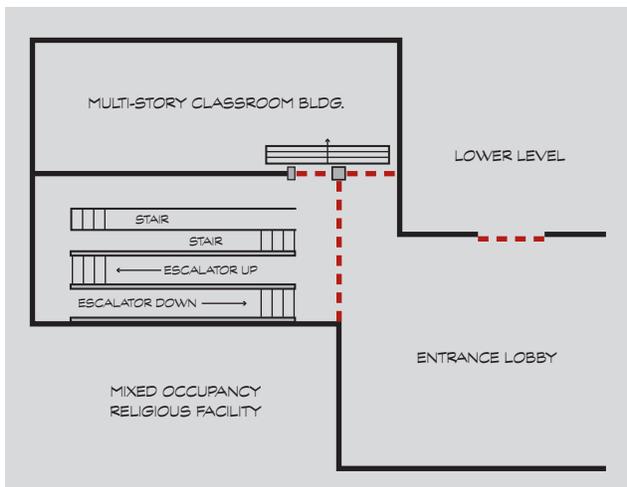
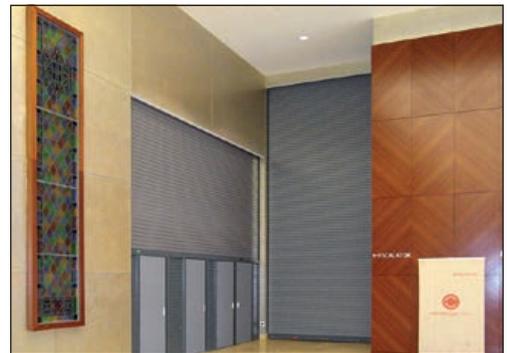
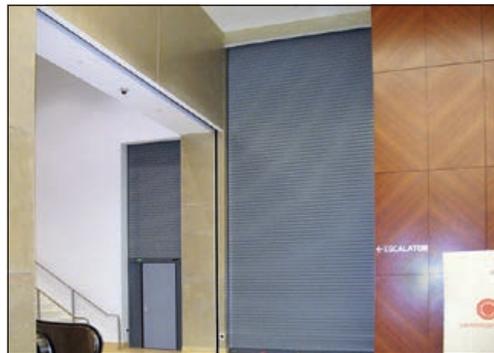
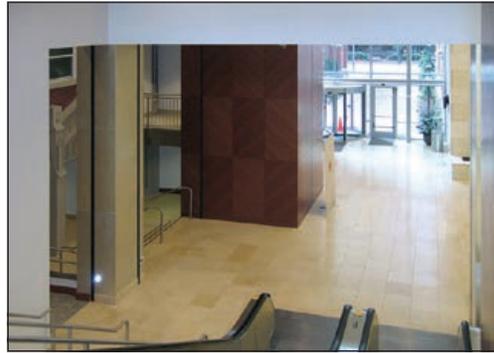
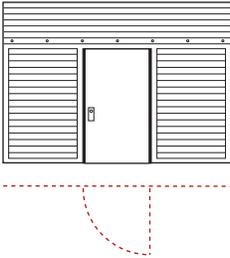


VERTICAL OPENING SEPARATION

● Case Study 2: Vertical Coiling without Egress & Vertical Acting with Complying Swing Egress Door(s)

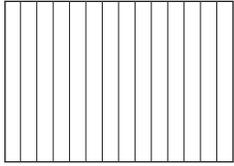


In the second case study sustaining an open design presented significant challenges to the design professional due to excessive heights which brought new meaning to the term wide-span openings. Without hesitation McKeon offered a unique resolve with a patented and time-tested product designed specifically for these seemingly difficult openings. With the vertical acting assembly, full height conforming rated egress doors were easily accommodated near the floor level while routinely fitting a super-sized height condition with rated vertical rolling steel.

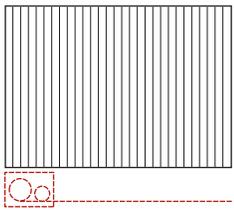


VERTICAL OPENING SEPARATION

● Case Study 3: Side Acting Accordion with Power-assisted Egress



● Case Study 4: Side Coiling without Egress



Inquiry Discussion & Questions

These applications, at first glance, would seem to fall under the atrium provisions because there are at least two floors common to each other. Notwithstanding the third floor is separated from the other two, the definition of an atrium is two or more floors interconnected. The purpose for separating floors in order to create only two floors common is to consider the space under the vertical opening provisions of Section 712 in lieu of the atrium provisions in Section 404. Aside from the exit access stairway provisions referenced in Section 712 and detailed in Section 1009, the code includes additional acceptance criteria for two-story openings. Essentially, in other than Groups I-2 and I-3 a floor opening that is not used as one of the applications already listed in Section 712 shall be permitted if it complies with all of the following seven criteria:

1. Does not connect more than two stories.
2. Does not contain a stairway or ramp required by Chapter 10.
3. Does not penetrate a horizontal assembly that separates fire areas or smoke barriers that separate smoke compartments.
4. Is not concealed within the construction of a wall or floor/ceiling assembly.
5. Is not open to a corridor in Group I and R occupancies.
6. Is not open to a corridor on nonsprinklered floors.
7. Is separated from floor openings and air transfer openings serving other floors by construction conforming to require shaft enclosures. (712.1.8)

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 you a wide-span opening protective to separate vertical spaces that can also serve as the required exit from unenclosed stairways?

Vertical Openings – Escalator

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

The following exceptions are allowed in lieu of creating a shaft:

Escalators must be enclosed unless the design incorporates the following requirements: *(712.1.3)*

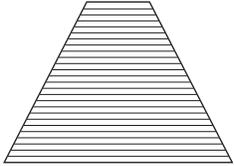
First, an automatic sprinkler system must be installed throughout the entire building and, secondly an escalator must NOT be a portion of the means of egress system. If both of these issues are satisfied then the following criteria must be met:

1. The area of the floor opening between stories does not exceed twice the horizontal area of the escalator. *(712.1.3.1)*
2. The opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13. *(712.1.3.1)*
3. In other than Groups B and M, this application is limited to openings that do not connect more than four stories. *(712.1.3.1)*

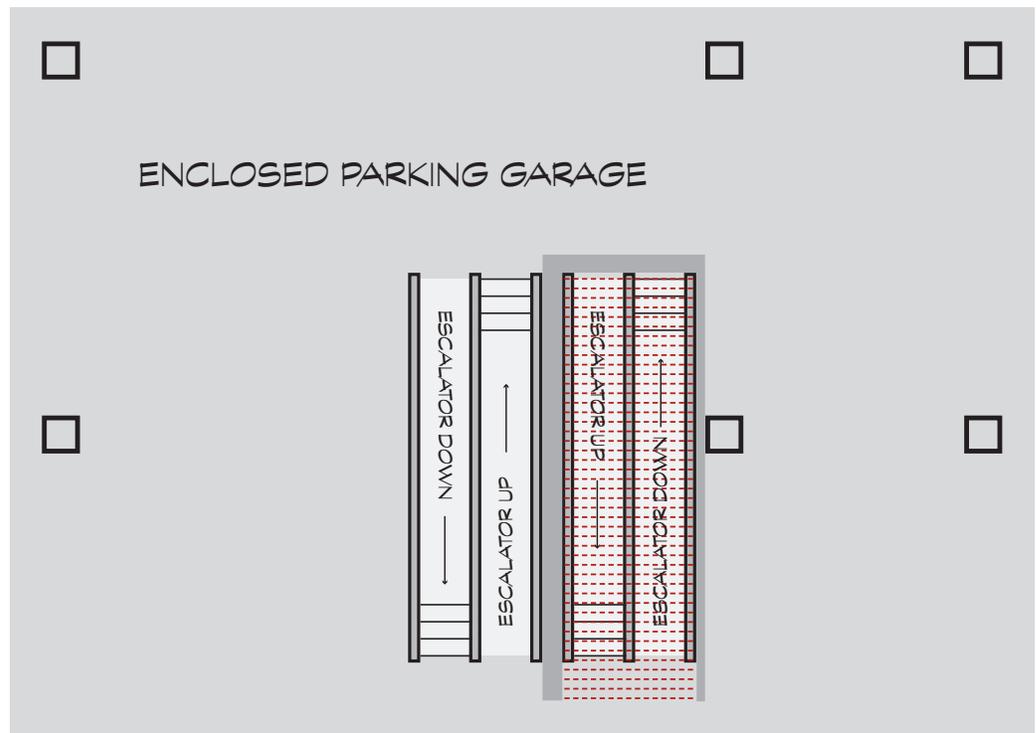
VERTICAL OPENING SEPARATION

Design Solution

● Case Study: Horizontal (Floor) Shutter



This case study features a much reduced aesthetically valuable ambiance with the design of a parking garage. However, from a fire & life safety perspective the need for fire and smoke protection is the same. The use of the 2-hour rated horizontal shutter quickly satisfies the basic requirement of opening protection at the opening and the escalator is enclosed.



Interior Exit Stairs

Section 1022

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

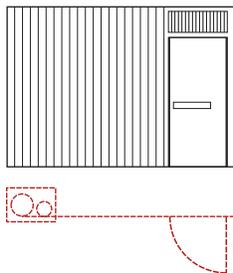
Because exit enclosures penetrate horizontal floor and ceiling assemblies, fire, heat, smoke and toxic gases can potentially penetrate into building spaces at each floor level. Therefore, enclosures become critical barriers of protection for building occupants. The protected enclosure will be a non-contaminated 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. (1022.2)
2. Exit enclosures in buildings connecting four stories or more shall be rated at 2 hours; less than four stories at 1 hour. (1022.2)
3. Openings and penetrations shall be rated in accordance with Section 716. (1022.4)

Design Solutions

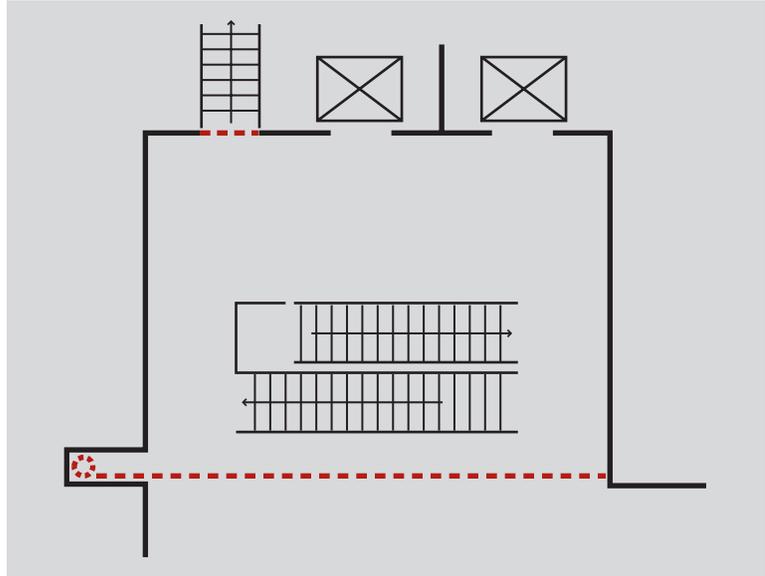
● Case Study 1: Side Coiling with Complying Swing Egress Door(s)



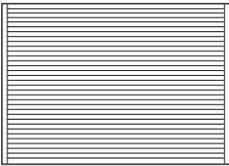
An absence of stacking space necessitated a unique McKeon product to seal this exit enclosure. The side coiling assembly requires a small box-like space and projects its 3-hour steel curtain with a conventional egress door along a very narrow pocket entry point and header slot path. However, when closed, complete compliance with shaft enclosure opening protective requirements is quickly achieved.



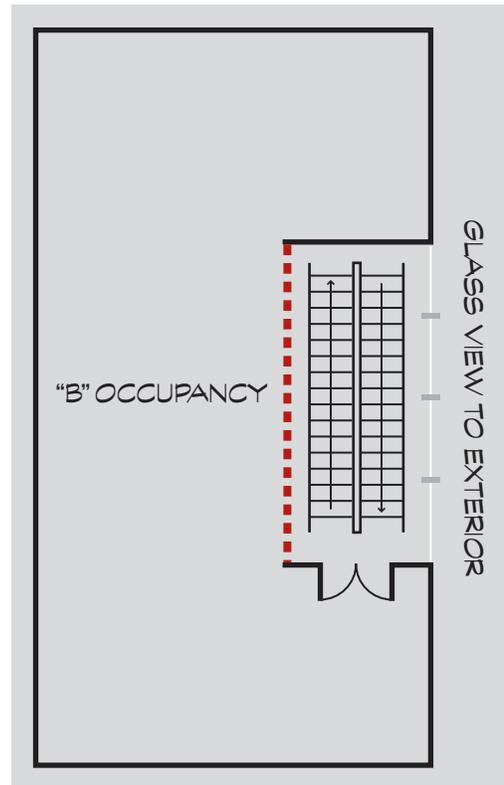
VERTICAL OPENING SEPARATION



● Case Study 2: Vertical Coiling without Egress

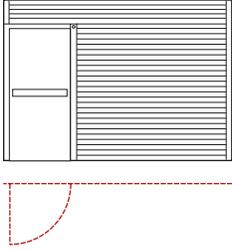


With a complying swing door hidden behind the columns, this expansive 3-hour rated roll-down assembly was more than enough protection to allow a wide-span open view only to close in case of fire.

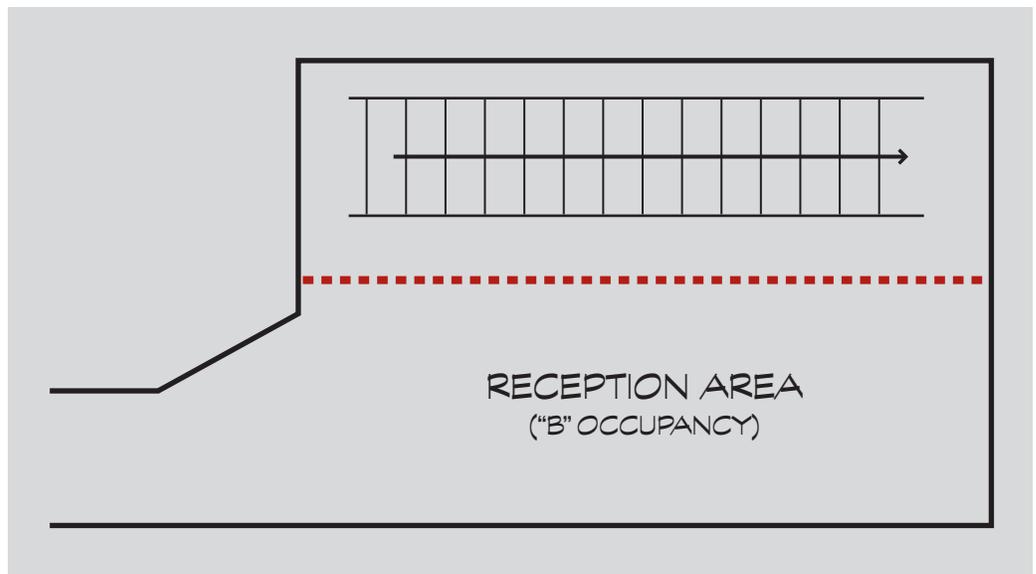


VERTICAL OPENING SEPARATION

● Case Study 3: Vertical Coiling with Complying Swing Egress Door(s)



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 tight spaces. It is equally difficult to satisfy egress requirements without compromising open spacious design. This vertical coiling and egress conforming assembly accommodates narrow header lines, obscure side guides and deploys with both separation and egress.



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. 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 these provisions are a substitute for 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 shaft enclosure. Listed below are the specific provisions allowing atriums to be open and spacious:

- 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*)
- An approved automatic sprinkler system shall be installed throughout the entire building. (*Section 404.3*)
- A fire alarm system shall be provided. (*Section 404.4*)
- 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*)
- 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*)
- A glass wall forming a smoke partition where automatic sprinklers are spaced 6 feet or less along both sides of the separation wall, or on the room side only if there is not a walkway on the atrium side, and between 4 and 12 inches away from the glass ... the entire glass surface must be wet upon activation ... the glass shall be mounted in a gasketed frame ...

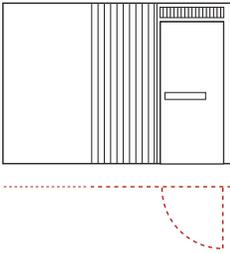
VERTICAL OPENING SEPARATION

- Provide a glass block wall assembly in accordance with Section 2110 ...
- The adjacent spaces of any three floors of the atrium shall not be required to be separated from the atrium ... if included in the smoke control calcs.
- Smoke control equipment must be on a standby power system. (*Section 404.7*)
- The atrium interior finish of walls and ceilings must be not less than Class B. (*404.8*)
- With the exception of the lowest level of the atrium, the required means of egress in the exit access system travel distance shall not exceed 200 feet.

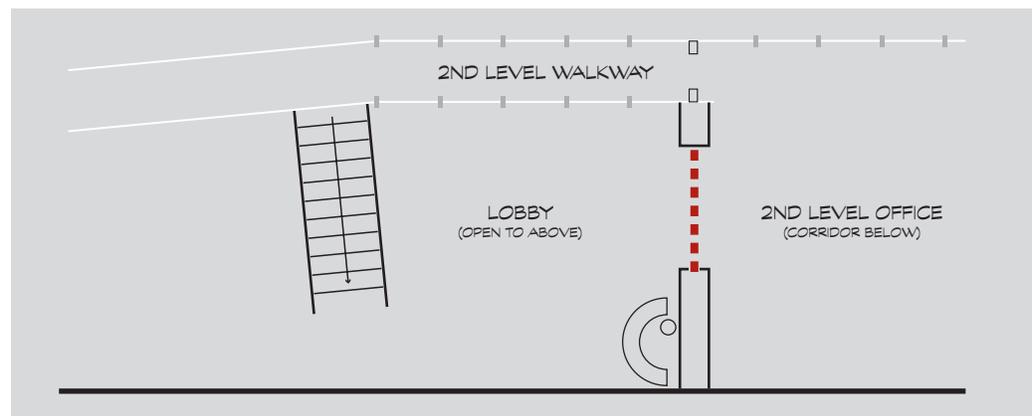
Design Solutions

The optimum protection of a vertical opening is to create a shaft enclosure. All of the requirements listed above that become a substitute for a shaft enclosure are erased from the design if a shaft is created. The cost savings can be tremendous.

● Case Study 1: Side Acting with Complying Swing Egress Door(s)

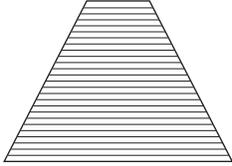


This unique case study features another of the McKeon diversified products for resolving multiple design/code challenges simultaneously. The lower floor travel path is a required design feature for egress and – combined with the non-rated second floor overlook – is certainly an ingenious solution. However, without the side acting, extreme height & egress conforming McKeon assembly this would not be possible!

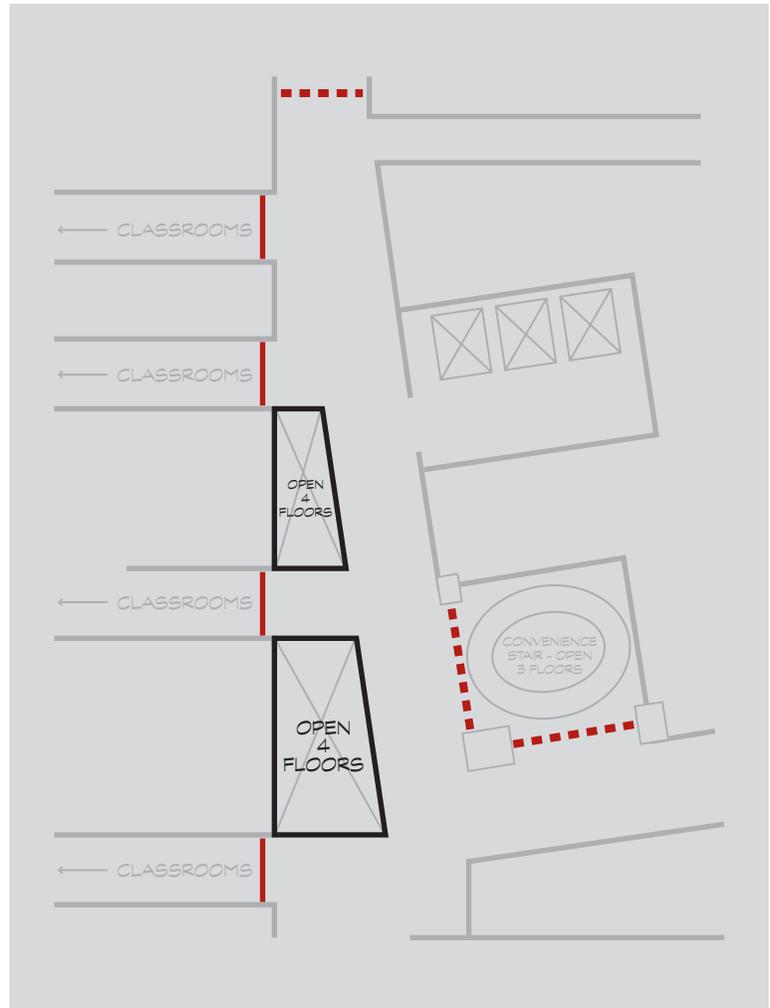


VERTICAL OPENING SEPARATION

● Case Study 2: Horizontal (Floor) Shutter

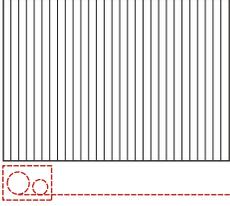


In this case study the atrium space is essentially converted to a vertical compartment separation using the McKeon horizontal shutter. Please refer to the “vertical compartmentation” case studies at the end of this section for more information. Note the absence of any smoke evacuation systems!

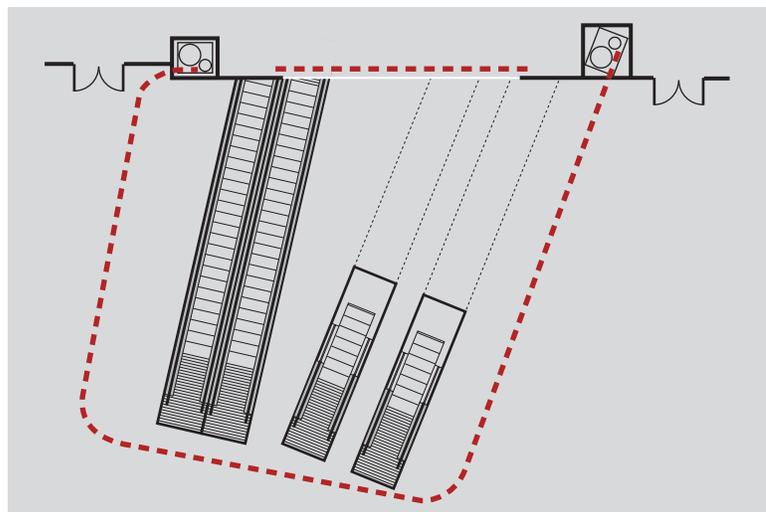
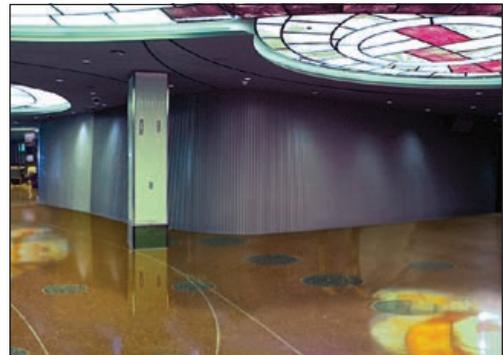


VERTICAL OPENING SEPARATION

● Case Study 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 2.5" 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 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 largely in Section 712, Vertical Openings and Section 713, Shaft Enclosures. Prior to the 2012 edition of the code, all vertical openings were essentially considered under the shaft enclosure provisions only. The older Section 708.2, Shaft Enclosure hosted 16 exceptions, in other words 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. Those items, originally written as exceptions to the shaft requirements became stand-alone provisions defining vertical opening conditions, rather than exceptions to strict shaft enclosure requirements. Even though the fundamental content did not change, the simple act of 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 vertical openings being protected in the creation of vertical compartments.

VERTICAL OPENING SEPARATION

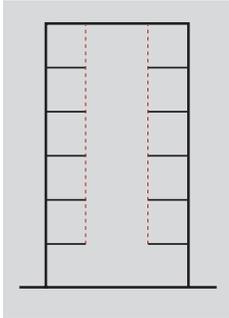


Figure 1

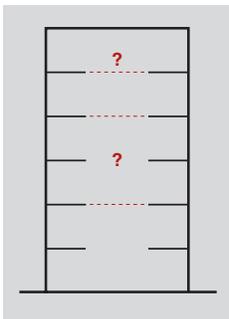


Figure 2

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.

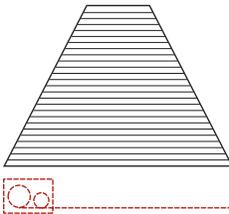
Within the current provisions set forth in Sections 712 and 713, the basic core and shell of this structure is still going to be a protected shaft. For example as shown in **Figure 2**, when one uses certain provisions of Section 404, by way of exception two floors can be common and the smoke evacuation 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 1009 the incorporation of an exit access stairway allows two unprotected floors common.

The question is, is it possible to eliminate the “vertical” open condition “horizontally” 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?

Design Solutions

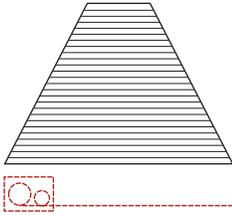
The following case studies demonstrate various accepted uses of the vertical compartmentation concept.

● Case Study 1: Horizontal (Floor) Shutter

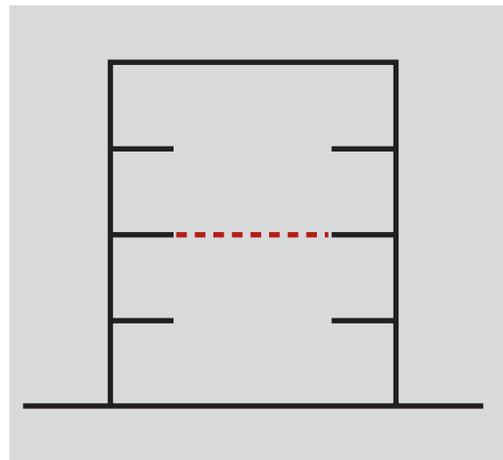
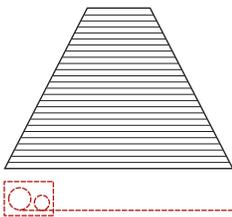


VERTICAL OPENING SEPARATION

● Case Study 2: Horizontal (Floor) Shutter

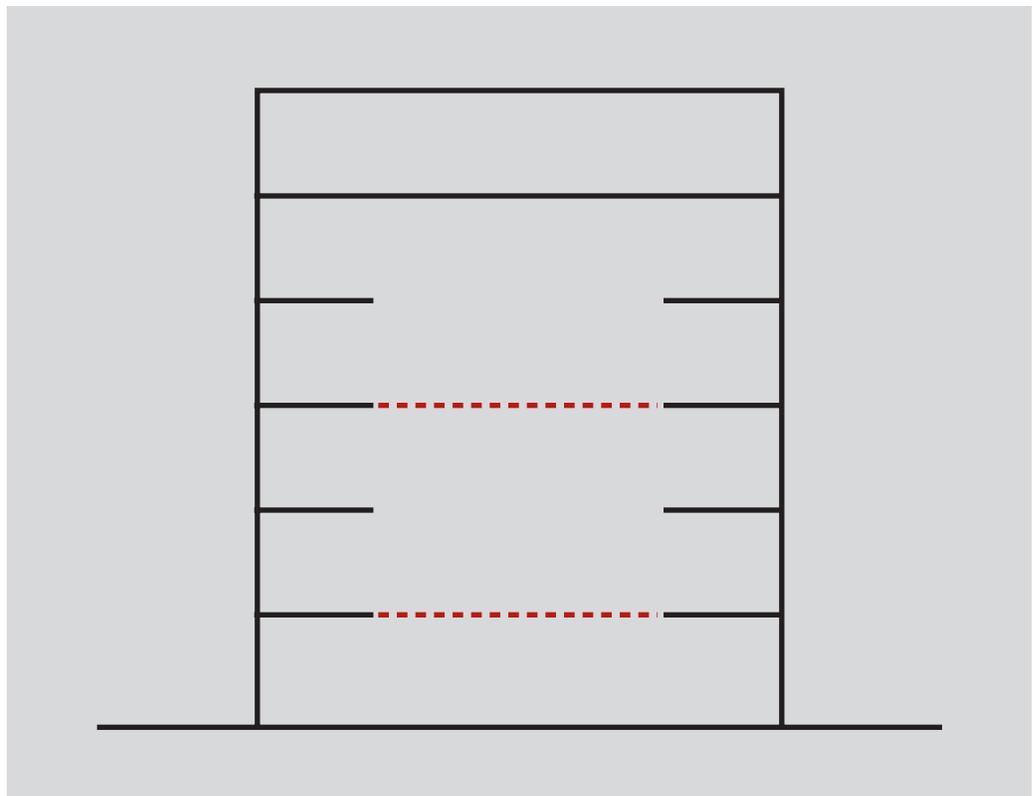
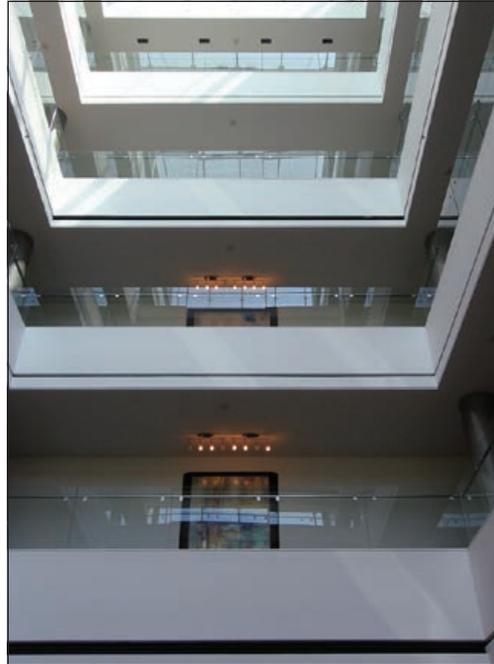
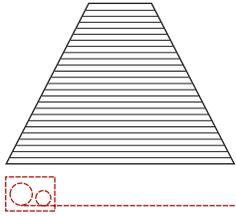


● Case Study 3: Horizontal (Floor) Shutter



VERTICAL OPENING SEPARATION

● Case Study 4: Horizontal (Floor) Shutter



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 508.2.4**

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.

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:

OCCUPANCY SEPARATION

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. *(508.2.1)*
3. Aggregate accessory occupancies shall not exceed the tabular values in Table 503 without height and area increases. *(508.2.1)*
4. Accessory occupancies shall be individually classified in accordance with Section 302.1. *(508.2.2)*

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.
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.
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)*

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.

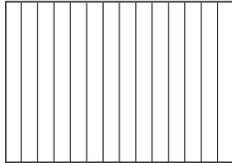
Code Requirements

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.

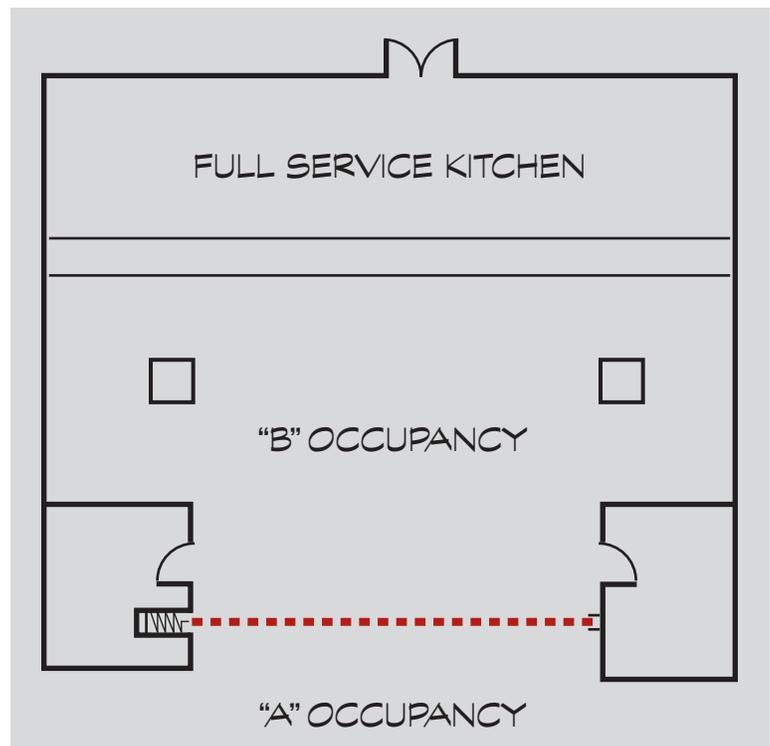
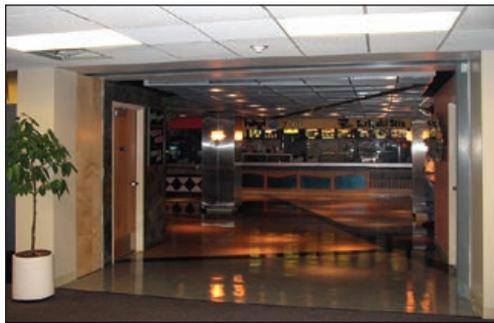
OCCUPANCY SEPARATION

Design Solutions

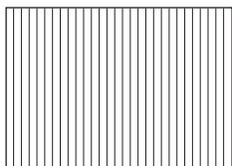
● Case Study 1: Side Acting Accordion with Power-assisted Egress



This first case study examines the use of the McKeon Side Acting Accordion fire door for use only in case of fire. Otherwise, the assembly is hidden from view unless there is a fire and is activated by the smoke detector. Egress is accomplished by compliance to 1008.1.4.3.



● Case Study 2: Side Coiling without Egress

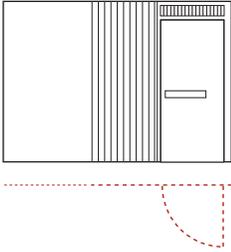


This case study is very similar to the previous application with the exception of an egress requirement. The McKeon side coiler without egress became the most economical solution without compromising life safety.

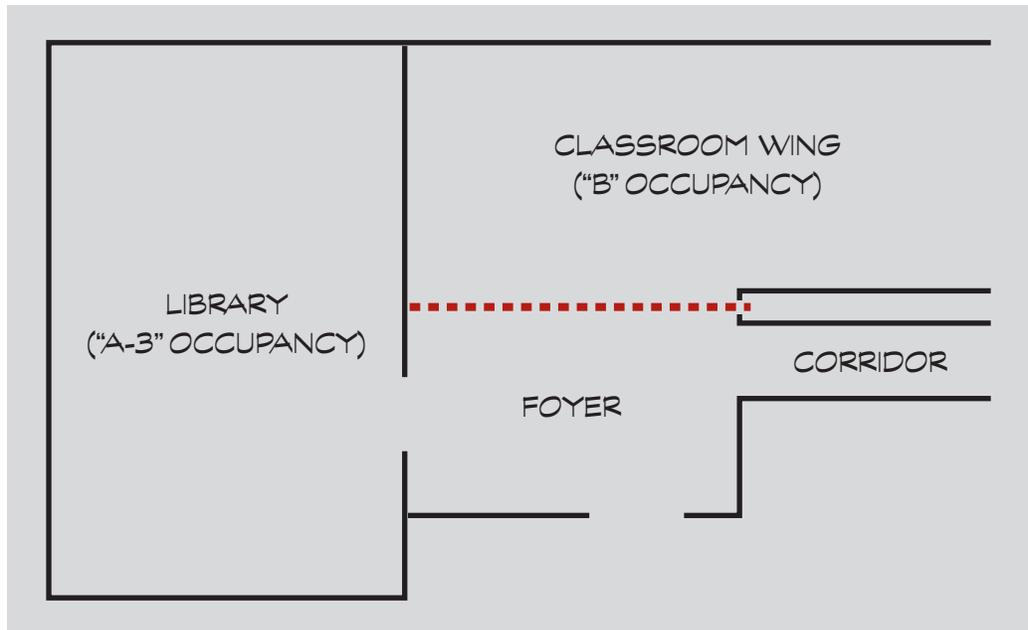


OCCUPANCY SEPARATION

● Case Study 3: Side Acting 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 Acting with Conventional Egress Assembly due to limited width of pocket space.



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:

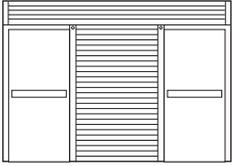
1. Each use shall be individually classified. (508.3.1)
 - The entire building is classified as a "B" occupancy. The space under consideration (Conference/Training room) is an A-3 occupancy.
2. The allowable building area and height of the building or portion thereof shall be based on the most restrictive allowances for the occupancy groups under consideration ... (508.3.2)

OCCUPANCY SEPARATION

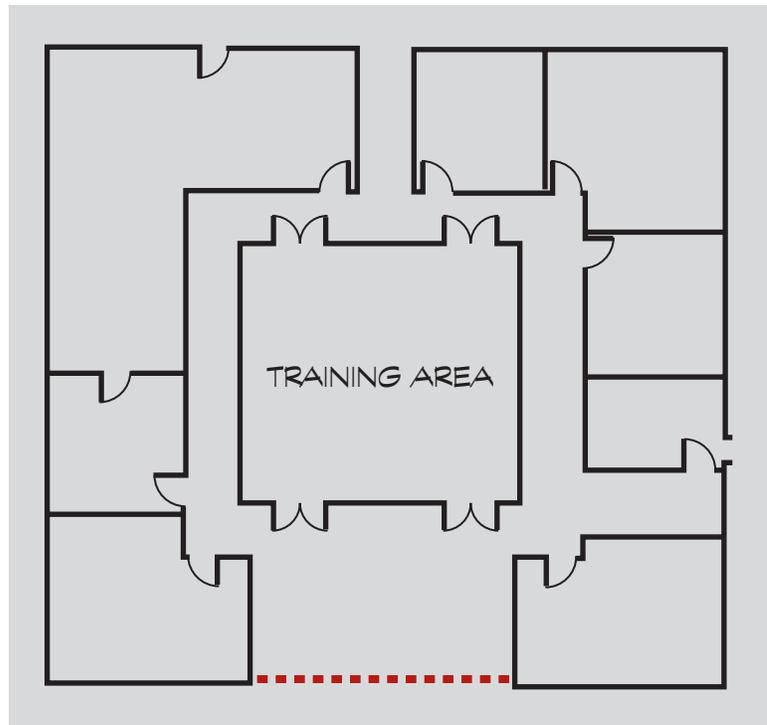
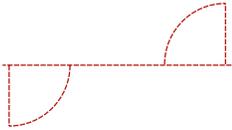
3. The most restrictive applicable provisions of Section 403 and Chapter 9 shall apply to the entire building or portion thereof. *(508.3.1)*
 - Section 403 encompasses the requirements for hi-rise construction and Chapter 9 include the provisions for fire protection systems. In other words, the building 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)*
 - Standby power *(403.4.8)*
 - Emergency power systems *(403.4.9)*
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.

Design Solutions

● Case Study 1: Vertical Coiling with Complying Swing Egress Door(s)

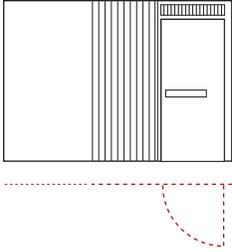


In this case study the most equitable alternative would be to provide occupancy separation at the conference/training room area separating the A-3 from the B occupancy. By incorporating a wide-span opening protective the design is not limited to a pair of conventional swing doors for opening width. Further, the overall building design can accommodate 5 stories and remain a Type IIIA building eliminating the need for imposing all of the most restrictive provisions of Section 403 and Chapter 9.

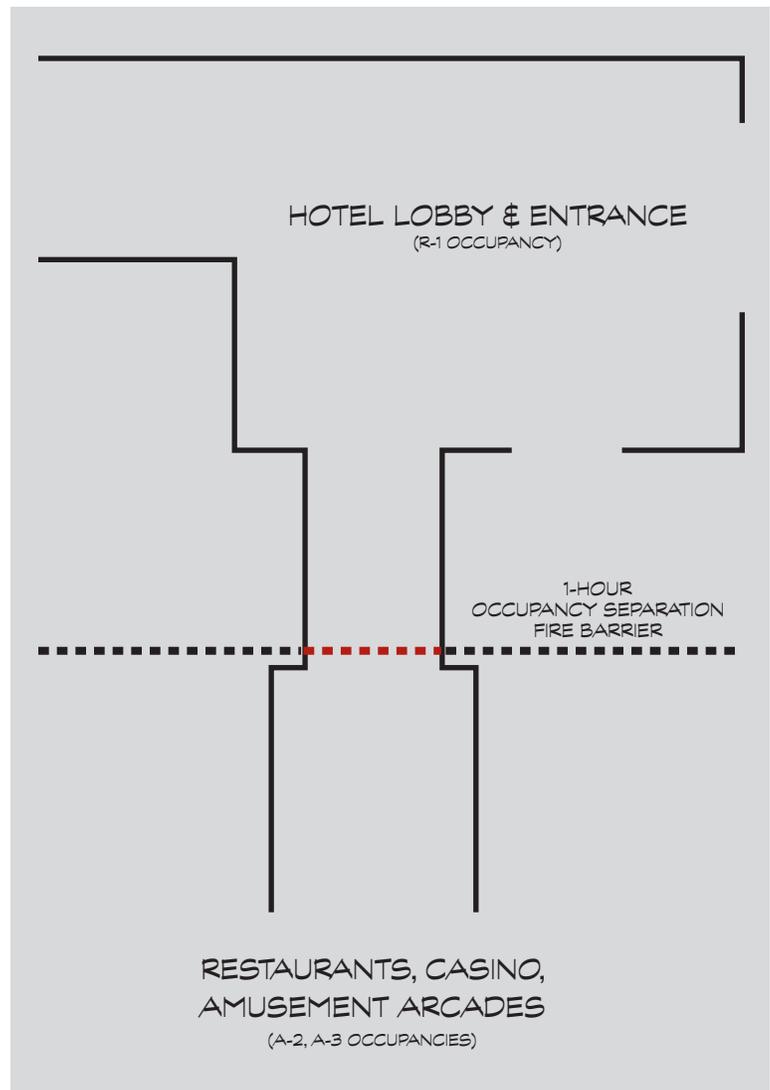


OCCUPANCY SEPARATION

● Case Study 2: Side Acting with Complying Swing Egress Door(s)

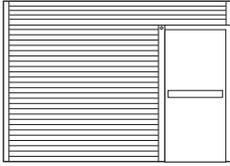


This case study is a text book case of occupancy separation, but is very unique in product application problem solving from an architectural perspective. The fire barrier wall was traversed the structure in very limited space areas. Pocket space was limited in width not depth and headroom was extremely limited. Due to the ambiance of the space conventional swing doors on magnetic hold-opens was not an option. McKeon provided the S7000 series which requires no more than 3.5" of pocket width and less than 3" of head track width space. Due to a patented side acting technology the assembly easily incorporated four conventional swing doors and simply allowed the entire assembly to slide into a 3.5" space parallel the fire barrier wall. Upon command of the smoke detector the 3 hour assembly slides into place providing occupancy separation and conforming egress.

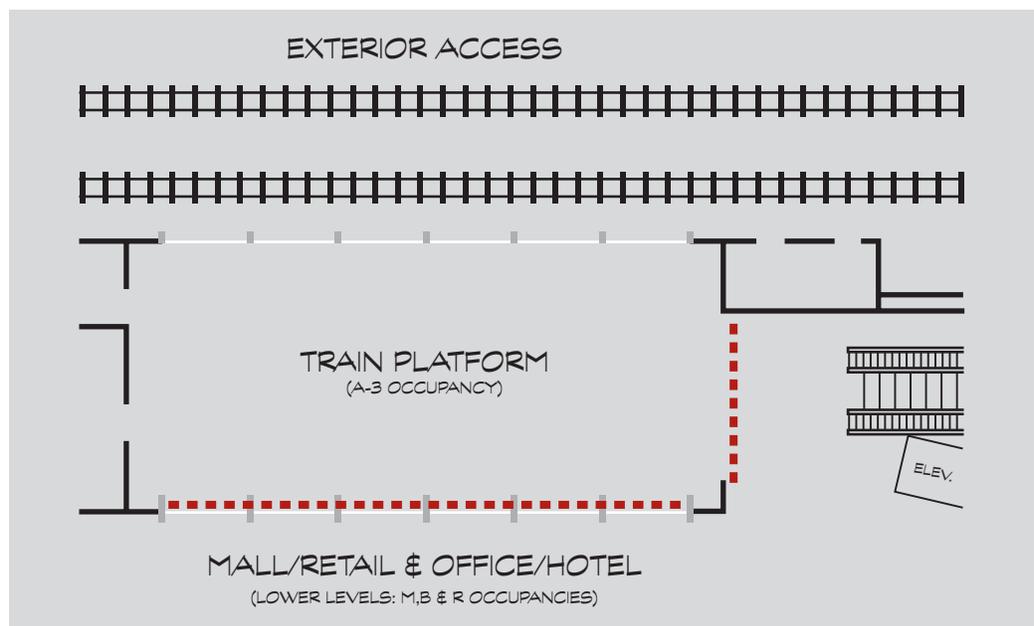
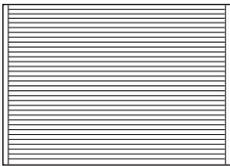


OCCUPANCY SEPARATION

● Case Study 3: Vertical Coiling with Complying Swing Egress Door(s) & Vertical Coiling without Egress

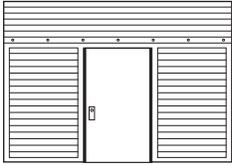


In this third case study McKeon Door Company offers a solution to a difficult challenge by providing two different products within the same space. A combination of six fire-rated vertical rolling shutters installed on a diagonal path of travel and one vertical coiling assembly with conventional egress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

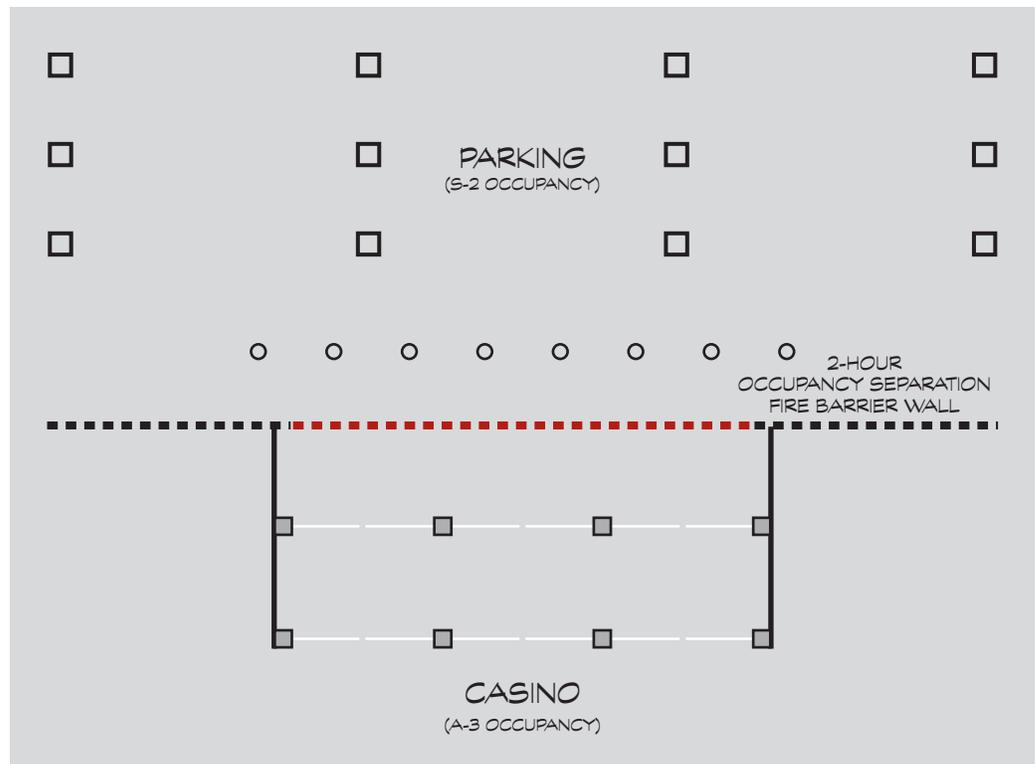


OCCUPANCY SEPARATION

● Case Study 4: Vertical Acting with Complying Swing Egress Door(s)

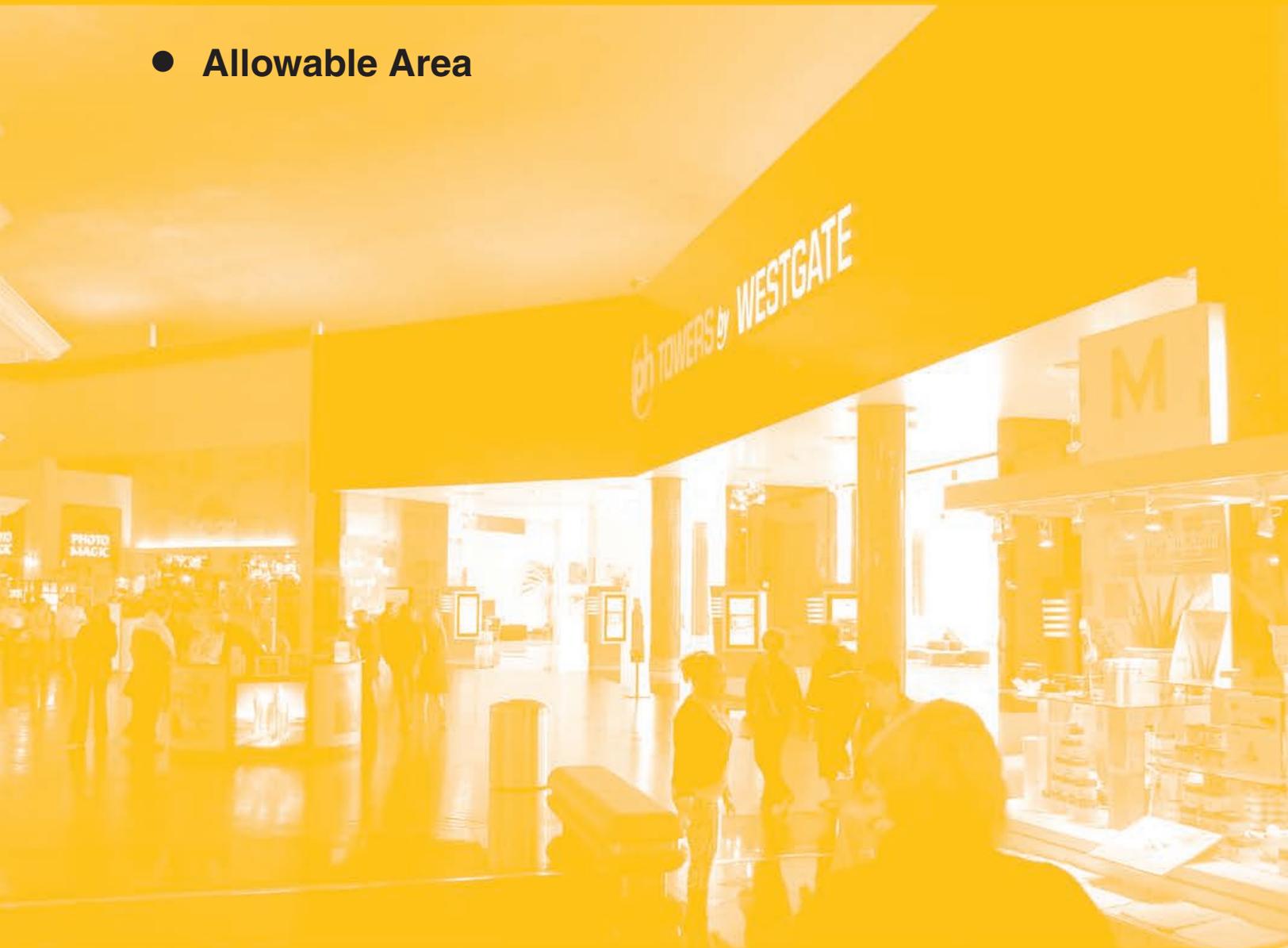


This application illustrates McKeon's capacity to provide 3-hour separation, conforming to a large occupant load exit width without occupying side stacking space. Deploying only in case of fire or emergency, both egress and fire separation requirements are satisfied without compromising design.



Area Separation

- Allowable Area



Allowable Area

Section 706; Table 503

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 fundamental principles in fire & 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 elements 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.

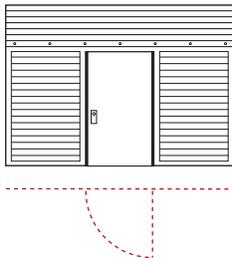
AREA SEPARATION

Code Requirements

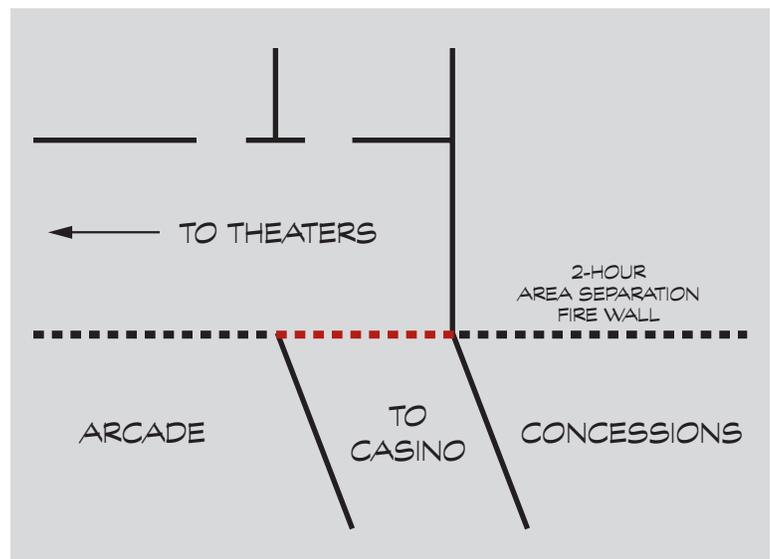
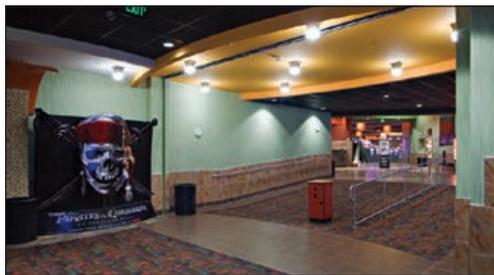
1. Table 503 of Chapter 5 indicates the tabular height and area allowances for specific building construction types and occupancies.
2. Each portion of a building separated by one or more fire walls shall be considered a separate building. (706.1)
3. Openings in fire walls are subject to the following 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.

Design Solutions

● Case Study 1: Vertical Acting with Complying Swing Egress Door(s)

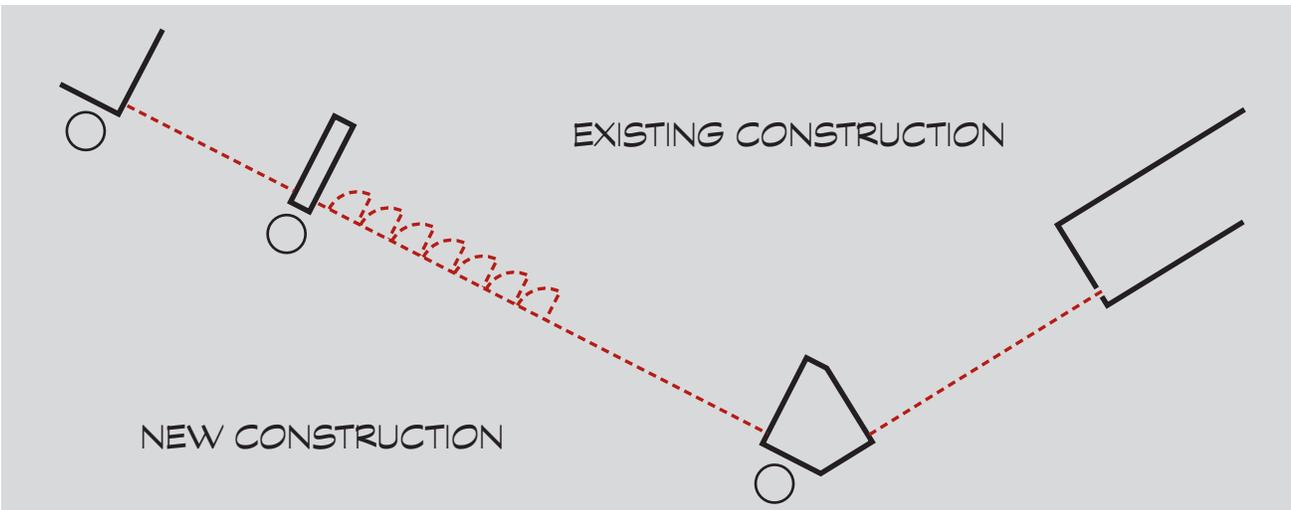
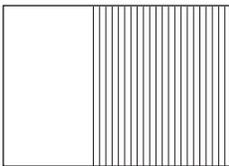
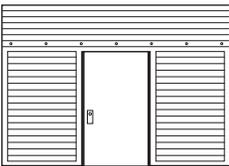
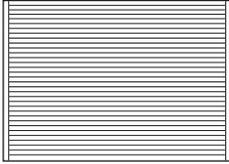


In this application McKeon resolved two significant design code compliance problems without sacrificing wide span open appearance. First, nearly the entire opening was necessary to meet the exit width requirements located in the primary means of egress system in an “A” occupancy. Using the McKeon accordion 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.



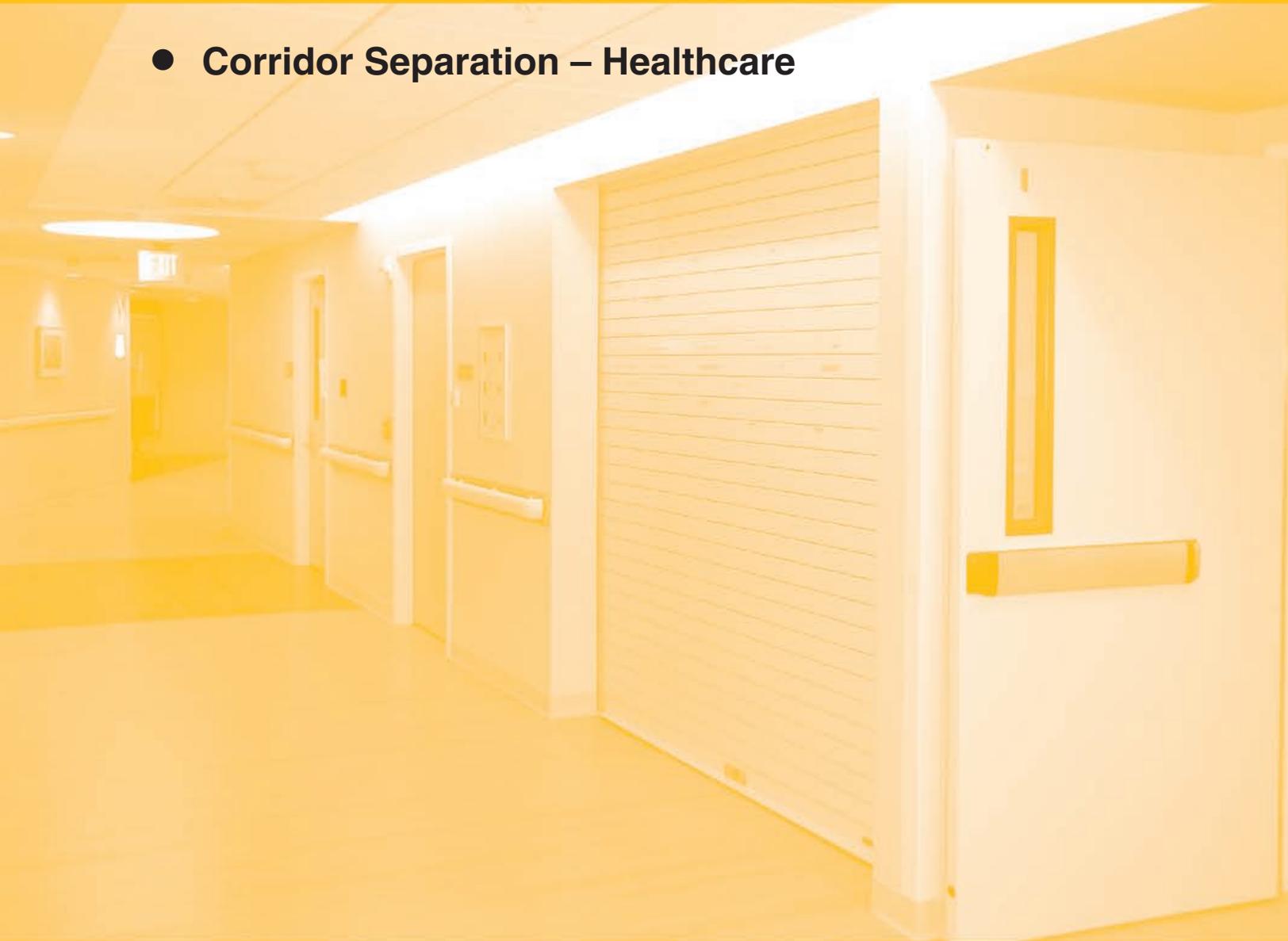
AREA SEPARATION

- **Case Study 2:** Vertical Coiling without Egress, Vertical Acting with Complying Swing Egress Door(s) & Side Acting without Egress



Corridor Separation

- **Corridor Separation – Healthcare**



Corridor Separation – Healthcare

Section 407.2.4

Gift shops focus on retail exposure to the public. Nonetheless they are located in hospitals and typically open to corridors that fall under strict provisions for life safety. Compliance with these strict provisions using conventional opening protectives can limit market exposure.

Fire & Life Safety Concerns

The corridor system in a hospital is designed to protect non-ambulatory patients and their attendants from the transfer of heat and smoke from adjacent spaces. Gift shops offer a particular threat due to the potential fuel load created by large quantities of merchandise and paper goods. So it goes, the smaller the shop the lesser the threat of contents that are burning during a fire emergency. Therefore the code requires no separation at the corridor opening of a gift shop if the square footage is minimal.

Code Requirements

Gift shops are allowed to be open to the corridor where the total square footage of the space does not exceed 500 square feet. (407.2.4)

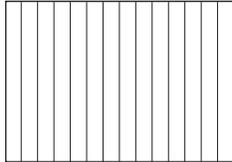
To better understand the opening protective requirements let's review the corridor provisions for I-2 occupancies (hospitals).

1. The corridor wall shall be constructed as a smoke partition. (407.3)
2. Smoke partitions are not required to be fire-rated. (710.3)
3. Doors protecting openings in smoke partitions in I-2 occupancies are as follows:
 - Non-fire-rated. (407.3.1)
 - Not required to be self-closing or automatic-closing. (407.3.1)
 - Must be positive latching. (407.3.1)
 - Shall provide an effective barrier to limit the transfer of smoke. (407.3.1)
 - Must be a smoke and draft control door listed under UL1784. (710.5.2)

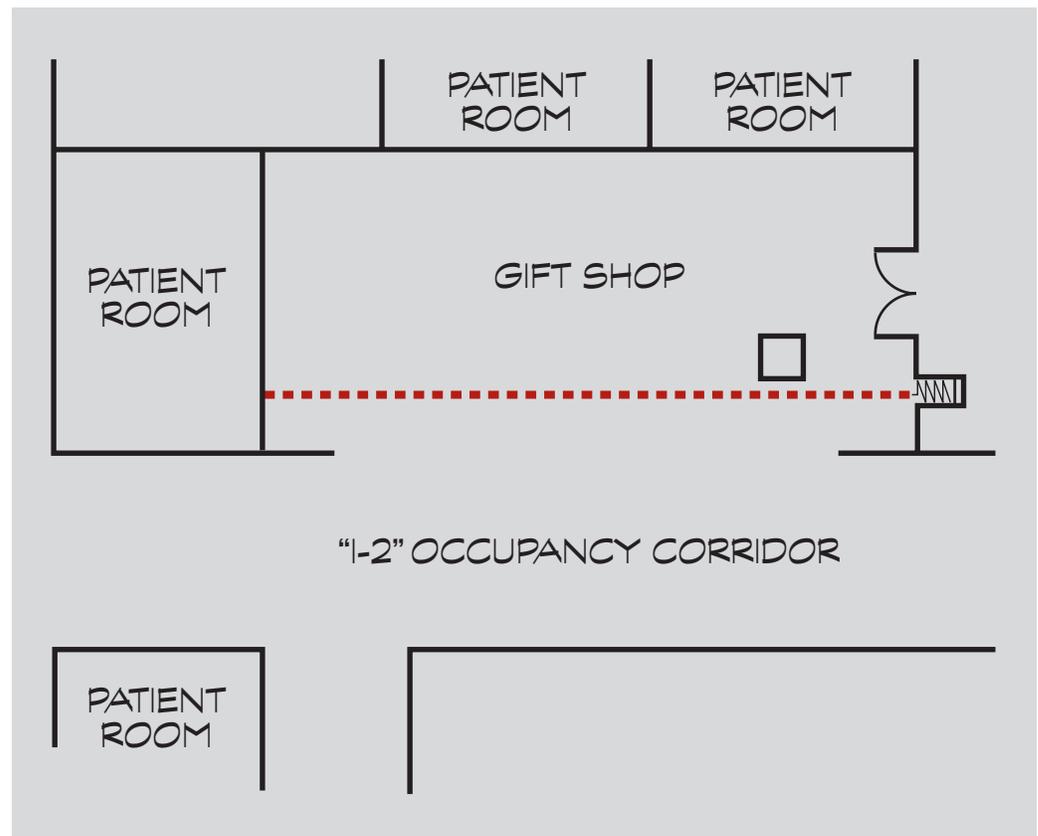
CORRIDOR SEPARATION

Design Solutions

● Case Study 1: Side Acting Accordion with Power-assisted Egress

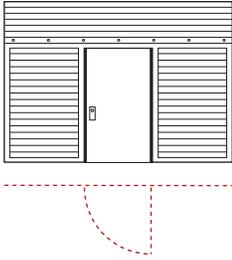


Incorporating the McKeon wide-span side acting accordion allows this space to be open for business without view or customer access restriction. At the command of a smoke detector the large width opening is quickly protected and the fire & life safety corridor provisions are not compromised.

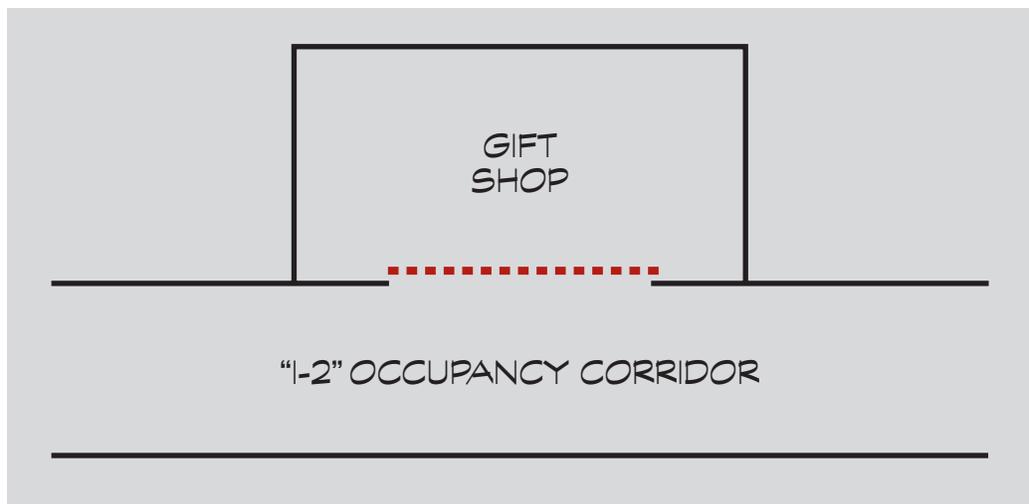


CORRIDOR SEPARATION

● Case Study 2: Vertical Acting with Complying Swing Egress Door(s)

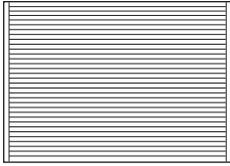


Incorporating the McKeon T5000 technology, the egress doors are completely concealed in the vertical space above, to close only in case of fire.

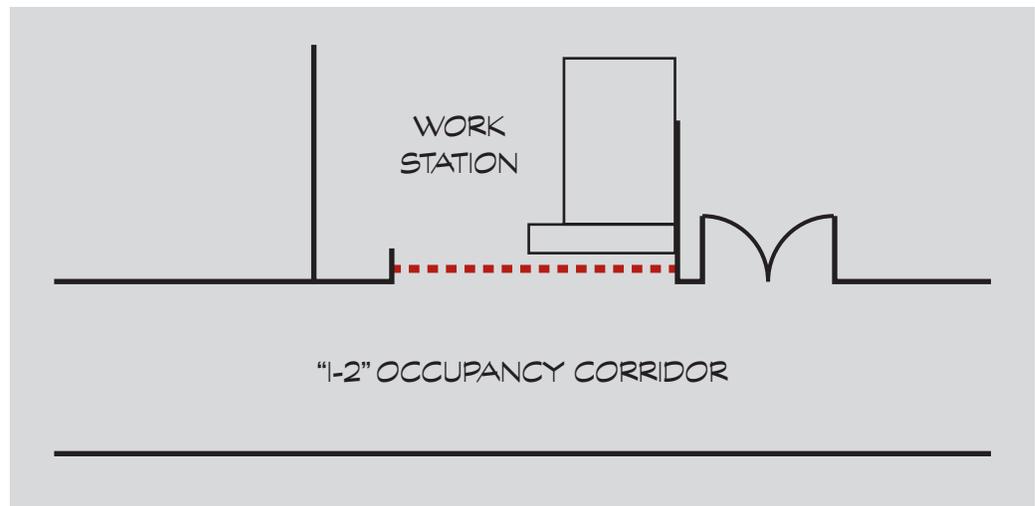


CORRIDOR SEPARATION

● Case Study 3: Vertical Coiling without Egress

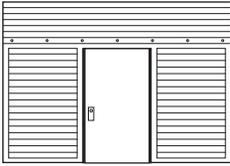


Egress is not required but a 2-hour fire rating is. This work station is left open during normal business hours and easily lowered and locked after hours. Completely automated, whether in fire or security mode any building occupant can operate the assembly.

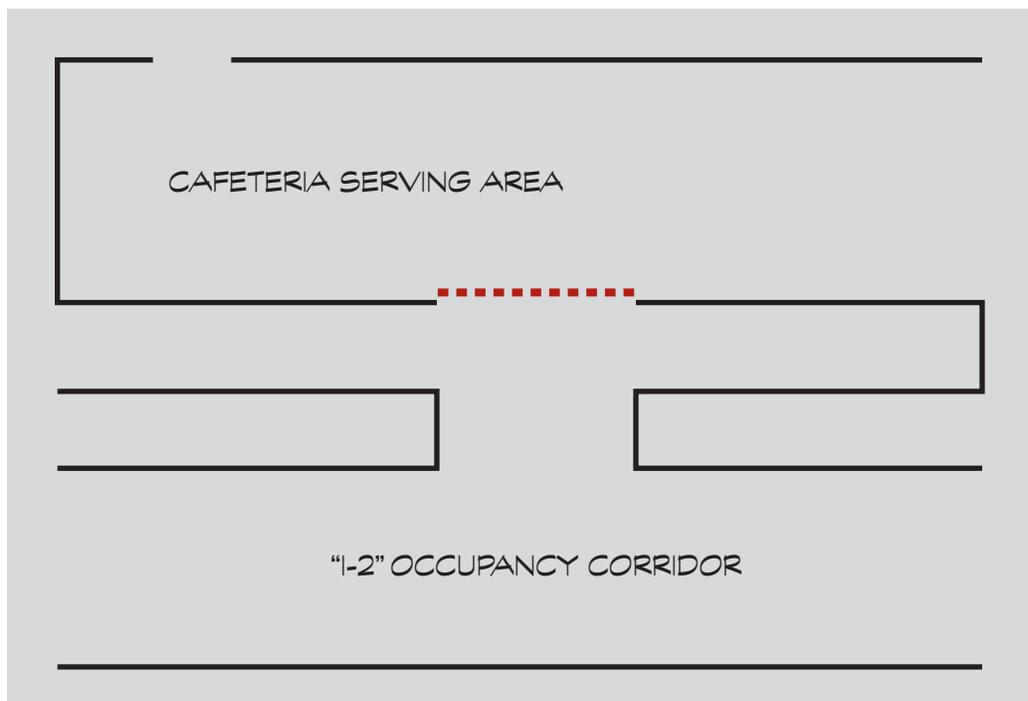


CORRIDOR SEPARATION

● Case Study 4: Vertical Acting with Complying Swing Egress Door(s)

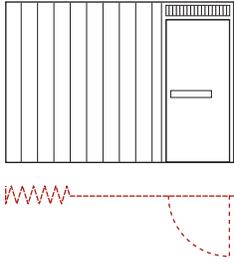


The width of the opening did not allow for much more rated assembly than the doors themselves. Using the T5000 technology a full pair of swing doors, meeting the required exit width, are incorporated in an opening that does not afford space for accommodating the doors mounted in the surrounding construction. By taking advantage of progressive wide-span opening protective engineering, neither the space nor the code requirements are compromised.

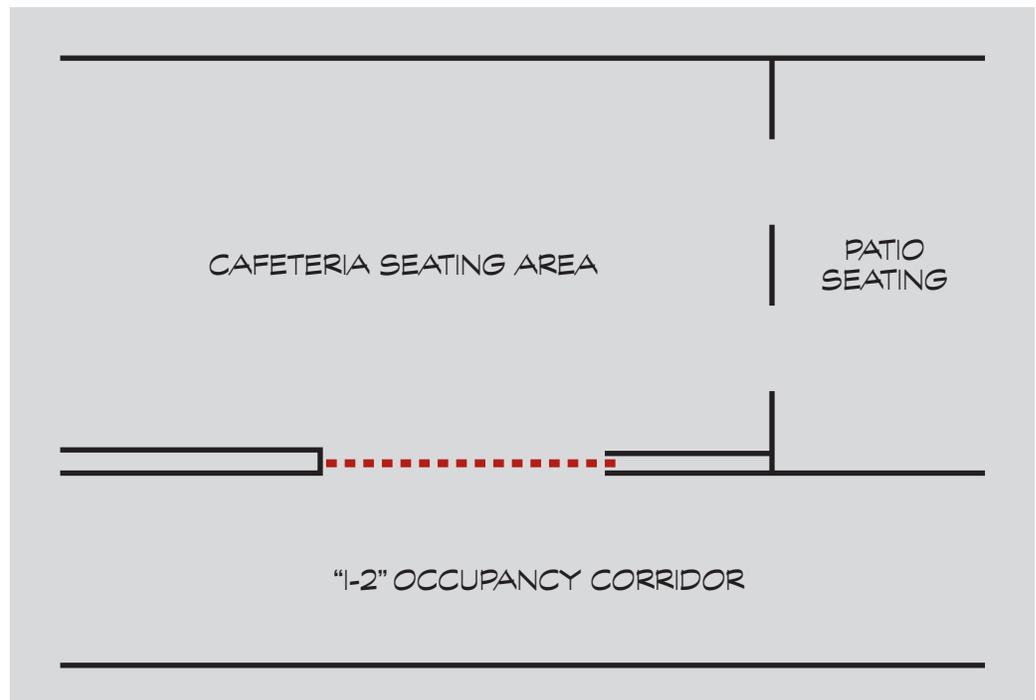
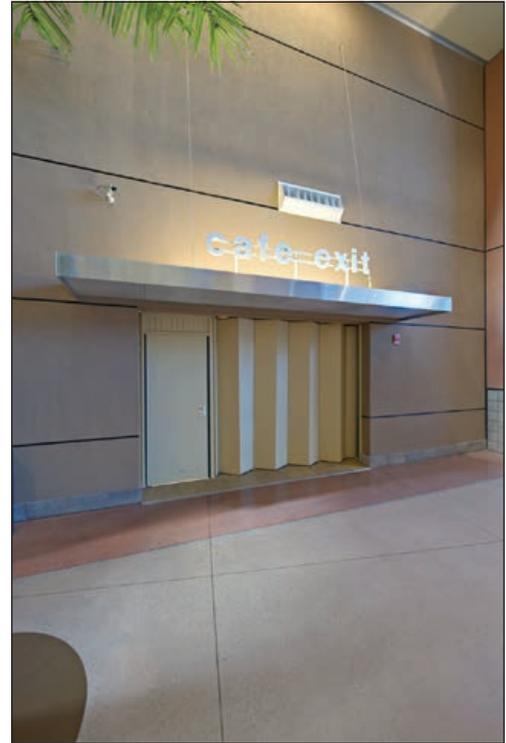


CORRIDOR SEPARATION

● Case Study 5: Side Acting Accordion with Complying Swing Egress Door



The accordion technology easily accommodates a conventional egress door.



Inquiry Discussion & Questions

This gift shop space is considered an incidental use area when it exceeds 500 square feet. Most designs will limit this space to 500 square feet or incorporate sheet rock, swing doors and wire glass to accommodate greater area spaces that open to the corridor. Table 509 lists other incidental use areas but does not include gift shops in I-2. The issue that drives the gift shop separation requirement is that it opens to a corridor. Incidental use areas that are required to be separated as listed in Table 509 may or may not be open to a corridor, regardless, each must be separated. This understanding would open an interesting discussion when attempting to differentiate between corridor separation spaces and/or incidental use areas.

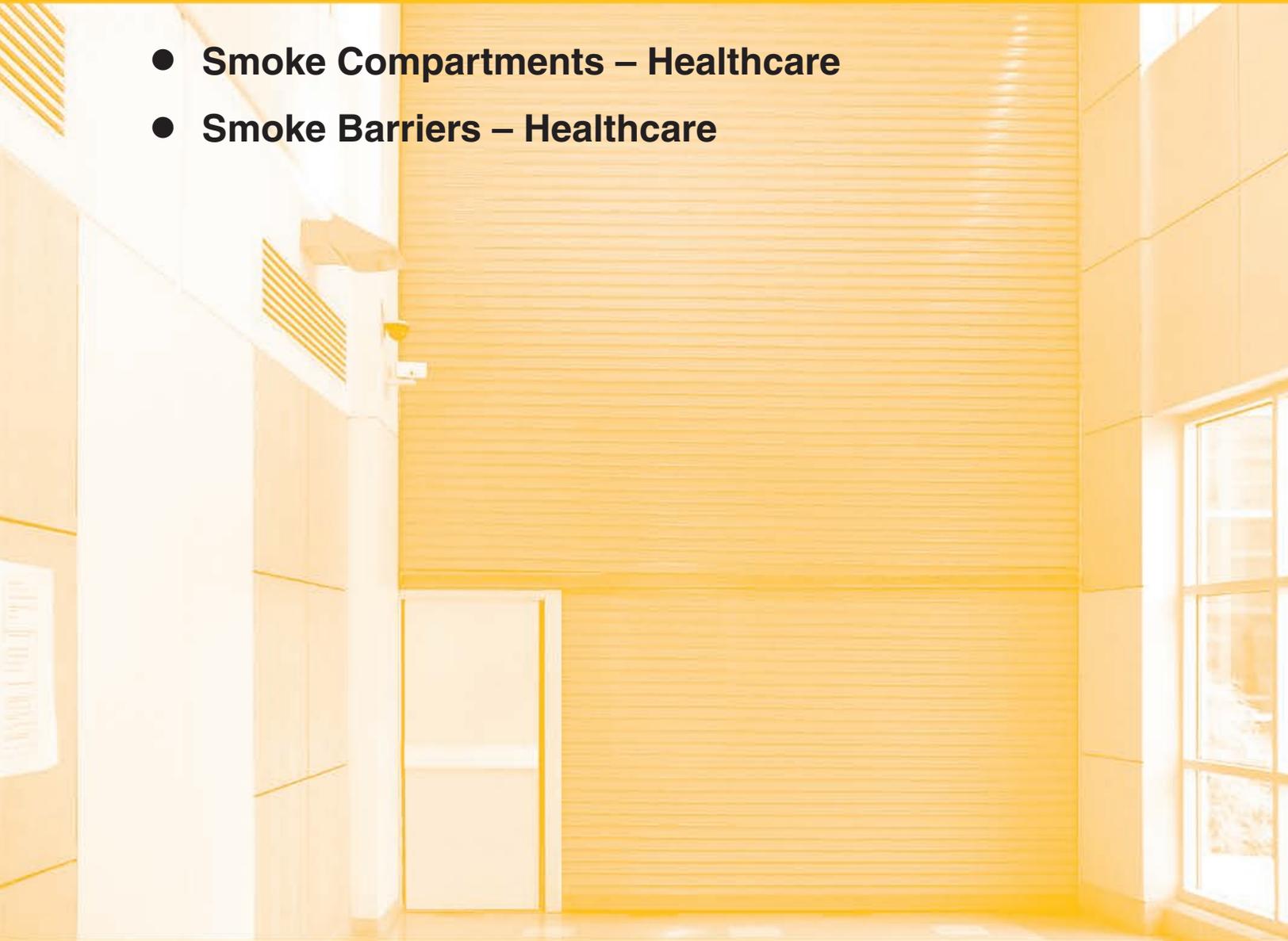
The following questions may be helpful in understanding pertinent challenges:

- Do you desire to have a gift shop larger than 500 square feet?
- Even though a gift shop, larger than 500 square feet, is not shown on Table 509 as an incidental use space ... why is it required to be separated with 1-hour construction?
- May I show you how McKeon can help you eliminate a closed-in appearance at the corridor bordering gift shops exceeding 500 square feet in area?
- Is a waste and linen room required to be separated if it is not located on a corridor? (See Table 509)
- Which is the least expensive when separating laboratories or vocational shops; 1-hour separation with wide-span opening protectives or elaborate fire-extinguishing systems in addition to sprinklers? (See Table 509)

Notes:

Smoke Compartmentation

- **Smoke Compartments – Healthcare**
- **Smoke Barriers – Healthcare**



Smoke Compartments – Healthcare

Section 407.4.3

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

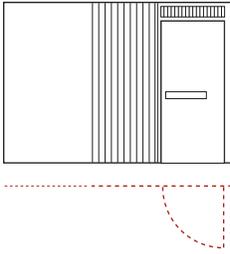
1. Habitable rooms or suites in Group I-2 occupancies shall have an exit access door leading directly to a corridor. (407.4.1)
2. Suites of patient sleeping rooms shall not exceed 5,000 square feet. (407.4.3.5.1)
3. Care suites containing other than patient sleeping rooms shall not exceed 10,000 square feet. (407.4.3.6.1)
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. (407.4.3.5.2)
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. (407.4.3.6.2)
6. Travel distance between any point and an exit access door in a room shall not exceed 50 feet. (407.4.3.4)
7. Travel distance between any point in a suite of sleeping rooms shall not exceed 100 feet. (407.4.3.5.3)
8. Vision panels are required in cross-corridor application of I-2 occupancies. (709.5, Exception #1)
9. Walls designed to create separate suites shall be construction as non-rated smoke partitions. (407.4.3.2)
10. Openings within smoke compartment walls that are not used to protect a

SMOKE COMPARTMENTATION

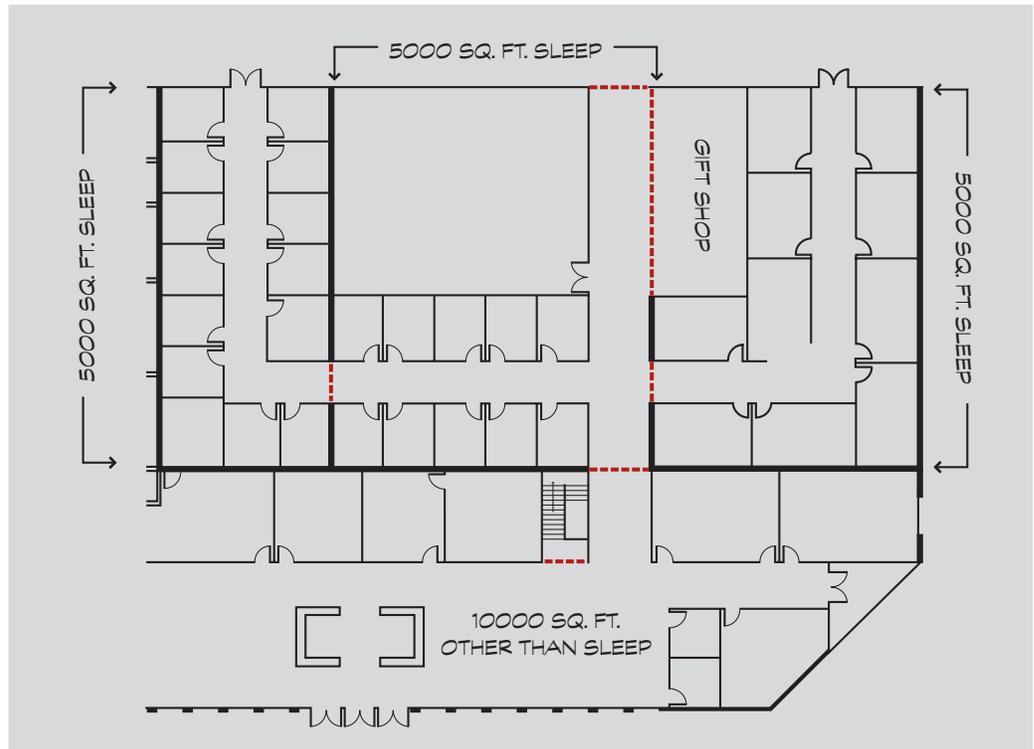
vertical opening or an exit are not required to have a fire-rating but shall provide an effective barrier to limit the transfer of smoke. Also, these opening protectives do not have to be self-closing. (Section 407.3.1)

Design Solutions

● Case Study 1: Side Acting with Complying Swing Egress Door(s)

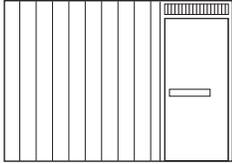


In this case study we find it difficult to maintain continuity with compartmentation when passing through corridors or other open areas with smoke partition walls. With the wide-span capabilities of the McKeon door assembly there is no compromise with building function ability and code compliance.

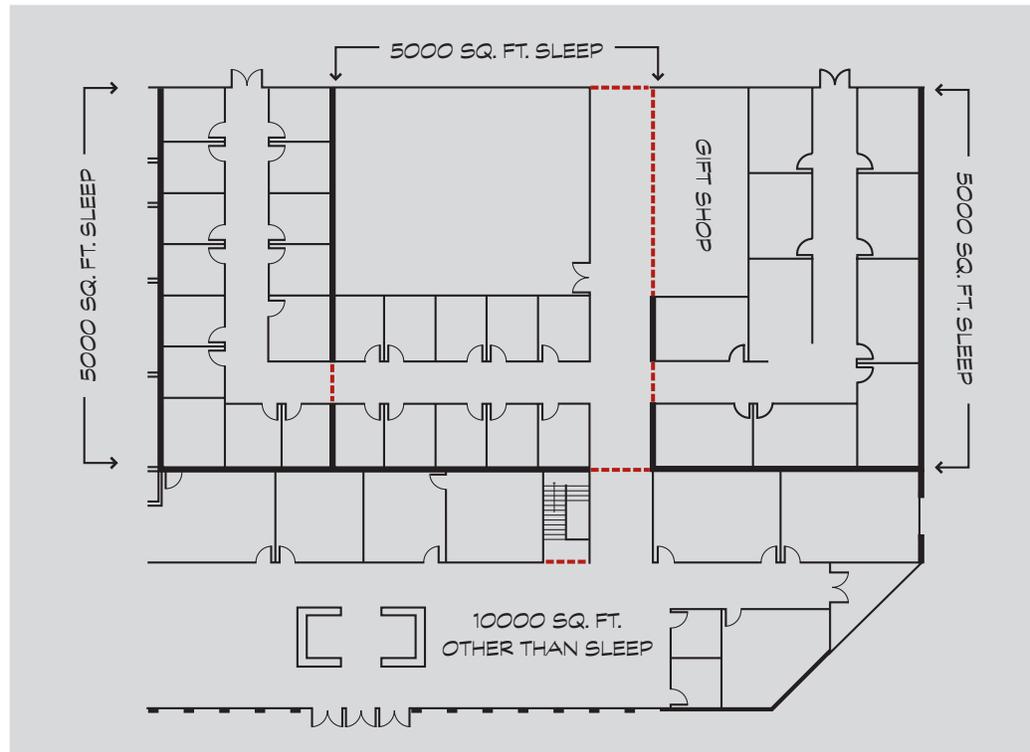


SMOKE COMPARTMENTATION

● Case Study 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 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 709.4)

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 407.4.3). 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:

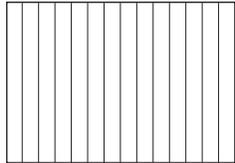
1. Group I-2 occupancies are required to subdivide every story into smoke compartments with an area not more than 22,500 square feet. (407.5)
2. Smoke compartments are to be divided using smoke barrier walls in accordance with Section 709. (407.5)
3. Smoke barriers are required to subdivide every story 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)
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 407.5.2)

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

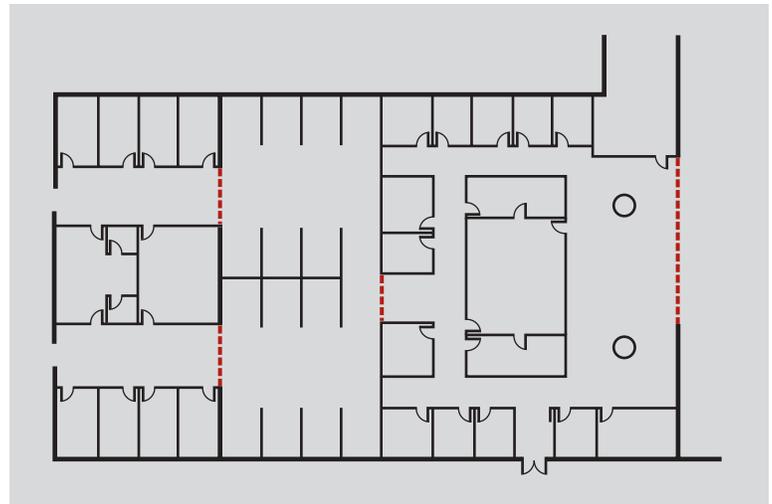
1. Minimum fire rating of 20 minutes. (Section 716.5.3 & Table 716.5)
2. Vision panels. (709.5, Exception #1)

Design Solutions

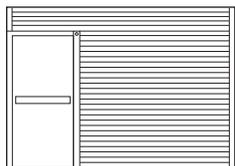
● Case Study 1: Side Acting Accordion with Power-assisted Egress



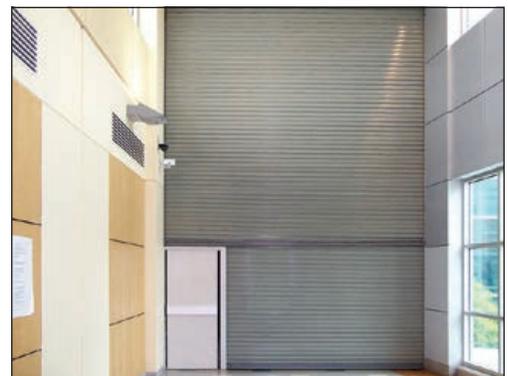
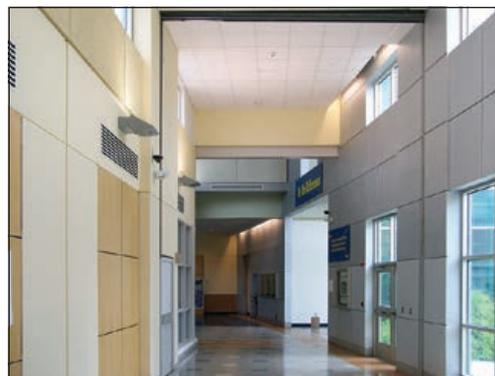
In this case study the intent is to add to an existing I-2 occupancy a 9,700 square foot Critical Care Suite. The existing building construction type is IIIA with 21,324 square feet and the desire is to have the new suite as open as possible to the existing hospital corridor system. The placement of 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 ambience desired.



● Case Study 2: Vertical Coiling with Complying Swing Egress Door(s)

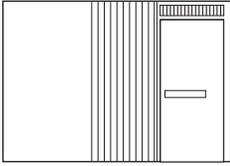


Smoke barrier requirements are no respecter of design. Regardless of the size of the space, these barriers must be maintained throughout the building. McKeon Door can easily meet the ambience with these unusually large openings without compromising fire & life safety or egress.

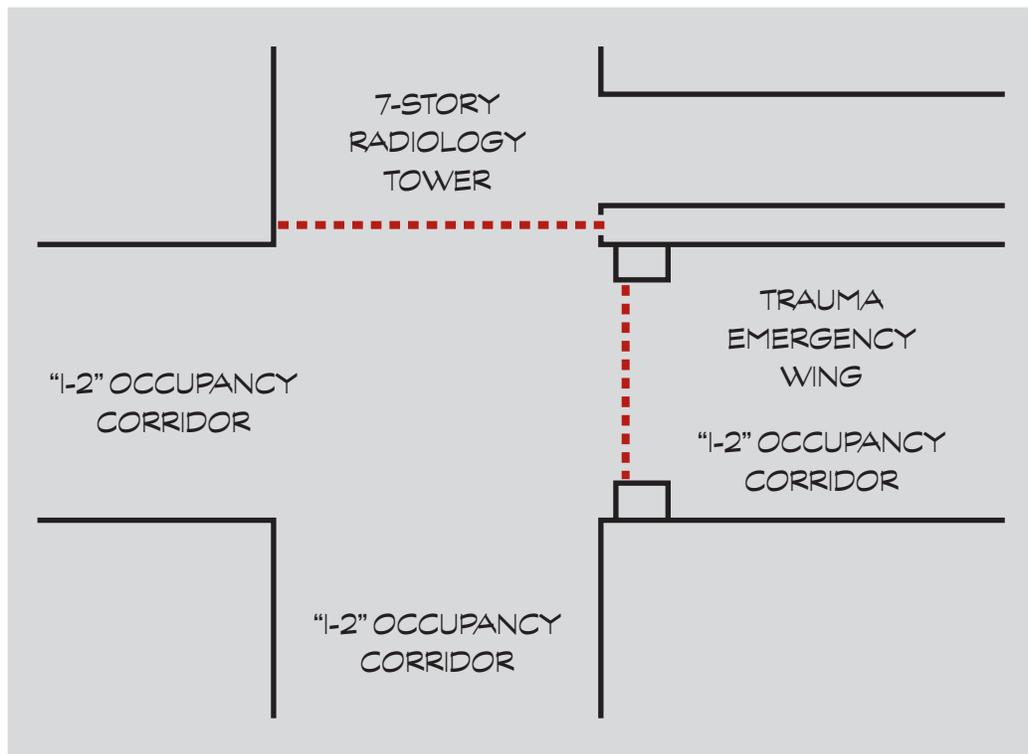
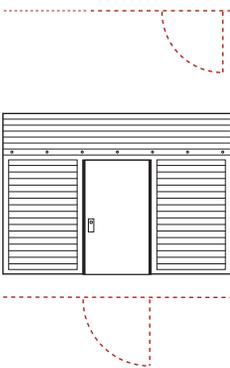


SMOKE COMPARTMENTATION

● Case Study 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.



Appendix

- **Definitions**
- **Resources**

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. (706.1)
- 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 (Table 503)
- Horizontal Exits (1025)

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: (Table 707.3.9)

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 (1022.1)
- Exit Passageways (1023.3)
- Horizontal Exits (1025.1)
- 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 (1009.3.1.2)

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 716.5) and shall be smoke tested under UL 1784. (708.6)

Design Notes

- Most rated corridor walls fall into this category. (708.1 and Table 1018.1)
- Corridor walls in an I-2 Occupancy (Hospital) shall be constructed as Smoke Partitions. (407.3 & 710)

Applications

- Walls separating dwelling units in the same building (708.1)
- Walls separating sleeping units in occupancies in Group R-1 Hotel, R-2 and I-1 Occupancies (708.1)
- Walls separating tenant spaces in covered mall buildings as required by Section 402.2 (708.1)
- Corridor walls as required by Section 1018.1 (708.1)
- Elevator lobby separation as required by Section 713.14.1, Exception #5 (708.1)

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 tested. (Table 716.5)

Design Notes

- Door assemblies in cross-corridor smoke barriers of I-2 Occupancies (Hospitals) shall have vision panels. (709.5, Exception #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. (407.4.3) 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

Smoke Partitions – Section 710

Definition

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

Fire Ratings (710.3)

Non-rated

Opening Protection

Door assemblies shall be UL 1784 tested and self closing by smoke detection. (710.5)

Design Notes

- Smoke partitions and their use lack clarity in the building code. Although it is not specifically referenced, smoke compartmentation can be accomplished with non-rated smoke partitions.

Applications

- Corridor walls of I-2 Occupancies (Hospitals) (407.3)
- Elevator Lobbies (713.14.1 Exception #5)
- Separation of Suites in Group I-2 Occupancies (407.4.3.2)

International Building Code, 2012

Means of Egress (AC8800 Series)

1008.1.2 Door Swing. Egress doors shall be side-hinged swinging.

Exceptions:

6. In other than Group H occupancies, horizontal sliding doors complying with Section 1008.1.4.3 are permitted in a means of egress.

1008.1.4.3 Horizontal sliding 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 1008.1.2 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 716.5.9.3 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, 2012

Means of Egress

7.2.1.4 Swing and Force to Open

7.2.1.4.1.4b Horizontal-sliding doors complying with 7.2.1.14 shall be permitted.

7.2.1.14 Horizontal-Sliding Doors. Horizontal-sliding doors shall be permitted in 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 horizontal-sliding exit access door 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*.

ICC Evaluation Service Report

ESR-2219

For access to this report:

- Download from the ICC Evaluation Service Website at www.icc-es.org
- Contact McKeon at info@mckeondoor.com
- Telephone at 800-266-9392



McKeon Door Company

44 Sawgrass Drive

Bellport, NY 11713

Phone: 800-266-9392

Fax: 631-803-3030

Email: info@mckeondoors.com

www.McKeonDoor.com

