Perimeter Fire Containment in Multi-Story Buildings

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Getting Started

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START

Learning Objectives

At the end of this program, participants will be able to:

- list and compare the three types (detection, suppression and passive) of life safety systems
- discuss the importance of adopting a balanced approach towards the design and installation of redundant life safety systems in multi-story construction
- define the areas and effects of fire propagation in multi-story buildings
- state the design principles for perimeter curtain wall fire containment to facilitate a successful installation, and
- discuss the current model building codes, standards, fire resistance directories that address life safety protection requirements for the perimeter of a building.

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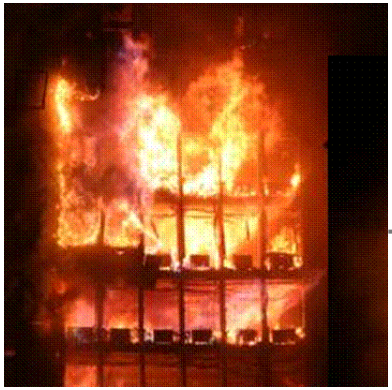


Photo Courtesy of Hilti, Inc.

Life Safety Systems:

An Introduction

Introduction

There are several important reasons why we need to be concerned about high-rise fire safety.

One concern is property preservation. We want to protect the building itself, as well as the contents of the building, such as computers, furnishings, and files: elements that are essential to maintaining a business or household. But what we most want to protect is the one thing that is irreplaceable and that is human life.

As such, the basis of fire containment and life safety requires attention to life safety at the perimeter of a building (the area where the exterior curtain wall and the floor assembly intersect); one of the most complex and least understood areas where fire can spread.

Life Safety at the Perimeter of the Building

The objective of developing a better understanding of perimeter fire containment is to prevent a fire like this that occurred at the 1st Interstate Bank, Los Angeles, CA.

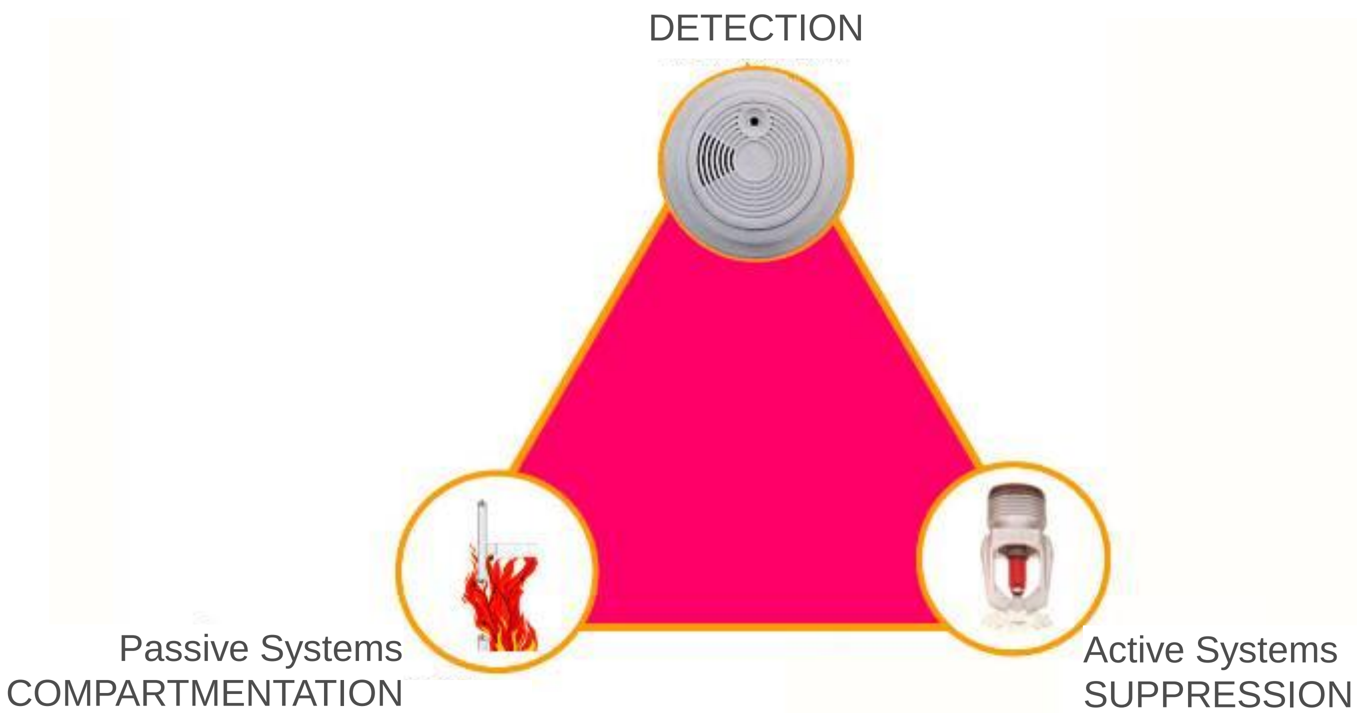
The intersection at the perimeter of the building was the very same area that allowed this fire to escape from the room of origin and move freely to several floors above.

According to the Los Angeles Fire Department investigative report: *the fire transmitted up the inside of the curtain wall. The curtain walls were firestopped with fiberglass or some other material that burned out, allowing fire to run up the interior of these walls…*

1st Interstate Bank, Los Angeles, CA.

Three Elements of Life Safety

There are three elements that the building community uses to address life safety: detection, suppression (active systems) and compartmentation (passive systems).



Three Elements of Life Safety cont'd…

Detection:

Known as the "detective" approach to life safety, a detection system includes alarm systems (smoke and heat detectors).

Suppression:

A suppression system (or active system) has a turn on/turn off mechanism that must switch on in order for it to work. The most common suppression system is a sprinkler system.

Compartmentation:

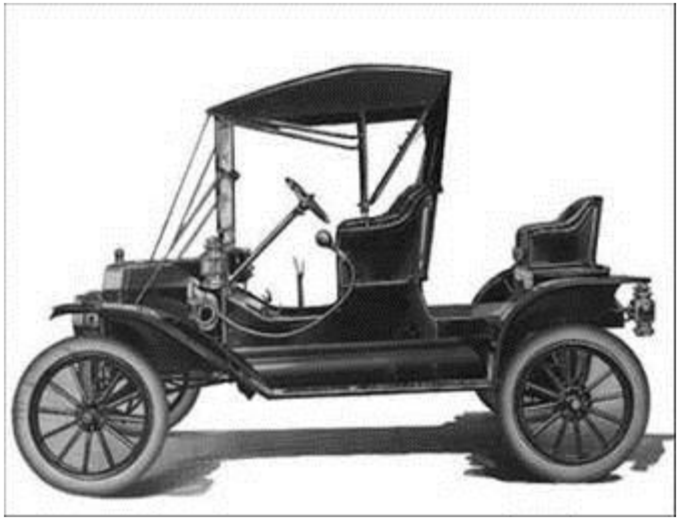
Passive fire protection, which includes compartmentation of the overall building through the use of fire-rated walls and floors, has no turn on/turn off mechanism, so once it is properly installed, it provides protection 24-7. A passive system prevents or slows the spread of fire from the room of fire origin to other building spaces, limiting building damage and providing more time for the building occupants to safely evacuate the building or reach an area of refuge as well as allowing first responders to effectively fight the fire.

Evolution of the Automobile – 1900's

When discussing the three elements of life safety, let's first look at the evolution of safety in the automotive industry as an example.

The first automobile was the Model "T" which had no safety features.

The need for implementing life safety design was not a vital concern, because in the early 1900's there were very few automobiles on the road and what few there were, traveled at slower speeds.



1912 Model T Safety Features: None

Evolution of the Automobile – 1960's

In the 1960's, as technology improved, there was an increase in the number of automobiles, with more occupants, on the roads.

Better roads and interstates allowed cars to be driven at higher speeds, thus the need for improved safety features became apparent.

Passive systems, such as seat belts, laminated windshields, and padded dashes began to be incorporated to provide protection for the occupants.

Automobile of the 1960s:
Passive Safety Features Only

Evolution of the Automobile – 2000's

Today, with the volume of cars and the speeds at which they travel, design safety is a very high priority. Through the evolution of automobile safety, these features are now available:

- audible seat belt alarm
- seat belts/air bags
- energy absorbing bumpers
- padded passenger compartment
- collapsible steering wheel
- disc/anti-lock brakes
- door reinforcements
- laminated windshield
- tempered side windows
- unitized body construction
- no sharp/angular metal in body/passenger compartment

Many of today's automobiles incorporate all 3 elements of life safety:

Detective - such as audible seat belt alarm
Active - e.g., air bags
Passive - i.e., anti-lock brakes

Evolution of High-Rise Construction: Pre-1930's

Comparing the evolution of automobile safety to the life safety features of high rise buildings, we've learned not to rely on just one of these elements of life safety, but to include all three.

Before we discuss the importance of redundant life safety systems, let's quickly review the evolution of high-rise construction.

Not many high-rise structures were constructed in the early 1900's, and of those few, the percent of occupancy in these buildings was low as compared to 21st century buildings. As a result, pre-1930's buildings had none to very few life safety features installed.

Pre-1930's Buildings: Possible use of heat detectors only

Evolution of High-Rise Construction: 1960's

Moving into the mid 1960's, society starts to see an increase in high-rise construction, with an expansion in the number of people working and living in multi-story buildings.

The need for life safety systems became more pronounced.

Consequently, safety features were installed, typically detective and passive systems.

Prudential Tower - Boston, MA

High-Rise Construction Today

What are the current high-rise construction trends? In most modern cities, the size and number of buildings being constructed today are bigger in every dimension, containing more occupants than ever before.

Accordingly, there is a greater need to provide high-rise fire protection.

The designers of this building (Four Times Square, NYC) chose the balanced approach to fire protection by including all three elements of life safety: detective, active, and passive.

Four Times Square – New York City, NY

MGM Grand Hotel - Las Vegas, NV

Conversely, The MGM Grand Hotel in Las Vegas, is an example of the tragic consequences that can result when buildings are constructed without safety features.

Eighty-four people died and 679 were injured in the MGM Grand Hotel fire on November 21, 1980.

The effect that disastrous events, such as this, has on human lives is obvious, but the impact can be devastating on the local economy as well. The loss of a such buildings not only affects the business world, but also the community that was supported by the structure, such as local shops, restaurants, and services.

MGM Grand Hotel, Las Vegas

Life Safety Systems:

A Balanced Approach

Introduction

As previously mentioned, incorporating only one type of life safety system is not a reliable solution in high-rise construction.

Detective and active methods may be tampered with or purposely disarmed, as well, both methods are subject to electrical/mechanical failure and may not always function properly. Therefore, having a balanced approach, using redundant life safety measures, assures greater life safety protection.

In this section of the course, we will review the potential problems of both detective and active systems.

DETECTIVE

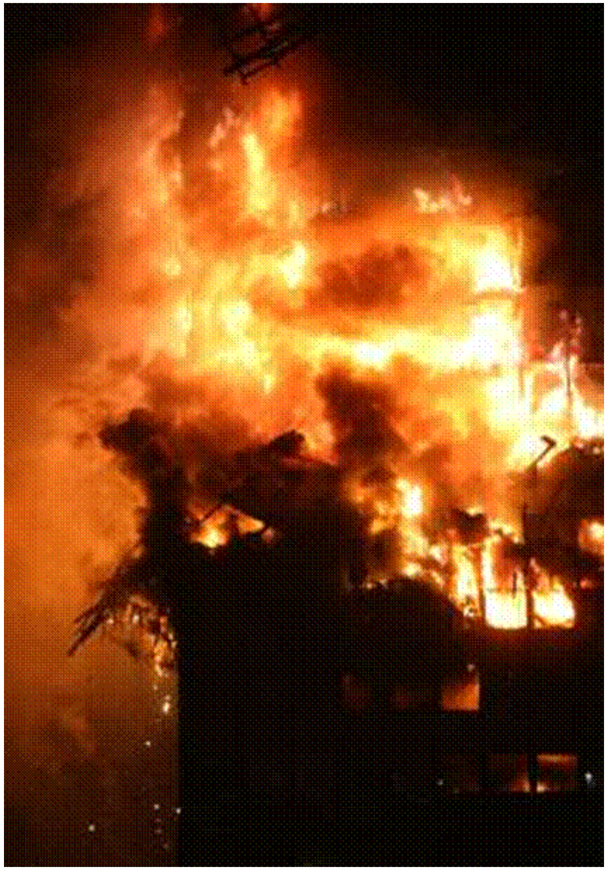
ACTIVE

PASSIVE

Detective System - Potential Problems

Listed below are some of the problematic issues that can lead to failure of detective life safety systems:

- power outage
- emergency power failure
- system malfunction
- system failure during fire
- human error



Active Systems - Potential Problems

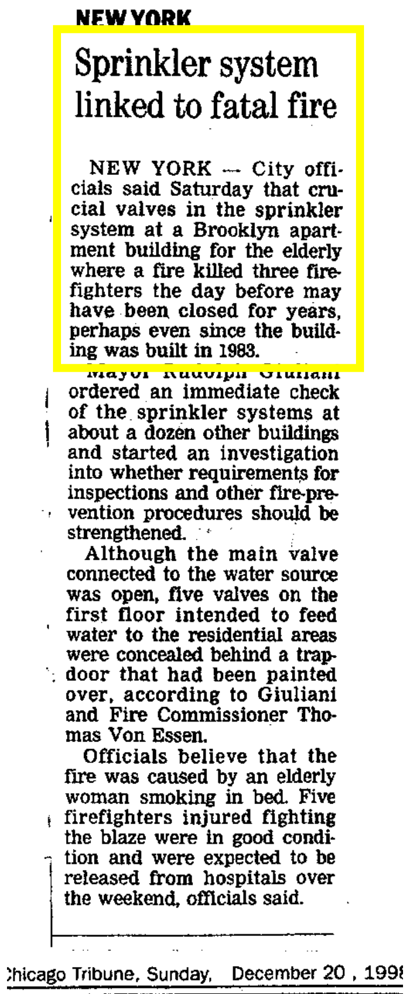
As previously mentioned, the most common active life safety system is the installation of a sprinkler system, although there are several other active methods available. Sprinklers are required in most buildings by model building codes and local jurisdictions. In many cases, sprinklers are installed as a trade-off to other types of fire rated constructions.

Serious potential problems related to sprinkler systems include:

- sprinkler head failure
- closed valves
- insufficient water pressure
- external problems
- microbiotic organisms (bacteria in the water lines can cause pipes to corrode, leading to sediment-clogged lines and sprinkler heads), and
- improper installation.

Some real life examples of these issues are presented in the next three slides.

Active Systems - Chicago Tribune Article, December 1998


NEW YORK

Sprinkler system linked to fatal fire

NEW YORK — City officials said Saturday that crucial valves in the sprinkler system at a Brooklyn apartment building for the elderly where a fire killed three firefighters the day before may have been closed for years, perhaps even since the building was built in 1983.

Mayor Rudolph Giuliani ordered an immediate check of the sprinkler systems at about a dozen other buildings and started an investigation into whether requirements for inspections and other fire-prevention procedures should be strengthened.

Although the main valve connected to the water source was open, five valves on the first floor intended to feed water to the residential areas were concealed behind a trapdoor that had been painted over, according to Giuliani and Fire Commissioner Thomas Von Essen.

Officials believe that the fire was caused by an elderly woman smoking in bed. Five firefighters injured fighting the blaze were in good condition and were expected to be released from hospitals over the weekend, officials said.

Chicago Tribune, Sunday, December 20, 1998

Sprinkler system linked to fatal fire … crucial valves in the sprinkler system … may have been closed for years perhaps even since the building was built in 1983.

Active Systems - Washington Post Article, June 2001

From The Washington Post: ***"Sprinkler Recall Sounds Alarm Some Safety Officials Fear Buildings Depend Too Heavily on Systems."***

For instance, when a fire destroyed a storage facility at the National Severe Storms Laboratory in Norman, Okla., earlier this month, vital research equipment was lost, including a new Doppler radar system for collecting data on tornadoes, thunderstorms and hurricanes. Damage was estimated at $1.8 million.

….. fire destroyed a storage facility …

The sole fire-control system was a sprinkler system. Unbeknown to fire officials and building managers, it had been disconnected four years before, when the lab cut part of the piping system to make room for taller equipment. The sprinkler system hadn't been checked annually, as it should have been.

…sprinkler system had been disconnected four years before...

Faulty heads were blamed in the sprinkler failure in a Santa Barbara, Calif., residence 18 months ago; the two-story house sustained $200,000 in damage. The failure was one of 13 reports that led to the July 19 recall by Central Sprinkler Co.

Faulty heads blamed in sprinkler failure.. The failure was 1 in 13 reports leading to recall by sprinkler company...

Meanwhile, it was clogged pipes -- caused by corrosion from bacteria in the water supply -- that was cited as the reason for the sprinkler failure in February 2000 in a nursing home outside Philadelphia. An 80-year-old woman died, and her sister was injured after the sprinkler closest to the fire failed. The system's pipes were so clogged that the full force of water couldn't reach the sprinkler heads.

Clogged pipes caused by corrosion from bacteria in water supply… reason for sprinkler failure… 80-year-old woman dies.

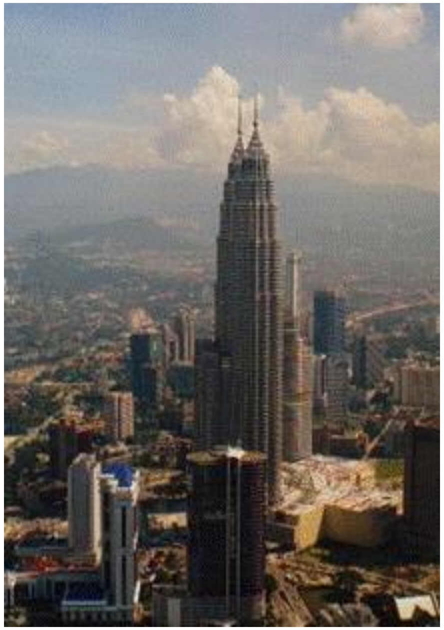
Active Systems - Insufficient Water Pressure

In 2005, multiple floors of this 34-story structure situated in Caracas, Venezuela burned as a result of insufficient water pressure in the pipes.

Photos Courtesy of Hilti, Inc.

Passive Systems

Perimeter fire containment systems (passive systems) have proven their ability to provide life safety and, as a result, many high-rise buildings around the world, such as those shown below, are having this safety feature installed.



Petronas Towers
Kuala Lumpur, Malaysia

Sears Tower - Chicago

Taipei 101 - Taipei, Taiwan

Passive Systems cont'd…

The fire at the LaSalle Bank in Chicago on December 2004 burned for six hours, but due to the passive life safety system, the fire was contained to the 29th and 30th floors.

LaSalle Bank Fire – Chicago, IL

Photos Courtesy of Chicago Tribune

Fire Propagation / Spandrel Failure

Introduction

The illustration below indicates the areas of a commercial building where fire can propagate. Although this course concentrates on the perimeter joints (far left), other areas include grease ducts, interior walls, head of walls, and penetrations.

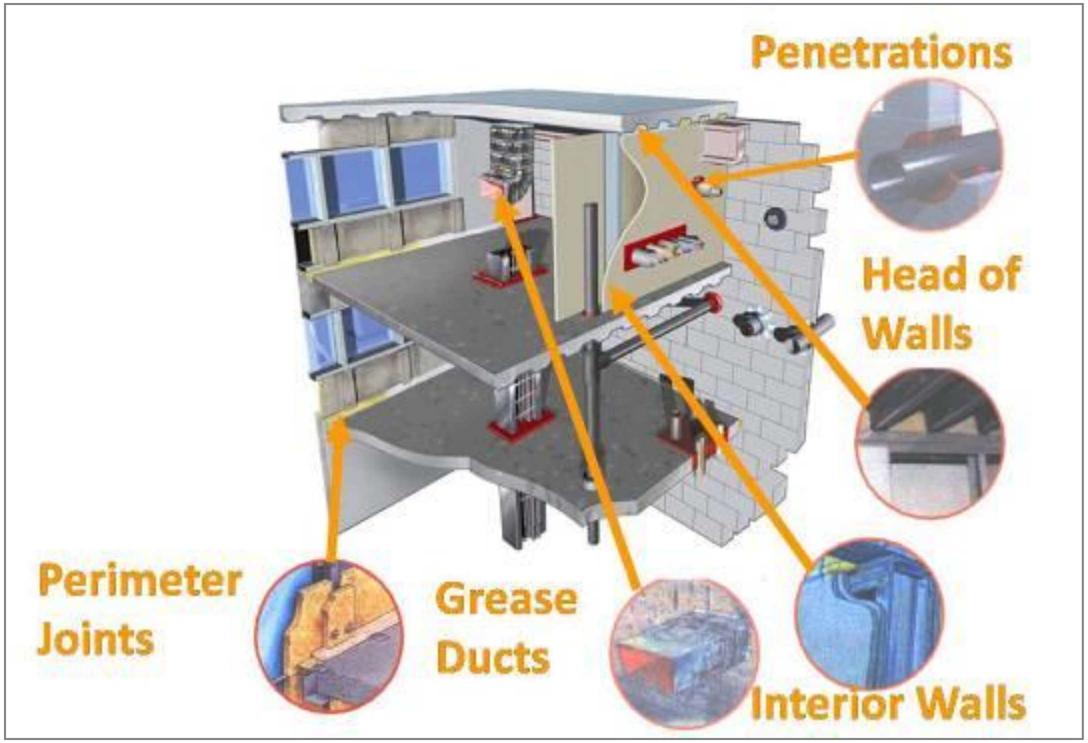


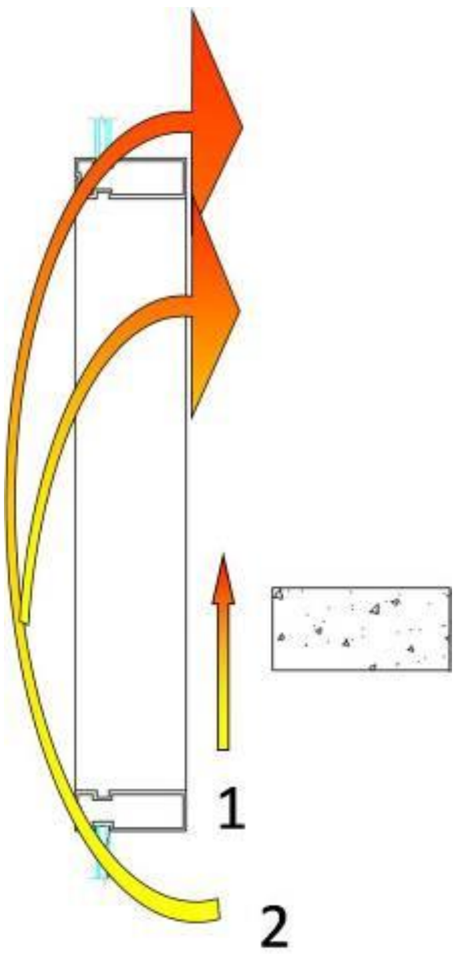
Photo Courtesy of Specified Technologies Inc.

Paths of Fire Propagation

Aside from flames burning through the interior wall, there are other ways fire spreads at the perimeter of a building.

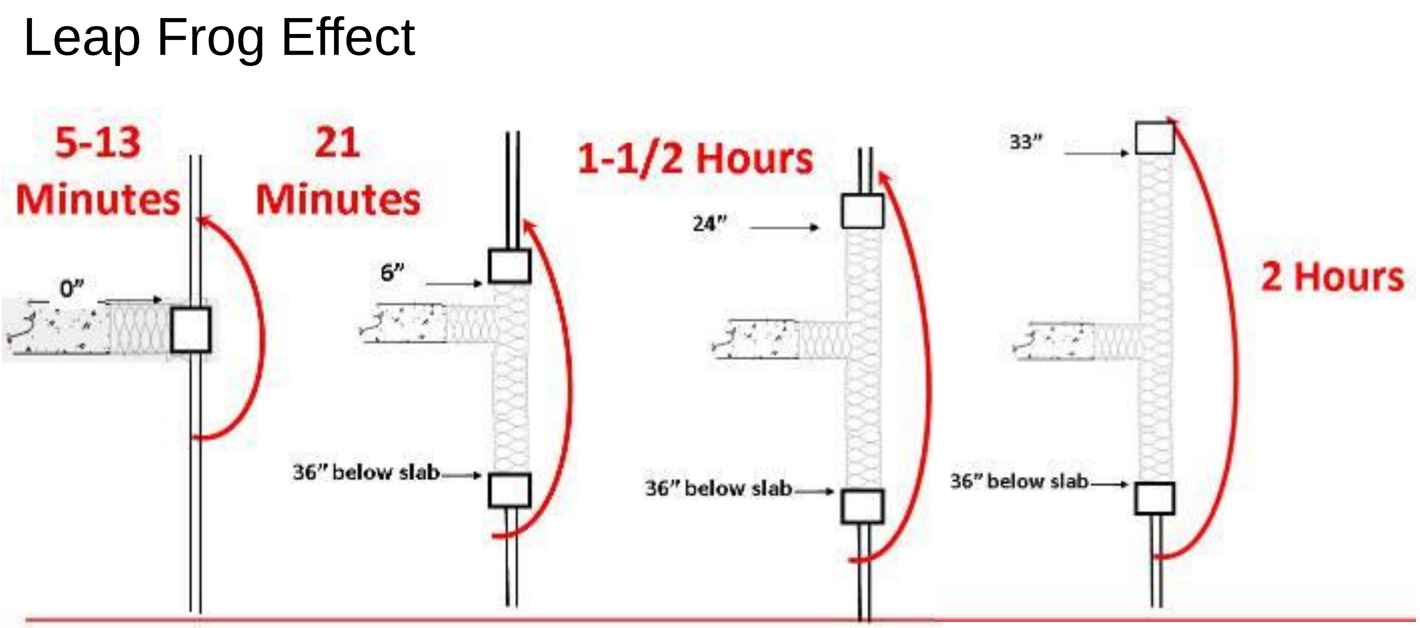
1. Flames and hot gasses propagate through the joint between the wall and the slab edge.

2. Known as leap frog, this occurs when fire breaks the glass and the flames and hot gases escape outside the building and spread up the face of the curtain wall, breaking through the vision glass on the floor above. Or, if the spandrel panel is not properly protected, the fire can break through the vision glass and compromise the wall via the exterior.



Effect of “Leap Frog”

This diagram represents the effects of leap frog on short spandrel heights and the time frame in which fire can break through the glass on the floor above and spread vertically from floor to floor.



Perimeter Fire Barrier Education

ASTM E 119

The standard definition of a commercial fire is defined by ASTM E 119 Standard Test Methods for Fire Tests of Building Construction and Materials.

The performance of walls, columns, floors, and other building members under fire exposure conditions is an item of major importance in securing constructions that are safe, and that are not a menace to neighboring structures nor to the public.

Designation: E 119 – 00a

An American National Standard

Standard Test Methods for Fire Tests of Building Construction and Materials[1]

This standard is issued under the fixed designation E 119; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

INTRODUCTION

The performance of walls, columns, floors, and other building members under fire exposure conditions is an item of major importance in securing constructions that are safe, and that are not a menace to neighboring structures nor to the public. Recognition of this is registered in the codes of [illegible] building, and of buildings of like character and use in a community; and also to promote uniformity in requirements of various authorities throughout the country. To do this it is necessary that the fire-resistive properties of materials and assemblies be measured and specified according to a common standard expressed in terms that are applicable alike to a wide variety of materials, situations, and conditions of exposure.

Such a standard is found in the methods that follow. They prescribe a standard exposing fire of controlled extent and severity. Performance is defined as the period of resistance to standard exposure elapsing before the first critical point in behavior is observed. Results are reported in units in which field exposures can be judged and expressed.

The methods may be cited as the "Standard Fire Tests," and the performance or exposure shall be expressed as "2-h," "6-h," "½-h," etc.

When a factor of safety exceeding that inherent in the test conditions is desired, a proportional increase should be made in the specified time-classification period.

1. Scope

1.1 The test methods described in this fire-test-response standard are applicable to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs. They are also applicable to other assemblies and structural units that constitute permanent integral parts of a finished building.

1.2 It is the intent that classifications shall register comparative performance to specific fire-test conditions during the period of exposure and shall not be construed as having determined suitability for use under other conditions or after fire exposure.

1.3 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products or assemblies under actual fire conditions.*

1.4 These test methods prescribe a standard fire exposure for comparing the test results of building construction assemblies. The results of these tests are one factor in assessing predicted fire performance of building construction and assemblies. Application of these test results to predict the performance of actual building construction requires the evaluation of test conditions.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

[1] These test methods are under the jurisdiction of ASTM Committee E05 on Fire Standards and are the direct responsibility of Subcommittee E05.11 on Construction Assemblies.

Current edition approved July 10, 2000. Published October 2000. Originally published as C 19 – 1917 T. Last previous edition E 119 – 00.

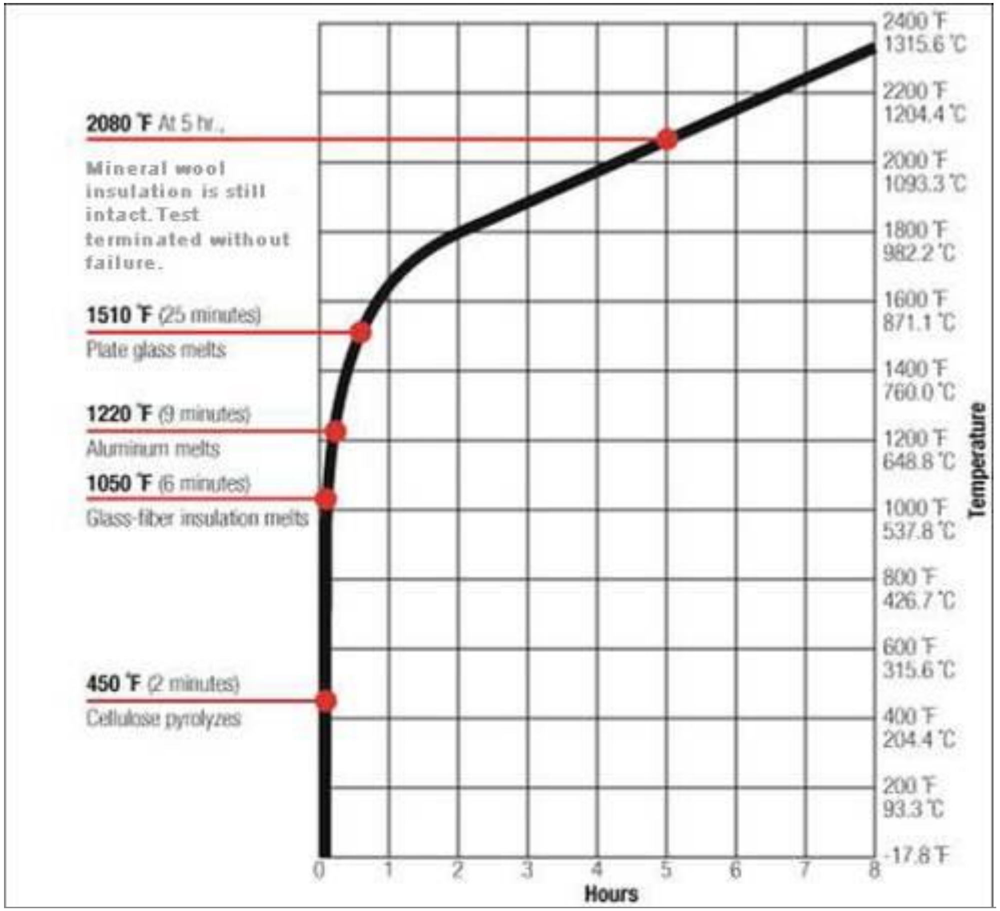
These test methods, of which the present standard represents a revision, were prepared by Sectional Committee on Fire Tests of Materials and Construction, under the joint sponsorship of the National Bureau of Standards, the ANSI Fire Protection Group, and ASTM, functioning under the procedure of the American National Standards Institute.

ASTM E 119 Time-Temperature Curve

The ASTM E 119 Time-Temperature Curve illustrates the temperature increase (Y-axis) in relation to time, expressed in hours (X-axis) that occurs during a typical fire.

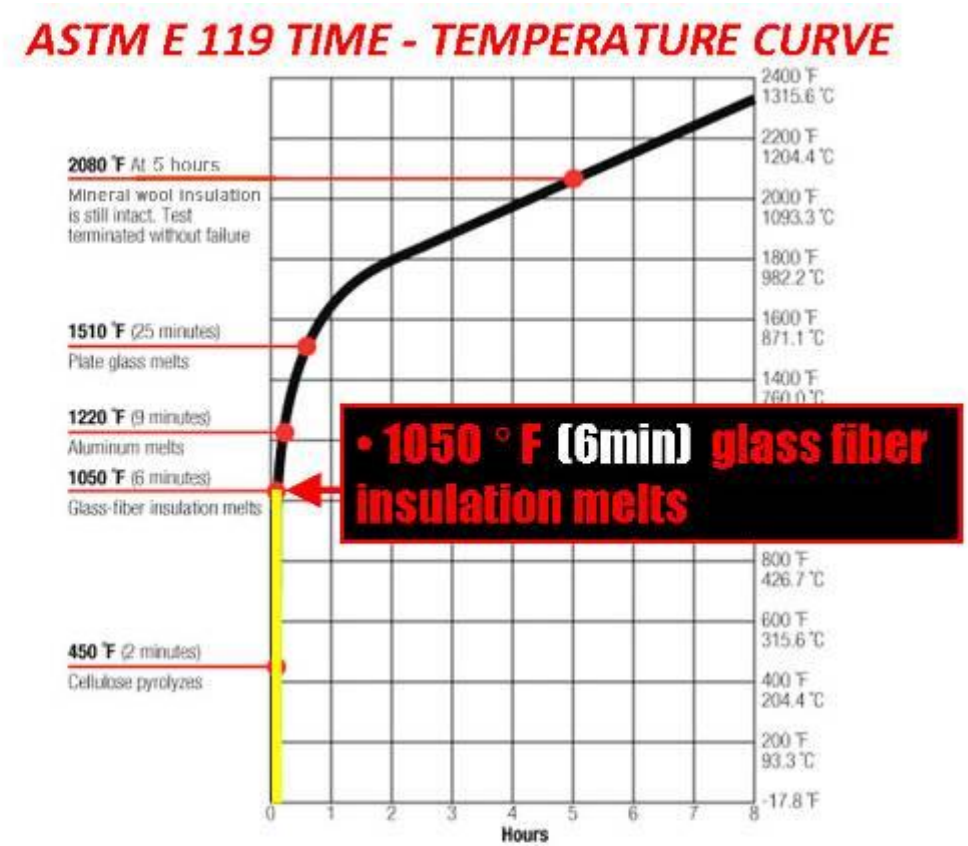
Note how quickly the temperature rises within the first few minutes of a fire.

The performance of various materials are indicated to the left of the graph and reviewed in subsequent slides, beginning with glass-fiber insulation.



ASTM E 119 Time Temperature Curve: Glass Fiber Insulation

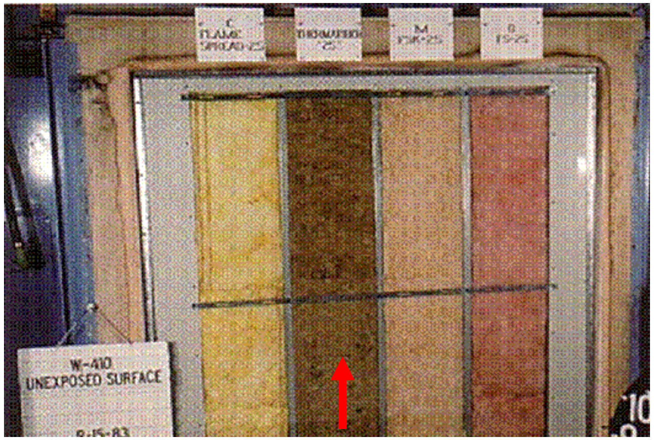
The ASTM E 119 Time-Temperature Curve indicates that glass fiber insulation melts at 1,050° F, which will typically occur within 6 minutes into the ASTM E 119 fire test.



Glass Fiber Insulation Versus Mineral Wool Insulation

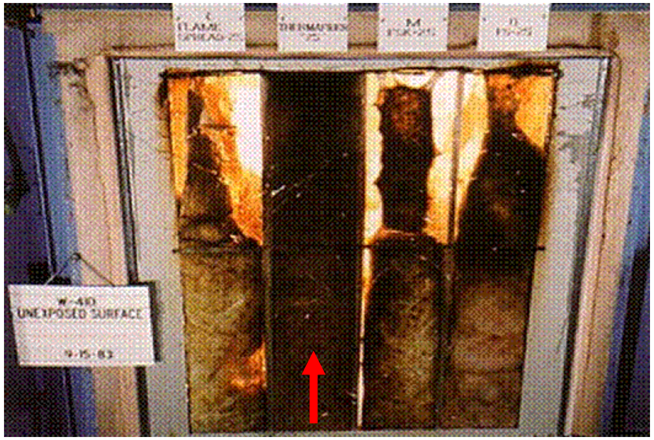
Tests were conducted to compare different types of glass fiber insulation's performance versus mineral wool insulation (second test specimen from the left in both images). Notice how the glass fiber insulation melts away from the framing, while the mineral wool insulation remains intact (right image).

Insulation Before Fire Test.



Mineral Wool Insulation

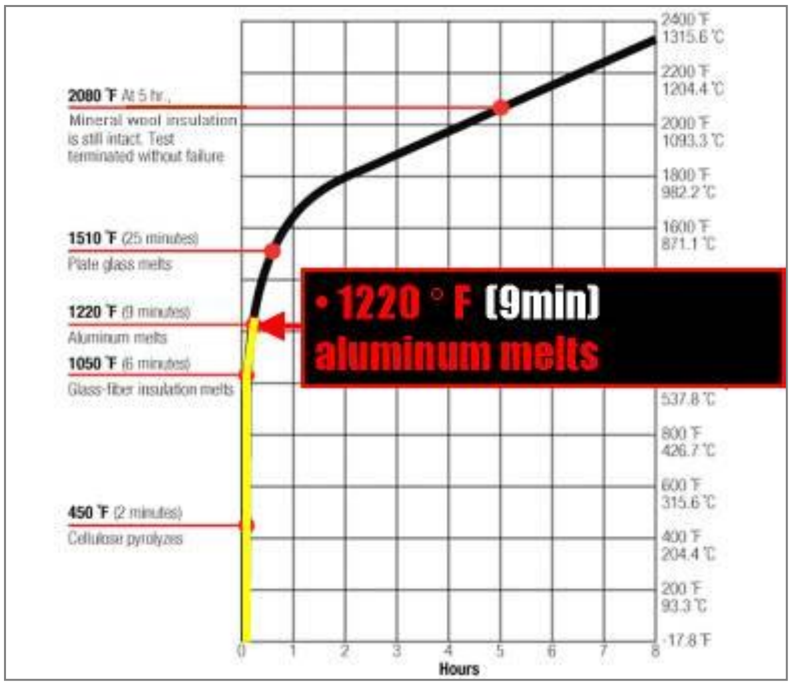
Insulation During Fire Test.



Mineral Wool Insulation

ASTM E 119 – Aluminum Performance

At 9 minutes into the ASTM E 119 fire test, the temperature on the curve is 1,220°F, which is the melting point of aluminum. At that point, any aluminum components in a curtain wall will melt.



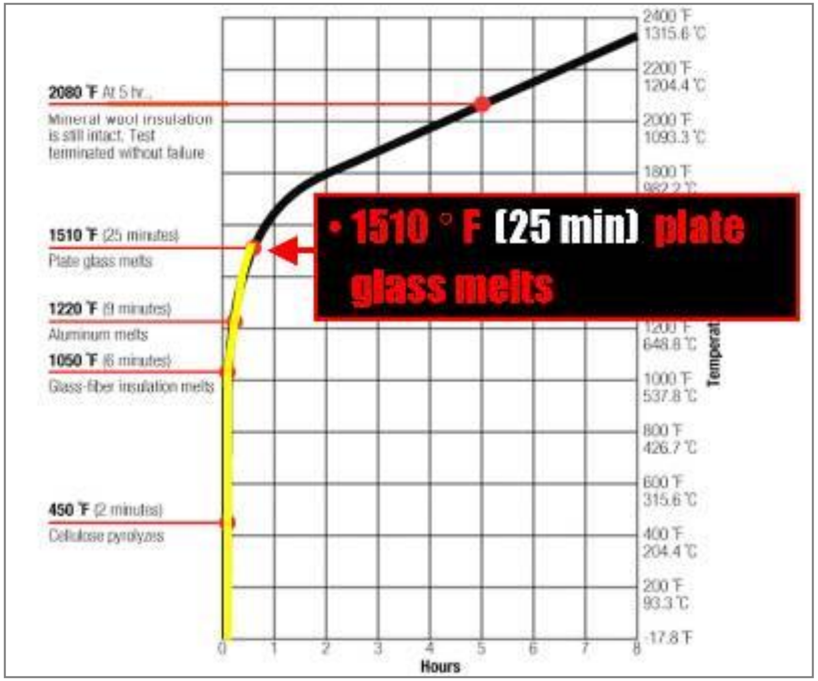
ASTM E 119 Time-Temperature Curve

Mullions and Transoms After Exposure to Fire Test

Less than 20 minutes of exposure melts aluminum transom.

ASTM E 119 – Plate Glass

The temperature on the curve at 25 minutes into the fire test is 1,510°F, and it is at this temperature that plate glass melts. Observe the failure of the plate glass at the spandrel and vision glass as a result of exposure to the flames and hot gasses (right image).

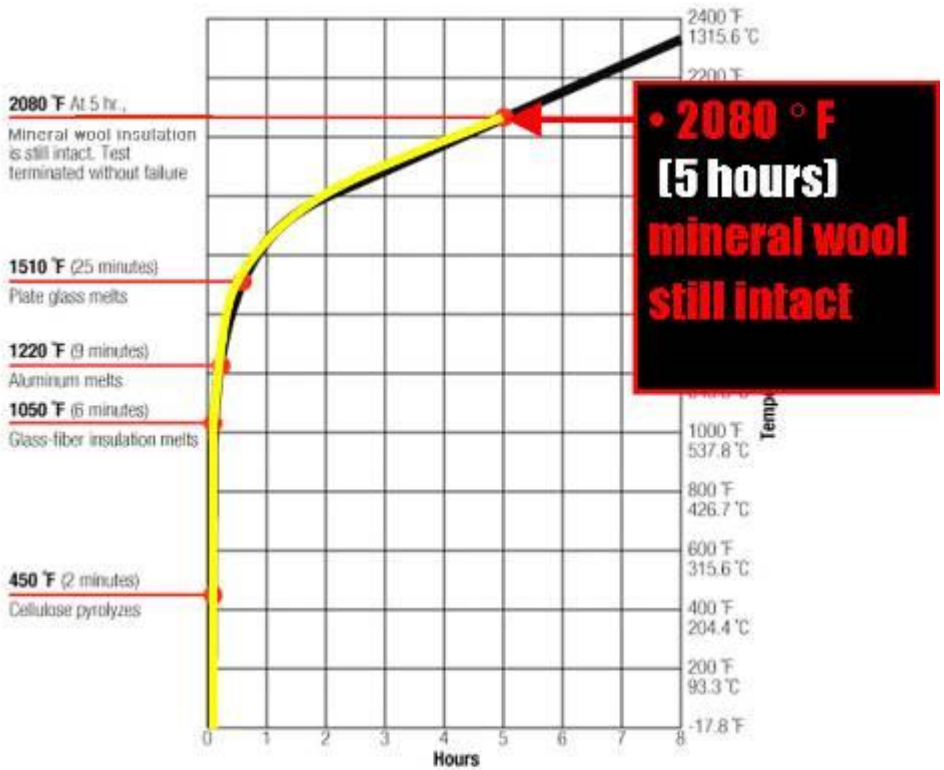


ASTM E 119 Time-Temperature Curve

Plate Vision Glass Failure

ASTM E 119 – Mineral Wool Performance

At 5 hours into the ASTM E 119 time-temperature test the temperature is 2080°F and that is the temperature at which the mineral wool insulation was exposed. At 5 hours the test was terminated and the mineral wool was still fully intact.



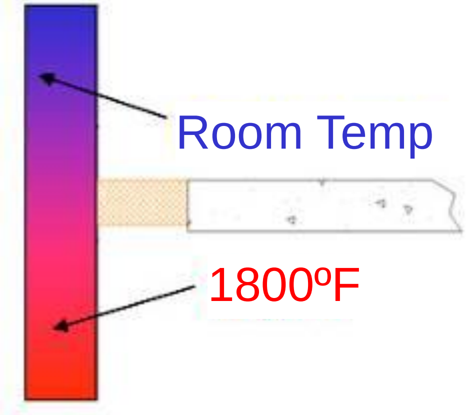
Spandrel Failure

In a fire, glass spandrels explode when exposed to flame and hot gasses.

Aluminum melts at 1,220° F, roughly 9 minutes after the fire starts.

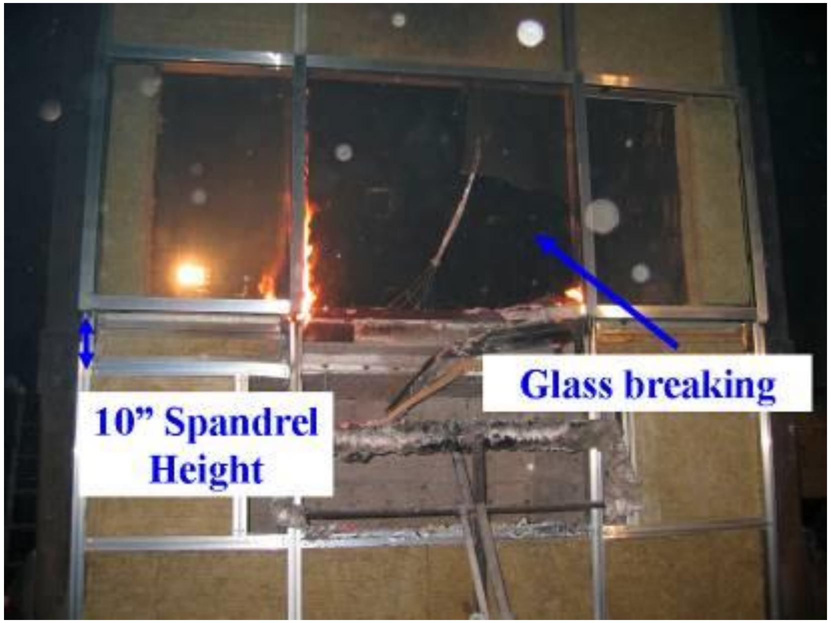
A granite, stone, or precast spandrel fails from cracks in the surface due to expansion and contraction that is created due to temperature differentials from the lower portion of the spandrel panel that is exposed to the fire versus the upper portion of spandrel that remains at room temperature, since it is protected by the floor slab (lower image).

Because these materials are porous, other failures occur from moisture trapped within the walls that super-heat, then explode, causing failure of the panel.



Spandrel Failure cont'd…

This was a curtain wall test on an assembly with a 10" spandrel. Failure occurred in less than 30 minutes of fire exposure. Almost instantly after the exterior burner was lit, the vision glass broke, negating any leap frog protection for the assembly. With such a short spandrel, if this had been an office with window drapery, the fire would have quickly spread to the 2nd floor.



ASTM E 2307

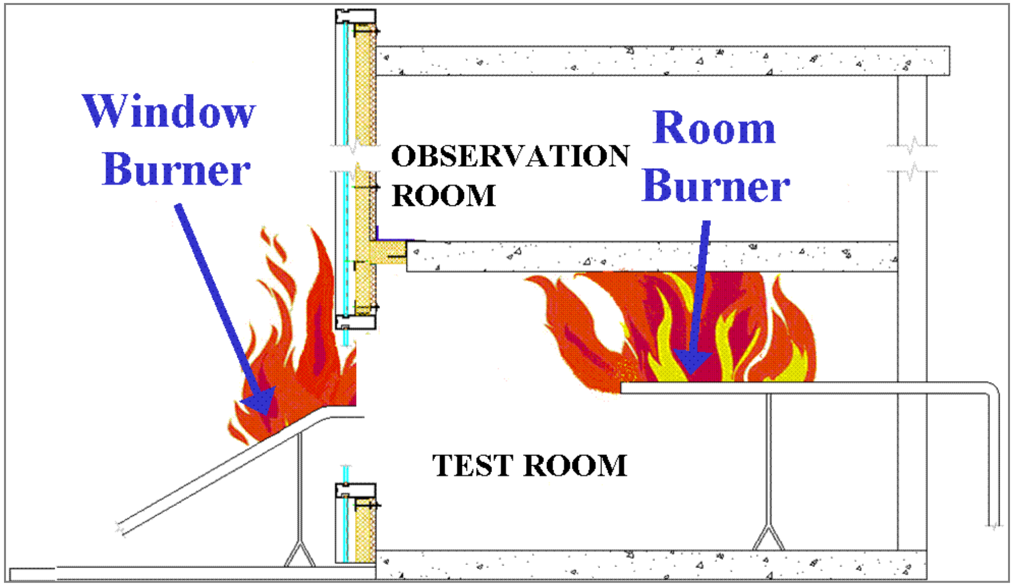
Perimeter fire containment systems are tested differently than other rated construction. ASTM E 2307 is the standard test method used to determine fire resistance of exterior curtain walls.

Pictured on the following slide, the test uses 2 rooms in a multi-story apparatus: a burner room on the first floor, and an observation room located on the second floor directly above the burner room.

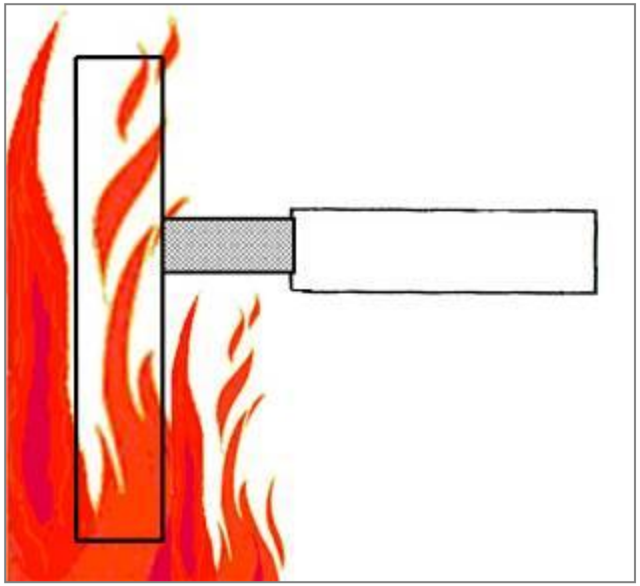
The basic principle is to engulf the first floor room with flame and hot gasses to simulate a room fire. Approximately 5 minutes after ignition the window burner is ignited to simulate fire exposure on the outside of the building. The vision glass on the first floor will break and flames and hot gasses spread up the face of the exterior wall and through the joint between the floor slab and perimeter curtain wall.

The objective is to prevent flames and hot gasses from entering into the room above.

ASTM E 2307 cont'd…



An illustration of ASTM E 2307 Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using the Intermediate-Scale Multi-story Test Apparatus.



ASTM E 2307 evaluates the joint beginning at the face of the floor slab to the exterior curtain wall.

ASTM E 2307: Actual Test

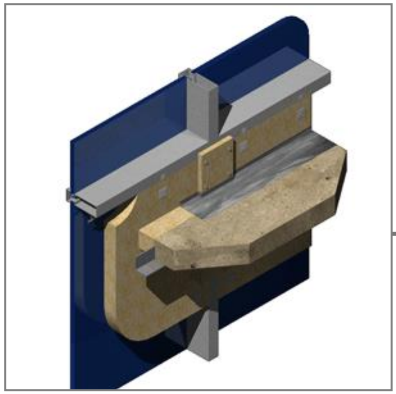
The pictures below are of an actual test per ASTM E 2307.

Showing the assembly as the fire begins with the room burner.

To simulate an actual fire, the window burner is ignited 5 minutes into the test – at that point, the vision glass breaks out.

This image shows the test with a fully developed fire. Note the pressure from the fire pushing the flame out and up the face of the building, resembling an actual fire.

The aftermath of the fire shows the destruction caused by the flame and hot gasses. Note the loss of the transom and mullion.



Curtain Wall Fire Containment:

Design Principles

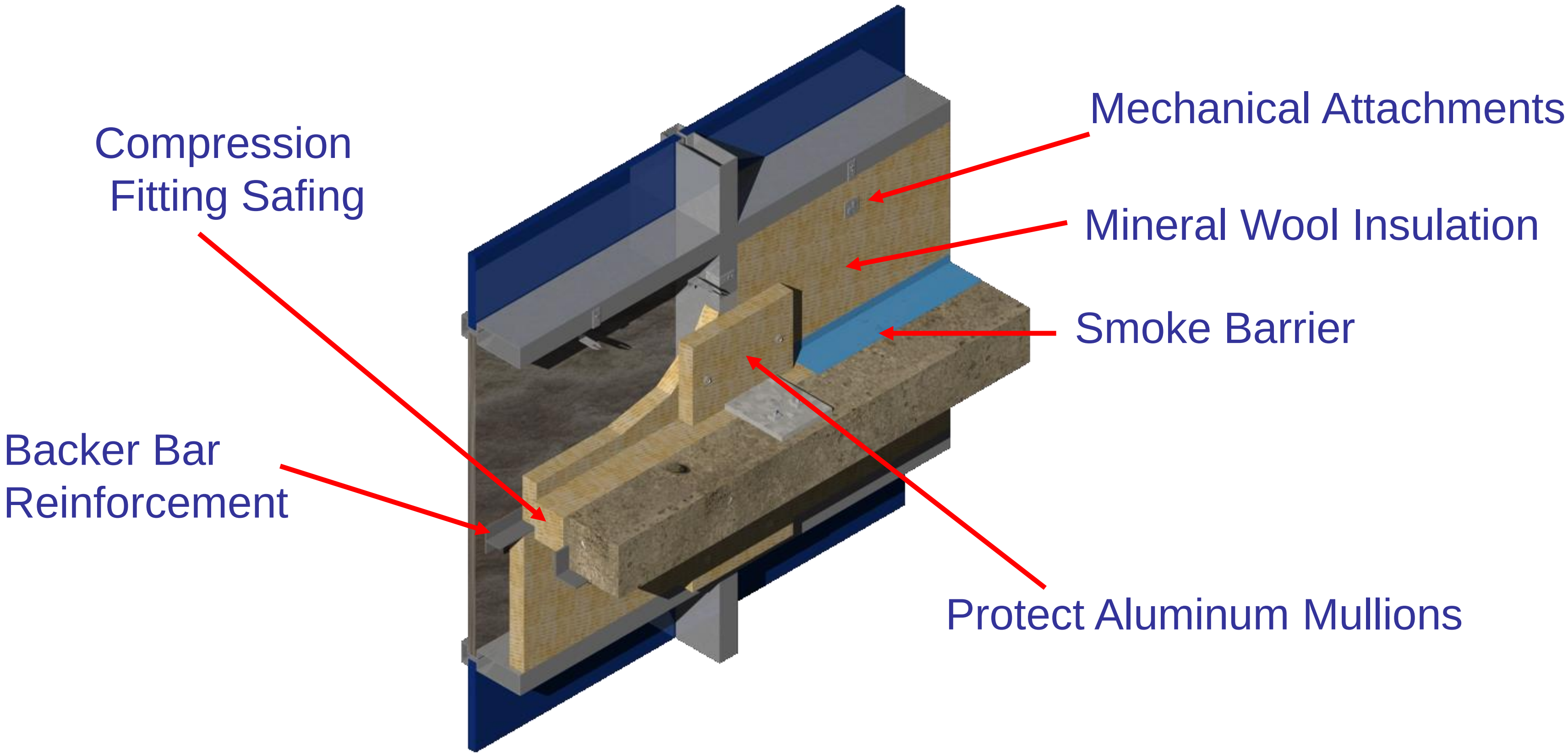
Introduction

In this section of the course, we present a review of the design principles for curtain wall fire containment.

The 6 basic design principles for installation and successful perimeter fire containment are pictured on the following slide, which include:

1. incorporate backer bar reinforcement
2. use mineral wool insulation
3. mechanically attach the insulation
4. compression fit the safing insulation
5. protect the mullions
6. ensure an approved smoke barrier system is in place

6 Basic Design Principles for Curtain Wall Fire Containment

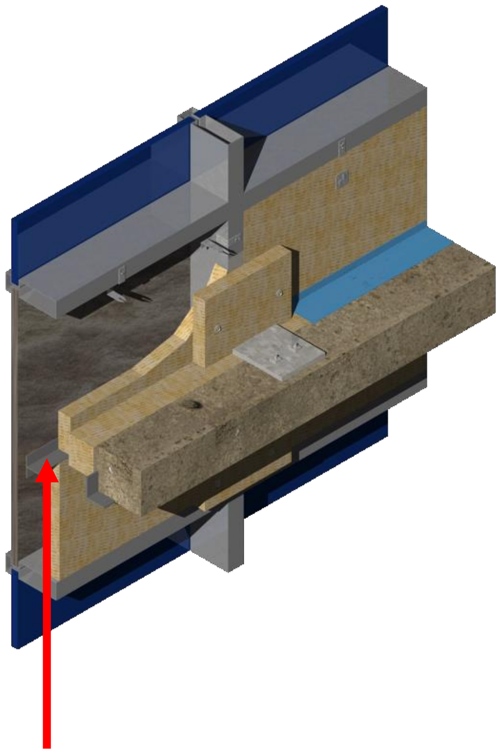


Backer Bar Reinforcement

A backer bar reinforcement is required at the safing line.

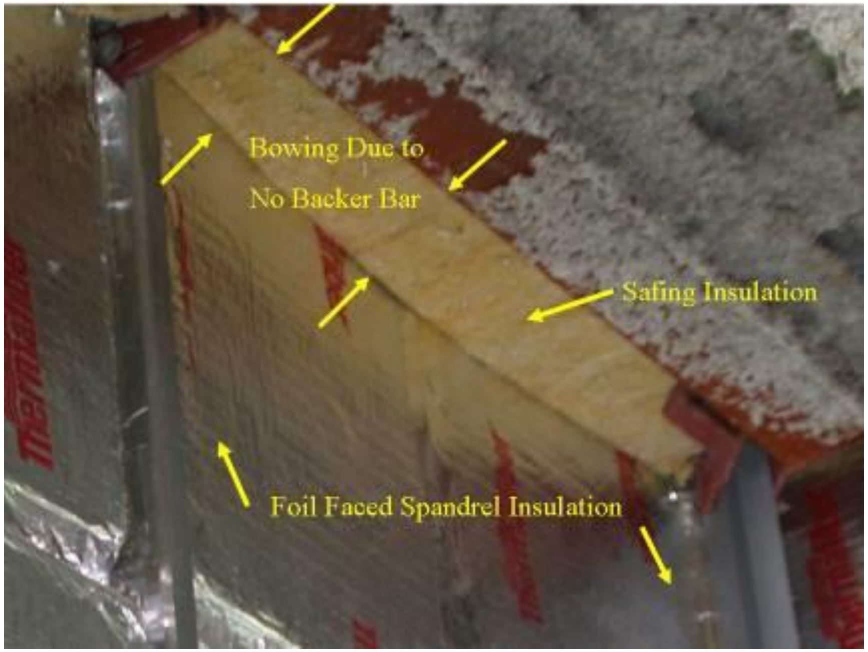
Backer bars are required to maintain the seal created in the void that results when the safing is compression-fit from 25-50% between the slab edge and the vertical insulation.

The force that the compressed safing creates will cause the spandrel insulation to bow, losing the integrity of the seal and creating an area where fire can breach through the void.



Backer Bar Reinforcement cont'd…

Here is an example of an installation that does not have a backer bar. Notice how the compression-fit of the safing insulation is causing the curtain wall insulation to bow. Also note the openings this creates at the floor line. These openings allow for flame and hot gasses to propagate to the floor above.

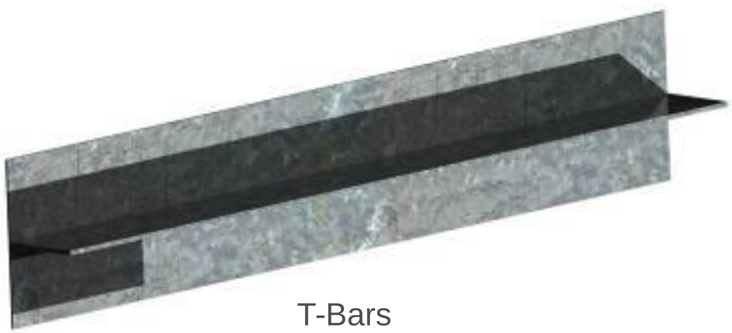


Backer Bar Reinforcement cont'd…

Different types of backer bar reinforcements are pictured below. Typically, they are made with 20 gauge galvanized steel.

Angles

Hat Channels



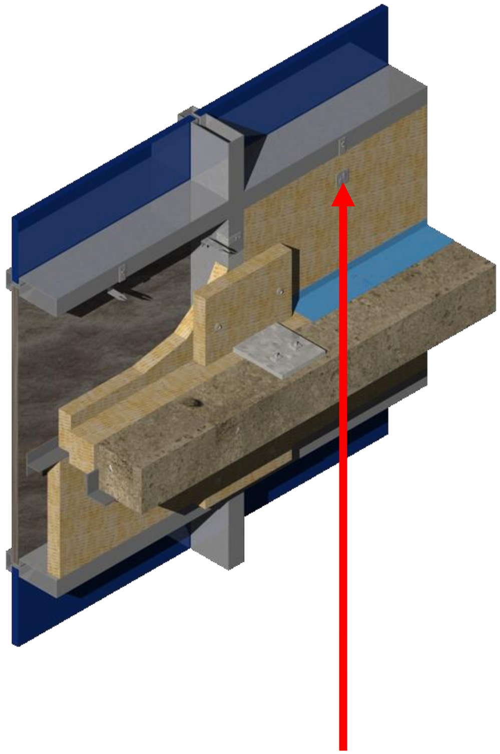
T-Bars

Mechanical Attachments

The curtain wall insulation (mineral wool) should be mechanically held in place to provide protection to the assembly from the intense heat of a fire.

Mechanical attachments keep the material in place over the life of the installation, otherwise the insulation could fall out during a fire and loose the protection that it was intended to provide.

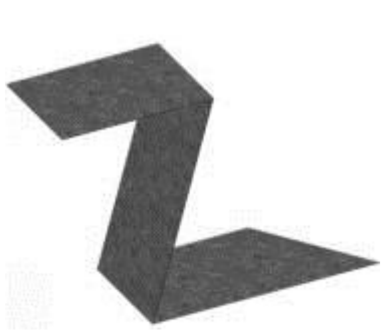
Note that adhesive-applied stick pins are not a viable solution for attaching the curtain wall insulation as the glue would melt when exposed to fire, allowing the insulation to fall out.



Mechanical Attachments cont'd…

There are several types of mechanical attachments. Refer to the UL (Underwriters Laboratories) or OPL (Omega Point Laboratories, Inc.)/ Intertek Fire Resistance Directories for specific use of various fasteners.

Impaling Pin



Z Clip

90° Insulation Hanger

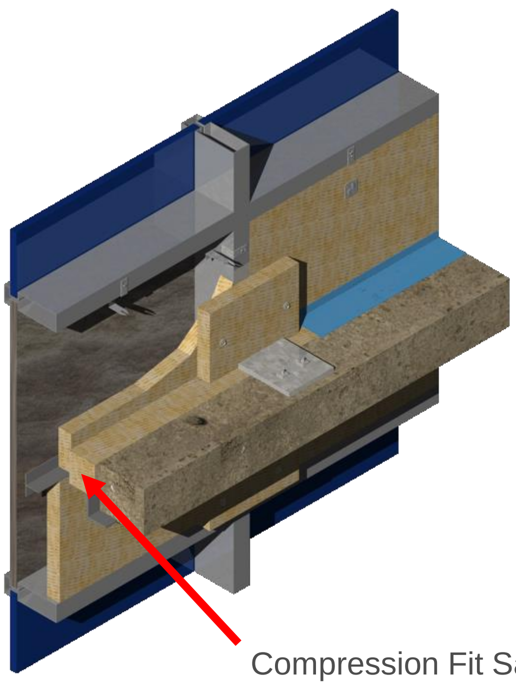
Impaling Pin with Clutch Clip

Horizontal Impasse Hanger

Vertical Impasse Hanger

Compression Fit Safing

Compression-fit safing insulation is used to fill the gap between the face of the slab and the exterior curtain wall insulation (left image). Safing can be installed with the fibers either in the vertical or horizontal direction. The designs are very specific and the safing needs to be installed according to a tested system.



Compression Fit Safing

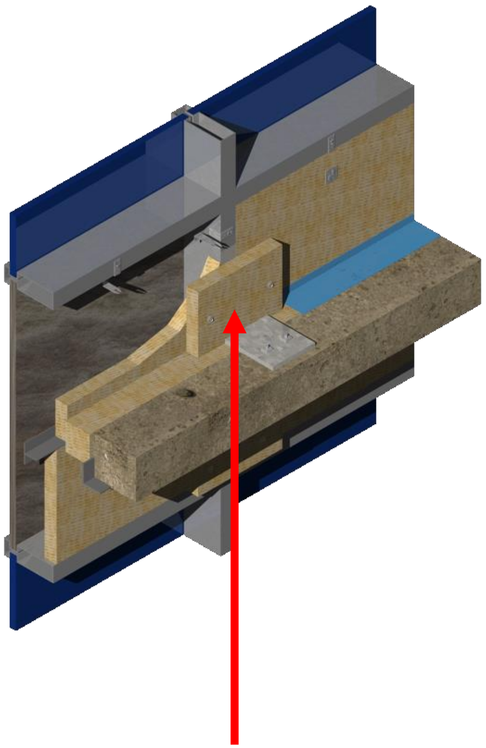
Vertical Fiber Horizontal Fiber

Protect the Mullions

Why is it important to protect the aluminum mullions?

Because, aluminum melts at 1220° F and it happens as quickly as 9 minutes into a fire.

This image shows a mineral wool mullion cover, mechanically fastened over the aluminum mullions to protect them from fire exposure.



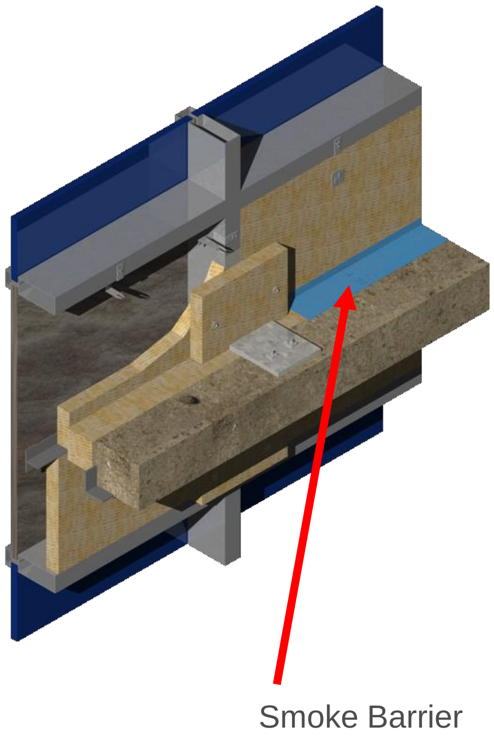
Smoke Barrier

Smoke is the leading cause of death in a fire. In fact, 75% of fire related deaths are caused by smoke inhalation.

The proper application of a smoke barrier system is an important design practice for smoke containment.

As illustrated in the image at right, the smoke sealant goes over the safing insulation.

What do the codes say about smoke?



Smoke Barrier cont'd…

According to the 2009 IBC Code, the definition of a smoke barrier calls for a continuous membrane designed to restrict the movement of smoke.

2009 IBC Code- Definition of a Smoke Barrier:

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.

Section 407.4 Smoke Barriers:

Smoke barriers shall be provided to subdivide every story used by patients for sleeping or treatment and to divide other stories with an occupant load of 50 or more persons, into at least two smoke compartments. Such stories shall be divided into smoke compartments with an area of not more than 22,500 square feet (2092 m2) and the travel distance from any point in a smoke compartment to a smoke barrier door shall not exceed 200 feet (60 960 mm). The smoke barrier shall be in accordance with Section 710.

Good Design Practices - Location of the I-Beam

Although tested assemblies are fairly prescriptive on the elements of a successful perimeter fire containment system, there are other good design practices that are not always covered by the tested assemblies.

One is the location of the I-beam.

If the I-beam is in close proximity to the exterior curtain wall, it can interfere with the mechanical installation of the curtain wall insulation, the backer bar, and the mullion covers.

It is far easier to install the curtain wall fire containment system if the structural beam is not flush to the floor slab edge.

Insulation Spacing - Spandrel Glass

Another important design practice, although it's not spelled out in UL and OPL/Intertek designs, is allowing for a minimum 1" space between the curtain wall insulation and the spandrel glass panel.

According to The GANA Glazing Manual:

> The preferred practice for both ceramic and opacified spandrel glass is to space the insulation 1" (25mm), or more, back from the interior face of the glass. Also, the insulation should be secured so it will not touch the glass even if it should sag over time or be compressed at the floor line fire safing. The air space also will improve the thermal properties of the spandrel cavity and help ensure an even distribution of heat behind the glass.

The GANA Glazing Manual is recognized as the definitive source in the glazing industry. Its purpose is to educate and provide general guidelines for proper installation techniques.

Insulation Spacing - Pre-Cast Spandrel Panels

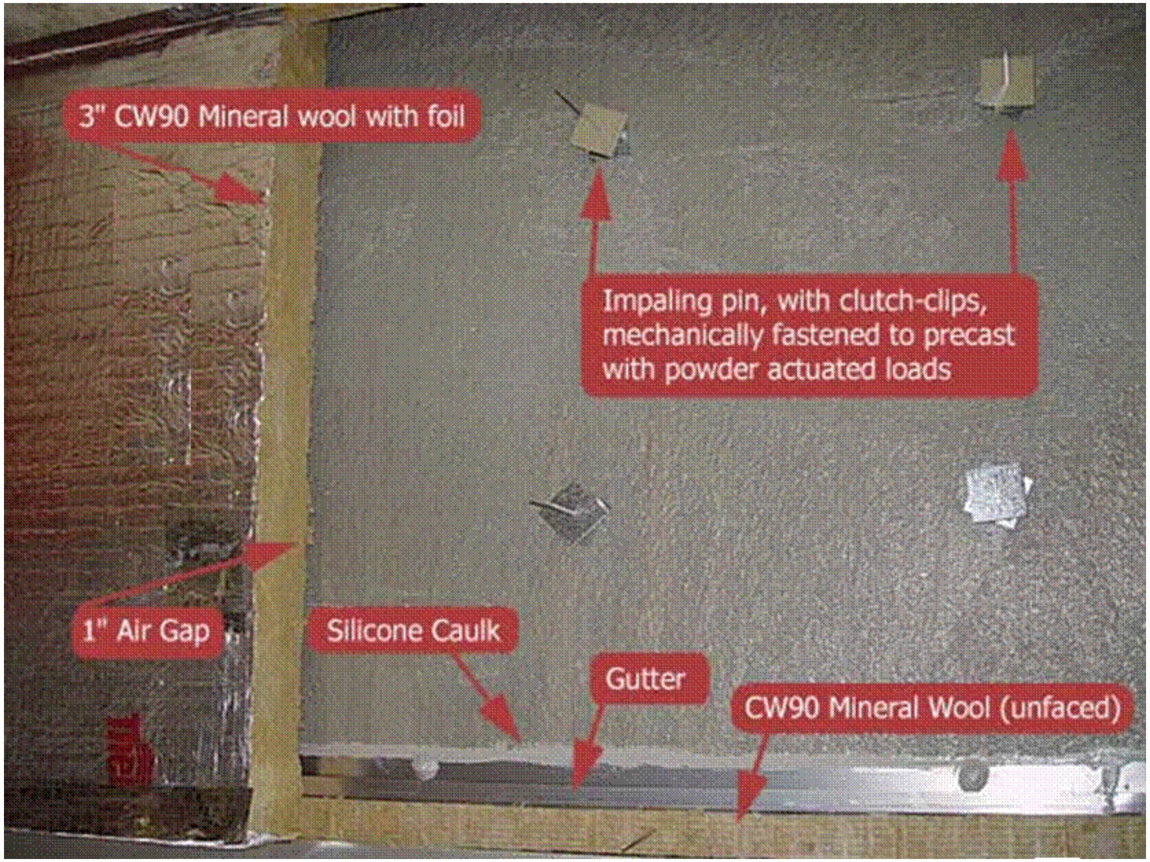
What about pre-cast spandrel panels?

There should also be a 1” space between the back of the curtain wall insulation and the interior face of the precast panel. The assembly shown on the next slide has clutch clips mechanically fastened to the precast, allowing a 1” air gap.

A gutter system is installed to properly drain moisture condensation through the cavity of the wall.

The curtain wall insulation is foil faced to provide a vapor retarder. Also, the use of silicone caulk aids in moisture control.

Insulation Spacing - Pre-Cast Spandrel Panels cont'd…



Building Codes / Testing Standards

Introduction

In this next section we present a review of how the current model building codes address life safety protection requirements for the perimeter of a building.

Underlined on the following slide, the IBC 2009 Section 714.4 basically states that the void created between the slab edge and the curtain wall must be sealed with an approved system that remains securely in position for the time period equal to the rating of the floor assembly.

Revisions were made in 2006 to include the new ASTM E 2307 Standard Test Method for Perimeter Fire Barrier Systems.

IBC 2009 – Section 714.4

IBC 2009 Section 714.4 Exterior Curtain Wall/Floor Intersection:

Where fire resistance-rated floor or floor / ceiling assemblies are required, voids created at the intersection of the exterior curtain wall assemblies and such floor assemblies shall be sealed with an approved system to prevent the interior spread of fire. Such systems shall be securely installed and tested in accordance with ASTM E 2307 to prevent the passage of flame for the time period at least equal to the fire-resistance rating of the floor assembly and prevent the passage of heat and hot gases sufficient to ignite cotton waste. Height and fire-resistance requirements for curtain wall spandrels shall comply with Section 705.8.5.

Note that the current code addresses interior spread of fire only and “leap frog” fire spread is not addressed. It is important that architects/designers consider “leap frog” fire spread when evaluating and designing buildings.

IBC 2009 – Section 714.4.1

IBC 2009 Section 714.4.1 Exterior Curtain Wall and Non Fire-Resistance Rated Floor Assembly Intersections:

Voids created at the intersection of exterior curtain wall assemblies and non fire-resistance-rated floor or floor/ceiling assemblies shall be sealed with an approved material or system to retard the interior spread of fire and hot gases between stories.

Until 2009, IBC did not address perimeter fire protection and non fire-rated floors. This section (714.4.1) was added to provide some level of fire protection at this location.

IBC 2009 - Section 705.8.5

The curtain wall section of the code also references Section 705.8.5 Vertical Separation of Openings (see next slide).

It refers to the 3’ spandrel height which is sometimes misinterpreted that a spandrel height is not needed or only safing is necessary to meet the extension of the rating of the slab.

Also, there is nothing in this section or any other section of the code that states the Exterior Curtain Wall/Floor intersection (714.4) can be ignored, therefore, the code strictly enforces the requirement that the fire resistance rating of the floor assembly be maintained.

IBC 2009 - Section 705.8.5 cont'd…

Section 705.8.5 Vertical Separation of Openings:
Openings in exterior walls in adjacent stories shall be separated vertically to protect against fire spread on the exterior of the buildings where the openings are within 5 feet (1524mm) of each other horizontally and the opening in the lower story is not a protected opening with a fire protection rating of not less than ¾ hour. Such openings shall be separated vertically at least 3 feet (914mm) by spandrel girders, exterior walls or other similar assemblies that have a fire-resistance rating of at least 1 hour or by flame barriers that extend horizontally at least 30 inches (762mm) beyond the exterior wall…

Exceptions:

1. This section shall not apply to buildings that are three stories or above grade plane.
2. This section shall not apply to buildings equipped throughout with an automatic sprinkler system in accordance with section 903.3.1.1 or 903.3.1.2.
3. This section shall not apply to open parking garages.

IBC 2009 - Section 714.5

IBC 2009 - Section 714.5 Spandrel Wall:

Height and fire–resistance requirements for curtain wall spandrels shall comply with Section 705.8.5. Where Section 705.8.5 does not require a fire-resistance-rated spandrel wall, the requirements of Section 714.4 shall still apply to the intersection between the spandrel wall and the floor.

This code strictly enforces the requirement that the fire resistance rating of the floor assembly be maintained and there are no exceptions. Tested and listed systems by UL and OPL/Intertek requires that the spandrel area must be protected in order to meet the Building Codes.

★ Please remember the **exam password** SPANDREL. You will be required to enter it in order to proceed with the online examination.

Tested Assemblies

Introduction

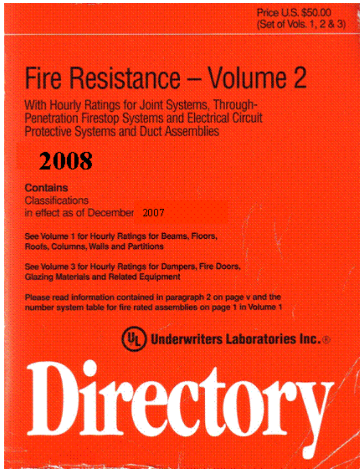
How does one source tested assemblies?

There are two fire resistance directories (URL links provided on Slide 74) in which fire containment systems are listed:

1. Underwriters Laboratories, Inc. (UL)
2. Omega Point Laboratories, Inc. (OPL)/Intertek

Within these two directories, there are over 280 tested and listed perimeter fire containment systems.

There are some very specific differences between the listed systems for UL and OPL/Intertek that will be reviewed in this section of the course.



UL and OPL/Intertek Directories

All UL curtain wall designs require a specific manufacturer’s insulation; no generic designs are published.

Conversely, OPL/Intertek does list some generic designs, but the insulation manufacturer must be listed in the OPL/Intertek Building Materials Directory in order to be used in these assemblies.

Industries pay UL and OPL/Intertek to provide frequent 3rd party inspections to ensure products are manufactured to meet testing standards. It is important to note that when substituting manufacturers, there is no assurance that their system will perform equally.

The next two slides explain the specifications of the directories.

Directory Specifications

Static or Dynamic	CW-D-/ CW-S-/ CEJ- P
Insulation Rating (hour)	maximum temperature rise not to exceed 325º F maximum individual or 250º F average above the starting temperature on unexposed surface or 1” above
L Rating (hour)	measure of air leakage in CFM/linear ft. @ ambient and 400º F temperatures
Movement Capabilities	vertical shear and horizontal movement
F- Rating (hour)	interior spread per ASTM E 2307
Integrity Rating (hour)	interior spread (F-Rating) and leap frog

Understanding the Directory Specifications

In explanation of the following slide, UL listings begin with CW (curtain wall) and OPL/Intertek listings begin with CEJ–P (perimeter). UL lists both Dynamic and Static Systems, designated by “D” or “S.” OPL/Intertek designs are all dynamic, therefore, there is no designation in their listing number. Dynamic systems were tested for movement capabilities at the joint, whereas static systems were not tested for movement.

The Insulation Rating listed in both UL and OPL/Intertek designs is an hourly rating based on the temperature transmission on unexposed surface or 1” above the unexposed surface (which is, typically, the criteria used in establishing hourly ratings for walls, floors, etc.).

The L Rating is the air leakage rating of the joint through the perimeter fire containment system in CFM per linear foot per minute at ambient and/or above 400° F air temperature at an air pressure differential of 0.30 in. of water.

Understanding the Directory Specifications cont'd…

The codes are incorporating language that is requiring specific measurements for smoke control and, in fact, it is anticipated that soon the code on smoke control language will be incorporated into all areas of fire containment.

Penetration smoke barriers shall be tested in accordance with the requirements of UL 1479.

Note that neither the ASTM standard or the codes specify that dynamic systems be tested. The requirement is a specification by the architect.

Understanding the Directory Specifications cont'd…

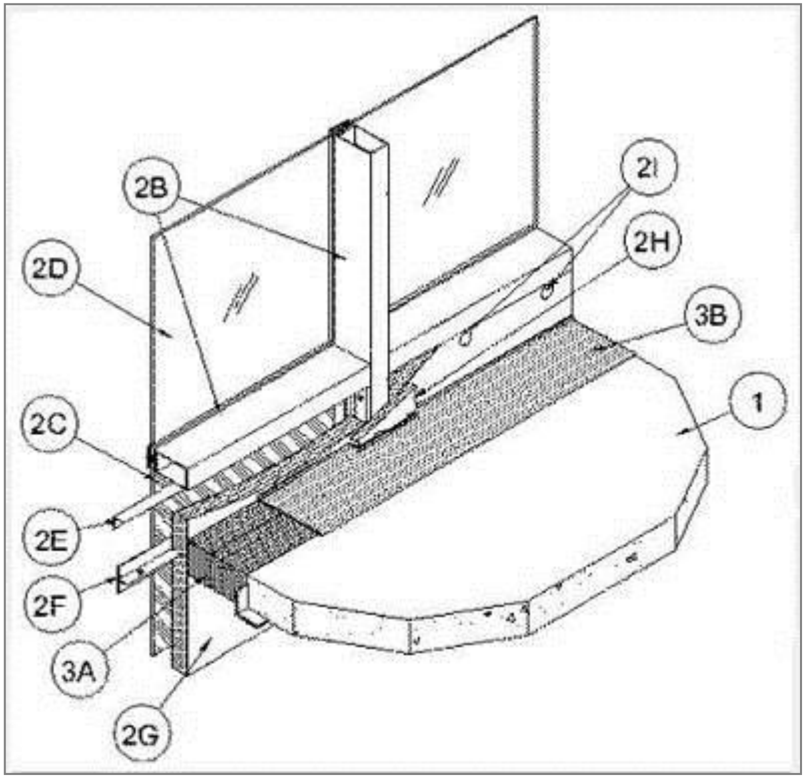
F Rating is required by ASTM E2307 and it is the ability of the design to prevent flame and hot gasses from passing through the interior of the system between the edge of the slab and the interior face of the curtain wall. Both UL and OPL/Intertek designs list the F Rating per the ASTM standard.

Integrity Rating is a listing only used by UL. This rating, expressed in hours, represents the systems ability to maintain the interior (F-Rating), plus prevent the leap frog effect from occurring and causing failure.

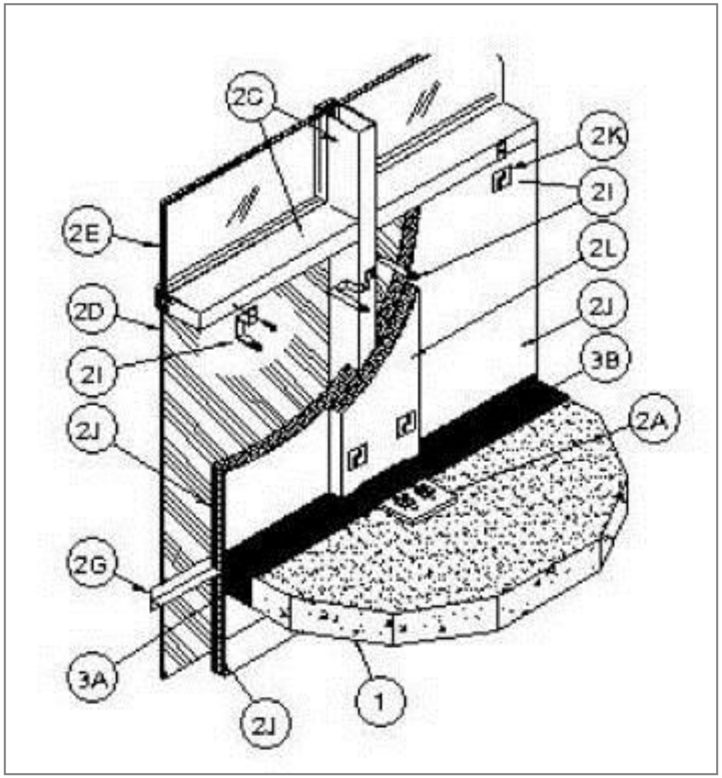
In terms of Movement Capabilities, the actual amount of movement at the curtain wall and slab edge is questionable. There will likely be some shear movement at the floor, but how much horizontal movement is debatable. A static system will be acceptable if the mullions are attached at the floor to deter horizontal movement.

Examples of rated assemblies appear on the next slide.

Examples of Rated Assemblies



F Rating — 2 Hour



Integrity Rating — 2 Hour

Engineering Judgments

What if there is no tested assembly available that matches a particular design?

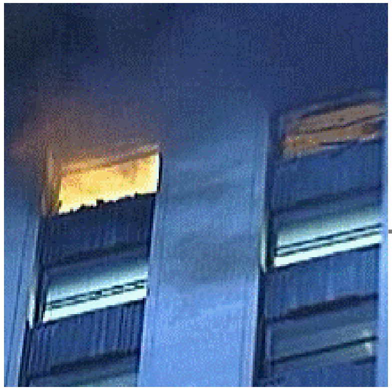
That is where engineering judgments come into play, since listed assemblies do not always match real-world situations.

If there is no tested assembly for a particular design, the manufacturer, or an independent third party, such as UL or OPL/Intertek, can evaluate the design and issue an engineering judgment. Engineering judgments are basically interpolations of previously tested systems that are similar in nature.

Sources of recommended guidelines for evaluating and providing engineering judgments for firestopping systems are available.

IFC (International Firestop Council)

One such source is the IFC (International Firestop Council). Click on the link provided on Slide 74 for further information.



Summary

Important Points

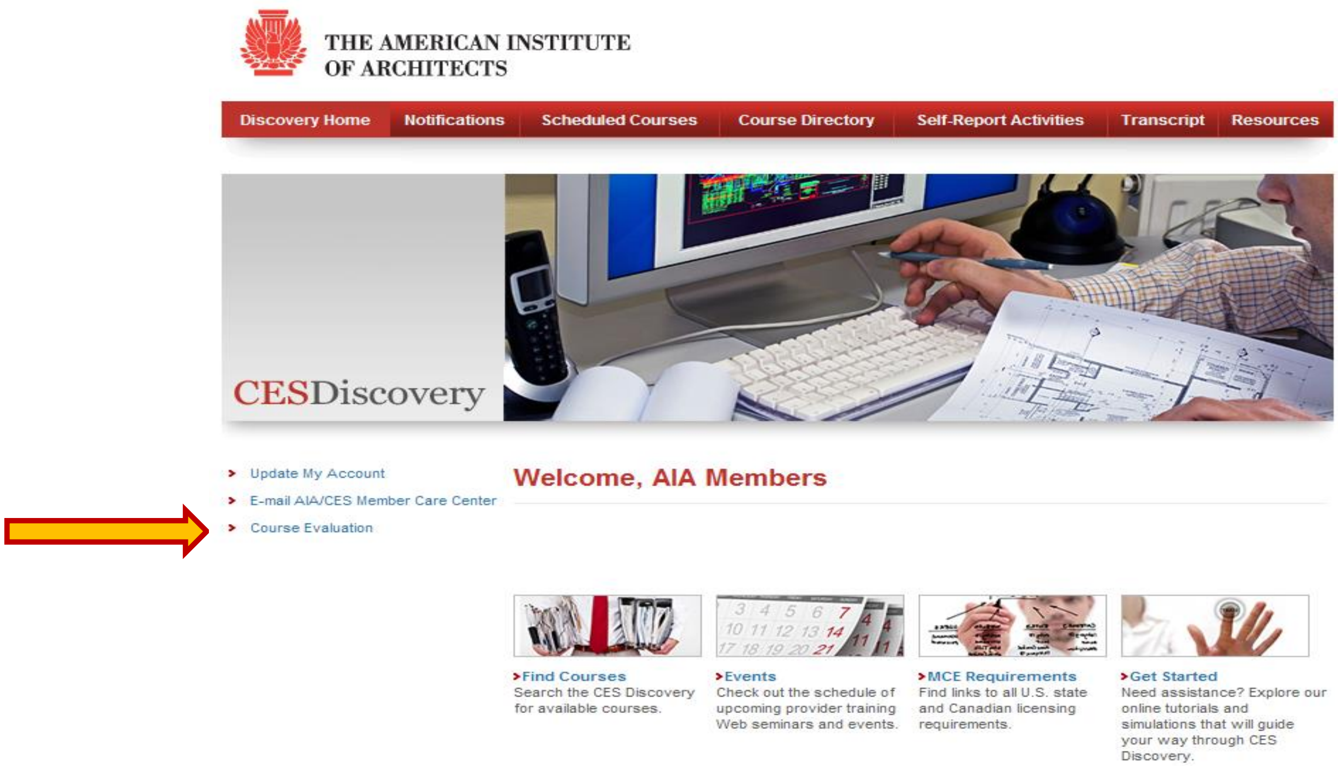
- The three elements that the building community uses to address life safety are detection, suppression (active systems) and compartmentation (passive systems).
- Six basic design principles for a successful fire containment system installation include: incorporating a backer bar reinforcement, using mineral wool insulation, mechanically attaching the insulation, compression fit the safing insulation, protecting the mullions, and ensuring an approved smoke barrier system is in place.
- IBC 2009 Section 713.4 states that the void created between the slab edge and the curtain wall must be sealed with an approved system capable of preventing the interior spread of fire. Such systems shall be securely installed and tested in accordance with ASTM E2307 to prevent the passage of flame for the time period at least equal to the fire-resistance rating of the floor assembly.
- A balanced approach (detection, active, and compartmentation) using redundant life safety systems provides the best fire protection in high-rise construction.

References and Resources

- UL (Underwriters Laboratories Inc.), www.ul.com (date accessed: Jan 06, 2009)
- OPL (Omega Point Laboratories, Inc.)/Intertek, www.opl.com (date accessed: Jan 06, 2009)
- IFC (International Firestop Council), www.firestop.org (date accessed: Jan 06, 2009)
- American Society for Testing and Materials, www.astm.org (date accessed: Jan 06, 2009)
- International Code Council (ICC), www.iccsafe.org (date accessed: Jan 06, 2009)
- National Fire Protection Association (NFPA), www.nfpa.org (date accessed: Jan 06, 2009)
- Alliance for Fire and Smoke Containment and Control, www.afscc.org (date accessed: Jan 06, 2009)

Course Evaluations

In order to maintain high-quality learning experiences, please access the evaluation for this course by logging into CES Discovery and clicking on the Course Evaluation link on the left side of the page.



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