Combustible Decorative Features and Unique Themed Environments

Douglas H. Evans, P.E., FSFPE
DHE FPE LLC
Las Vegas, NV

2/20/2024 EduCode 2024

DOUGLAS H. EVANS, P.E., FSFPE

After 22 years as a Fire Protection Engineer with Clark County (Nevada) Building Department, Mr. Evans founded **DHE FPE LLC** to provide specialized consulting services to the construction industry. In his position with Clark County, his primary focus was coordinating fire protection aspects for the mega-resorts on the Las Vegas Strip. Although this specialization requires a working knowledge of most fire protection aspects, Mr. Evans is primarily known for his expertise in plastics/foam plastics in building construction, unique interior features, smoke management systems and combustible exterior claddings. Mr. Evans is a Fellow of the Society of Fire Protection Engineers, member of NFPA and a registered Fire Protection Engineer.

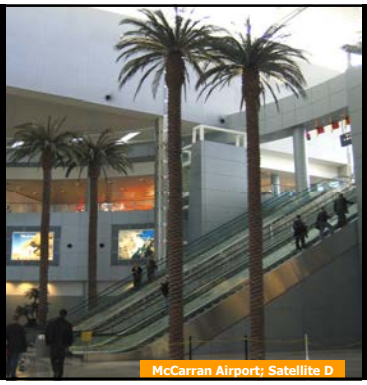
2/20/2024 EduCode 2024

Unique themed environments:

- Can include artificial trees, large statues, giant signs/LED screens, hand painted canvas murals adhered to walls and even buildings within the main structure.
- The materials used are most apt to be regulated by Chapters 8 and 26 of the IBC as Interior finishes and plastics in building construction, but a number of additional requirements can also apply.
- These regulations along with applicable portions of the IFC are used to provide an understanding of not only those subjects, but also the ability to extrapolate to unique applications.
- This class covers notable fire losses, present code requirements, applicable fire tests and associated fire dynamics, as well as provides a way to think about unique applications to achieve a reasonable level of fire safety.

2/20/2024 EduCode 2024

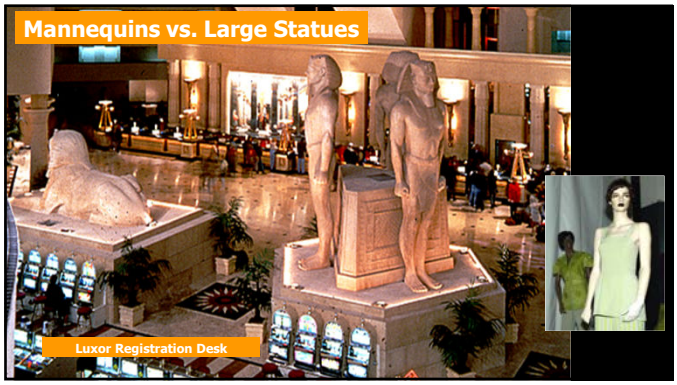
Artificial Plants



McCarran Airport; Satellite D

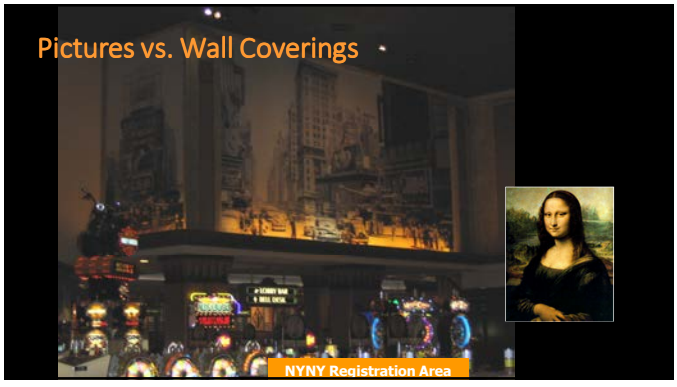
2/20/2024

Mannequins vs. Large Statues

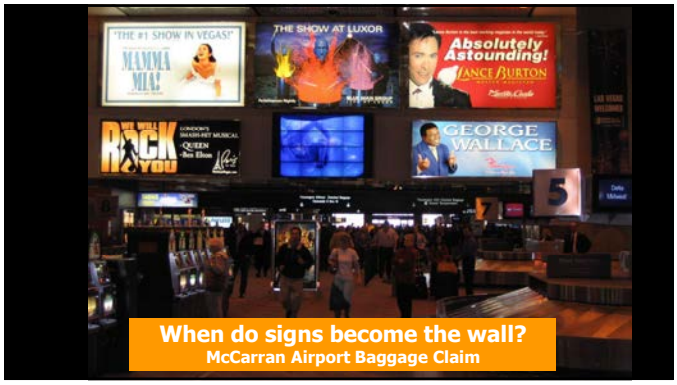


Luxor Registration Desk

Pictures vs. Wall Coverings



NYNY Registration Area


THE SHOW AT LUXOR
Absolutely Astounding!
GEORGE WALLACE
When do signs become the wall?
McCarran Airport Baggage Claim


Umbrellas
vs. Ceilings


Child's Playhouse
vs.
Interior Structures
Luxor Atrium

History of this Subject:

- Interdepartmental agreement between Clark County Building and Fire Departments (1998)
- Developed into Clark County Unique Building Interiors Design Guide (2003) (revised periodically)
  - https://www.clarkcountynv.gov/Building%20&%20Fire%20Prevention/How%20To%20Guides/BPG201.pdf
- Article published fall of 2004 SFPE Magazine
- Republished ICC Building Safety August 2005
- Versions of presentation given a number of times

Primary Focus of this Class

- Specific Requirements of the 2021 IFC
- Specific Requirements of Chapters 8 and 26 of the 2021 IBC
  - Identify appropriate tests
  - Understand related terminology
  - Code intent and limitations
- The level of protection intended by those requirements
- Associated Hazards relative to:
  - Interior Finishes
  - Decorative Materials
  - Trim
  - Plastics
- Unique applications using the IBC for guidance

Learning Objectives: An increased understanding of:

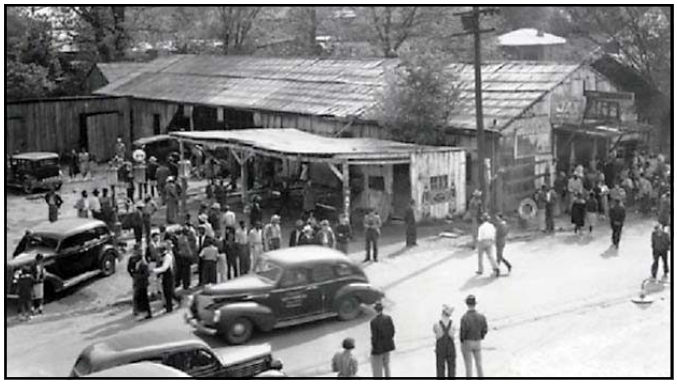
- Fire losses associated with interior finishes and decorative features.
- Recognize hazards attributable to interior finishes and decorative features.
- IFC/IBC requirements to limit losses and provide a safe environment.
- Applicable fire tests, associated challenges, along with appropriate and inappropriate applications of those tests.
- Related fire dynamics.
- Approaches to achieve reasonable fire safety when the fuel loading exceeds intended limitations.
- How to use the same thought process to achieve fire safety for other unique decorative features.

Notable Losses - Why we care

- Rhythm Club, MS 1940
  - 209 fatalities
- Cocoanut Grove, MA 1942
  - 492 fatalities
- Beverly Hills Supper Club, KY 1977
  - 165 fatalities
- Station Night Club, RI 2003
  - 100 fatalities
- Argentine Nightclub fire, 2004
  - 194 fatalities
- The Cosmopolitan, 2015
  - Exterior pool deck

April 23, 1940
The Rhythm Club
Natchez, Mississippi
(209 fatalities)

Losses Info\Rhythm Club fire - Wikipedia.pdf



The Rhythm Club

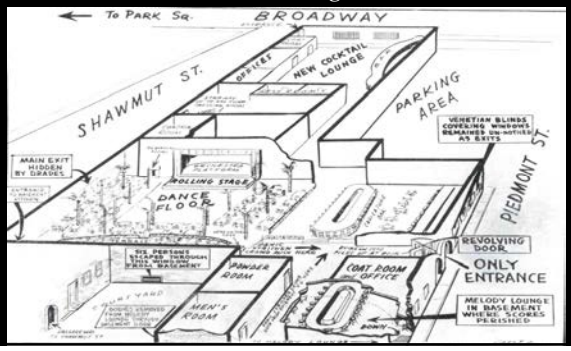
Spanish moss that had been draped over interior's rafters as a decoration, quickly engulfed the structure. To ensure there were no bugs in the decorative moss, it had been sprayed with a petroleum-based insecticide. Under the dry conditions, flammable methane gas was generated from the moss. The windows had been boarded up to prevent outsiders from viewing or listening to the music. The back door was padlocked and boarded shut.

November 28, 1942
Cocoanut Grove Night Club
Boston, MA
(492 fatalities)

Losses Info\Cocoanut Grove fire - Wikipedia.pdf

2/20/2024 EduCode 2024

Cocoanut Grove Night Club




COCOANUT GROVE
VISIT THE
Melody Lounge

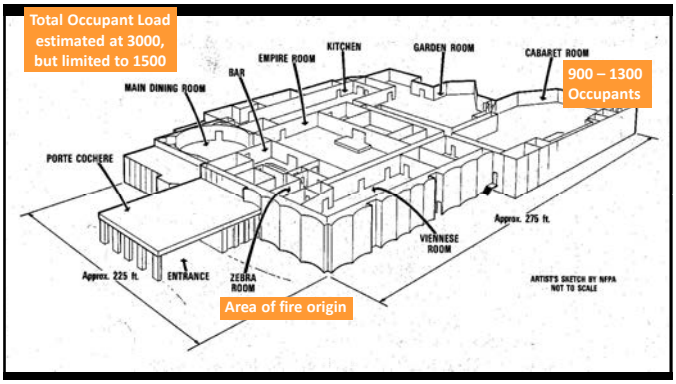
Area of Fire Origin

May 28, 1977
Beverly Hills Supper Club
Southgate, Kentucky
(165 fatalities)

Losses Info\Beverly Hills Supper Club fire - Wikipedia.pdf

2/20/2024 EduCode 2024

Total Occupant Load estimated at 3000, but limited to 1500



900 – 1300 Occupants

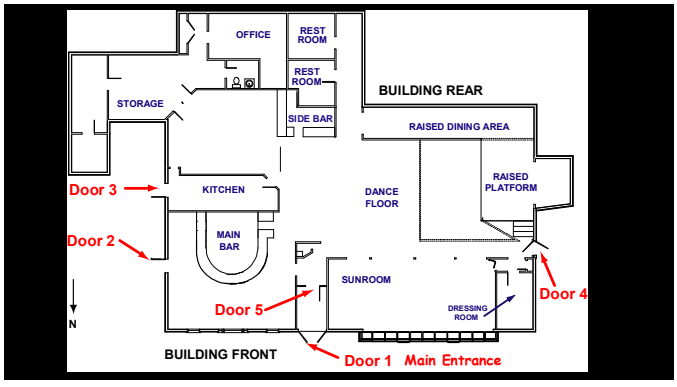
Area of fire origin

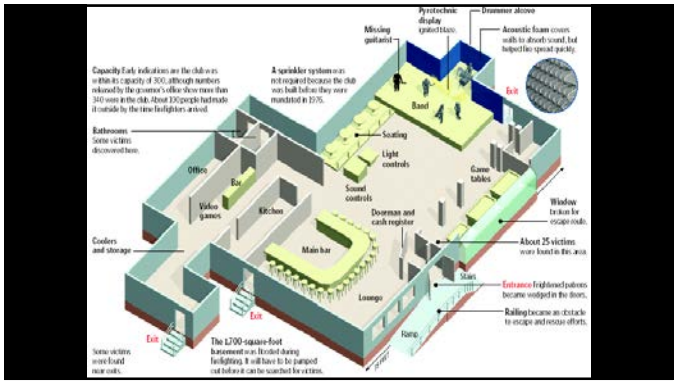

EduCode 2024

February 20, 2003
The Station Nightclub
West Warwick, Rhode Island
(100 fatalities)

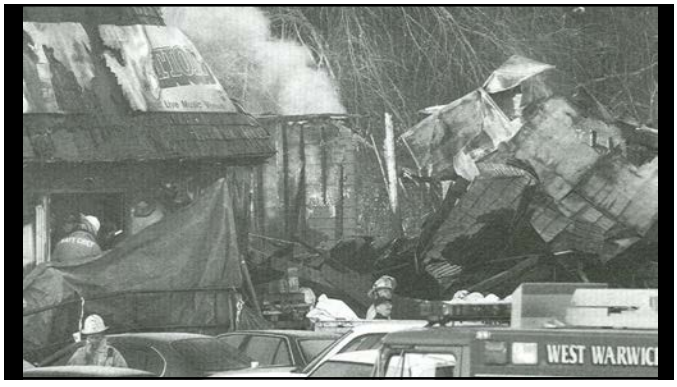
Losses Info\The Station nightclub fire - Wikipedia.pdf

2/20/2024 EduCode 2024



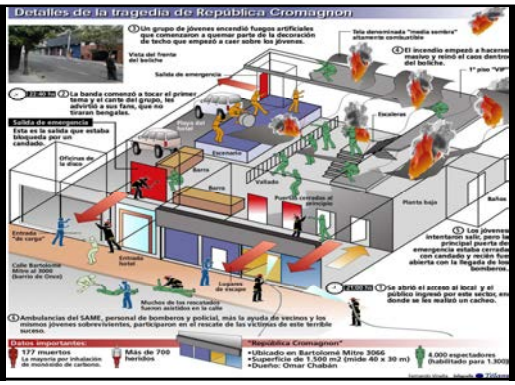

Pyrotechnic display
Drummer above
Missing guitarist
Acoustic foam covers walls to absorb sound, but helped fire spread quickly.
Capacity Early indications are the club was within its capacity of 300, although numbers released by the governor's office show more than 340 were in the club. About 100 people had made it outside by the time firefighters arrived.
A sprinkler system was not required because the club was built before they were mandated in 1976.
Exit
Band
Bathrooms Some victims discovered here.
Seating
Light controls
Game tables
Office
Bar
Sound controls
Video games
Kitchen
Doorman and cash register
Window Victim for escape route.
Coolers and storage
Main bar
About 25 victims were found in this area.
Stairs
Entrance Frightened patrons became wedged in the doors.
Lounge
Railing became an obstacle to escape and rescue efforts.
Exit
Exit
Ramp
Some victims were found near exits.
The 1,700-square-foot basement was flooded during firefighting. It will have to be pumped out before it can be searched for victims.


2/20/2024
EduCode 2024


WEST WARWICK

December 30, 2004
República Cromañón Nightclub
Buenos Aires, Argentina
(194 fatalities)

Losses Info\República Cromañón fire - Wikipedia.pdf



Around 3,000 people were in attendance. Double the venue's 1,500 capacity.

Materials used for decoration were mostly wood, Styrofoam, acoustic panels and a plastic net.

A pyrotechnic flare was determined to be the ignition source.

Four of the six doors were chained shut.

July 25, 2015
The Cosmopolitan
Las Vegas, Nevada
(Exterior Pool Deck)

Satellite view of Cosmopolitan roof deck pool areas.

Bamboo Pool Deck
Decorative palm trees

Videos posted on social media showed the inferno consuming the poolside tent-like cabanas, imitation palm trees, and just about everything else on the open-air deck of the Cosmopolitan of Las Vegas hotel sending thick black smoke billowing high above The Strip. Some of the hotel's rooms sustained water damage from sprinklers.

The Director of Clark County's department of building and fire prevention, said that "an independent analysis shows the plastic fronds burned 10 times faster and hotter than an actual southern pine tree without needles. The artificial trunk was constructed of metal, polyurethane foam and fiberglass resin and burned five times more intensely."

Test results indicated that the tree's materials didn't meet flame and smoke resistance standards for indoor uses and wouldn't be allowed inside buildings or as an exterior component on a building.

The building and fire codes adopted by the county don't apply the same rules to outdoor decorative foliage. As such, "no policy changes are being recommended because it would be difficult to regulate, identify or standardize such adornments, and could cause an undue burden to the businesses." The county also said current fire and building codes were sufficient enough to keep the fire from spreading beyond the pool's deck where it started.

Instead, the county urged resort properties to remove or test any such decorations on their sites. The county took a cursory look at other buildings and didn't identify the same materials being used elsewhere.

The Cosmopolitan of Las Vegas

Bamboo Pool Deck decorative palm trees

Pipe Column with expanded polyurethane, covered with hard coat plastic

Kiss nightclub fire

January 27, 2013

Santa Maria, Rio Grande do Sul, Brazil, killing 242 people and injuring at least 630 others.

Outdoor pyrotechnics used indoors

Investigators said soundproofing foam on the ceiling caught fire and released poisonous gasses that killed those attending a university party.

Bucharest, Romania

Basement level Colectiv nightclub fire
64 deaths – 146 injured

Friday October 30, 2015

Between 300 to 400, mostly young people, were at the club, when a pyrotechnics show went awry. A spark from the band's pyrotechnics ignited polystyrene foam plastic decor.

"People rushed to the entrance but it was too narrow. People panicked and stampeded, climbing over each other trying to get out."

The losses continue

— December 5, 2009: 156 people died when a blaze broke out at the Lame Horse nightclub in Perm, Russia. It started when an indoor fireworks display ignited a plastic ceiling decorated with branches.

— January 1, 2009: An indoor fireworks display after a New Year's countdown ignited a blaze in the Santika club in Bangkok, Thailand, killing 67 people and injuring over 200. Victims died from burns, smoke inhalation, and from being crushed.

— September 21, 2008: A fire killed 44 people at the jammed King of Dancers nightclub in Shenzhen, China. A stamped broke out after a fireworks show ignited the ceiling, causing a crush.

— December, 2000: A fire, blamed on a welding accident, killed 309 people at a disco in the central Chinese city of Luoyang.

— October, 1998: An arson attack against an overcrowded youth disco in the Swedish city of Goteborg killed 63 people and left around 200 injured. Four people were later convicted for starting the fire.

— March, 1996: A fire at the Ozone Disco Pub in Quezon City, Philippines killed 162 people. A large proportion of the victims were students partying to mark the end of the academic year.

— March, 1990: An arson attack at the Happy Land Social Club in the Bronx borough of New York City killed 87 people. It started when a man angry with his girlfriend threw gasoline on the club's only exit and set it on fire, then jammed down the metal front gate so people were trapped.

— December, 1983: A fire at the Alcala dance hall in Madrid, Spain left 78 people dead and more than 20 injured.

Summary of Contributing Factors

- Combustible interior finish
- Combustible decorative features
- Ignition source (including pyrotechnics)
- Lack of fire sprinklers
- Egress paths
  - Locked,
  - Blocked,
  - Inadequate for occupant load (overcrowding) or
  - Otherwise noncompliant
- Lack of occupant awareness of alternate egress paths

Definitions

DECORATIVE MATERIALS. All materials applied over the building interior finish for decorative, acoustical or other effect including, but not limited to, curtains, draperies, fabrics, streamers and all other materials utilized for decorative effect including, but not limited to, bulletin boards, artwork, posters, photographs, batting, cloth, cotton, hay, stalks, straw, vines, leaves, trees, moss and similar items, foam plastics and materials containing foam plastics. Decorative materials do not include wall coverings, ceiling coverings, floor coverings, ordinary window shades, interior finish and materials 0.025 inch (0.64 mm) or less in thickness applied directly to and adhering tightly to a substrate.

Definitions

- **FLAME SPREAD.** The propagation of flame over a surface.
- **FLAME SPREAD INDEX.** A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E 84 or UL 723.
- **INTERIOR FINISH** includes interior wall and ceiling finish and interior floor finish.
- **INTERIOR WALL AND CEILING FINISH.** The exposed interior surfaces of buildings, including but not limited to: fixed or movable walls and partitions; toilet room privacy partitions; columns; ceilings; and interior wainscoting, paneling or other finish applied structurally or for decoration, acoustical correction, surface insulation, structural fire resistance or similar purposes, but not including trim.
- **INTERIOR FLOOR FINISH.** The exposed floor surfaces of buildings including coverings applied over a finished floor or stair, including risers.

2/20/2024 EduCode 2024

Definitions

- **SMOKE-DEVELOPED INDEX.** A comparative measure, expressed as a dimensionless number, derived from measurements of smoke obscuration versus time for a material tested in accordance with ASTM E 84.
- **TRIM.** Picture molds, chair rails, baseboards, handrails, door and window frames and similar decorative or protective materials used in fixed applications.
- **Non-combustible - Section 703.3.1** - ASTM E136—19 (Combustible not defined)
- **FLASHOVER** – A stage in the development of a contained fire in which all exposed surfaces reach ignition temperatures more or less simultaneously.

2/20/2024 EduCode 2024

Fire-Resistant vs. Fire-retardant

- Fire-Resistant (primarily Chapter 7)
  - Applies to compartmentation
    - Structural frame
    - Walls
    - Floor/ceiling assemblies
    - Joints
    - penetrations
- Fire-retardant (Chapters 8, 23 and 26)
  - Resistance to ignition
  - Less apt to propagate

2/20/2024 EduCode 2024

Methods of "Fire-retarding" Combustible Materials

- Chemical
  - Plastics
- Impregnation
  - Natural fabrics
  - Dipping / soaking
- Coatings
  - Intumescence
  - Other topical applications
- Pressure Impregnation
  - Pressure treated wood products

Unprotected Wood fs & SD

2021 IFC

- Decorative Materials
  - 806 & 807
  - Decorative Vegetation
  - Foam plastics
- Furnishings
  - 805 & 808

The Fire Code Primarily addresses fuel loading inside a building

2021 IBC

- Interior Finishes
  - Chapter 8
    - 806 addresses Decorative Materials
- Special Detailed Requirements
  - Chapter 4
- Type of Construction
  - Chapter 6
- Plastics
  - Chapter 26

Primarily addresses materials that make up the building

Chapter 8: Interior Finishes

- 801 Scope
- 802 General
- 803 Wall and Ceiling Finishes
- 804 Interior Floor Finishes
- 805 Combustible Materials in Types I and II construction
- 806 Decorations and Trim

SECTIONS 801 & 802

- **801.1 Scope**. This chapter governs materials used as interior finishes, trim and decorative materials.
- **802.1 Interior wall and ceiling finish.** These provisions limit the allowable fire performance and smoke development based on occupancy classification (see 803.13).
- **802.7 Foam plastics** shall not be used as interior finish or trim except as provided in Sections 803.4 (2603.9), 806.5 or 2604.2. This applies to exposed foam plastics and foam plastics used in conjunction with a textile or vinyl facing or cover.

SECTION 803 WALL AND CEILING FINISHES

- **803.1.1** - NFPA 286
  - Includes pass/fail constraints
- **803.1.2 tested to ASTM E84 or UL 723**
  - Class A: Flame spread 0-25
  - Class B: Flame spread 26-75
  - Class C: Flame spread 76-200
    - In all cases smoke-developed 0-450.

803.2 Thickness exemption. Materials less than 0.036 inch (0.9 mm) thick applied directly to the surface of walls or ceilings are not required to be tested.

803.14 Stability. 200 °F for 30 minutes

803.3 Heavy timber exemption. Exposed portions of building elements complying with the requirements for buildings of heavy timber construction in Section 602.4 or Section 2304.11 shall not be subject to *interior finish* requirements except in interior exit stairways, interior exit ramps, and exit passageways.

Section 803.15 Application

- 803.15.1 Limited Combustible Voids
  - Substantial contact with non-combustible substrate
  - Eliminate
  - Mitigate
- 803.15.2 Larger Combustible Voids
  - Eliminate
  - Mitigate
- 803.15.3 Heavy Timber
- 803.15.4 Materials ≤ ¼ inch thick
  - Exception 1 - noncombustible
  - Exceptions 2 & 3 - tested for the application

2021 IBC Table 803.13

TABLE 803.13
INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY[a]

GROUP	SPRINKLERED[f]			NONSPRINKLERED		
	Interior exit stairways and ramps and exit passageways[b,c]	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces[d]	Interior exit stairways and ramps and exit passageways[b,c]	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces[d]
A-1 & A-2	B	B	C	A	A[g]	B[g]
A-3[e], A-4, A-5	B	B	C	A	A[g]	C
B, E, M, R-1	B	C[m]	C	A	B	C
R-4	B	C	C	A	B	B
F	C	C	C	B	C	C
H	B	B	C[g]	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B[h,i]	A	A	B
I-3	A	A[i]	C	A	A	B
I-4	B	B	B[h,i]	A	A	B
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No restrictions			No restrictions		

Always read the footnotes

803.5 Textiles

- As Interior Finishes Includes:
  woven, nonwoven, napped, tufted, looped, carpet, or similar materials
- NFPA 286 per Section 801.1.1,
- NFPA 265 Test Method B
  - Fully lined protocol
  - Pass/Fail constraints
  - Defines Flashover
- or …Must be Class A and protected by automatic sprinklers

803.10 SITE-FABRICATED STRETCH SYSTEMS

A system, fabricated on site and intended for acoustical, tackable or aesthetic purposes, that is composed of three elements:

1. A frame (constructed of plastic, wood, metal or other material) used to hold fabric in place.

2. A core material (infill, with the correct properties for the application).

3. An outside layer, composed of a textile, fabric or vinyl, that is stretched taut and held in place by tension or mechanical fasteners via the frame.

SECTION 804 - INTERIOR FLOOR FINISH

- **804.1 General.** Interior floor finish and floor covering materials shall comply with this section.
  - **Exception:** Floor finishes and coverings of a traditional type, such as wood, vinyl, linoleum or terrazzo, and resilient floor covering materials which are not comprised of fibers.
- **Pill Test** (DOC FF-1 / CPSC 16 CFR, Part 1630 / ASTM D2859)
- **NFPA 253** (Radiant flux test for specific exit paths)

Flooring Radiant Panel

Applicable standards

- ASTM E 648 or NFPA 253
  - (Floor coverings IBC Sec 804.2)
- Critical radiant heat flux is measured

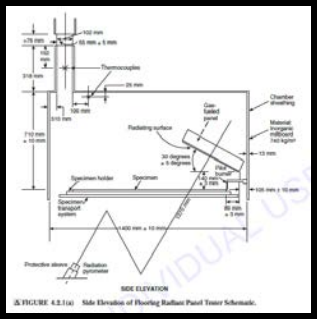


FIGURE 6.2.1(a) Side Elevation of Flooring Radiant Panel Tester Schematic.

Section 805 Combustible Materials in Types I and II Construction

805.1 Application
(in floors and flooring)

- 805.1.1 Subfloor construction
  - Combustible voids
  - Fireblocking per 718 allowed
- 805.1.2 Wood finish flooring
- 805.1.3 Insulation boards

[F] SECTION 806 DECORATIVE MATERIALS AND TRIM

- Occupancies regulated
  - A, B, E, I, M, R-1 and dormitories in R-2
- Suspended from walls or ceilings
  - Curtains
  - Draperies
  - Fabric hangings
  - Other combustible decorative materials
- Testing
  - Non-combustible, or
  - NFPA 701 (Test 1 or 2)
  - NFPA 289, using the 20 kW ignition source
    - 806.4 approved testing agency required

Limitations

- Non-combustible
  - unlimited
- Flame-resistant materials
  - 75% in Group A auditoriums w/ sprinklers
  - 50% in R-2 Dormitories w/ sprinklers
  - 10% in all other
    - (specific wall or ceiling area)

806.5 & 806.6

- **[F] 806.5 Foam plastic.** Foam plastic used as trim in any occupancy shall comply with Section 2604.2.
- **[F] 806.6 Pyroxylin plastic.** Imitation leather or other material consisting of or coated with a pyroxylin or similarly hazardous base shall not be used in Group A occupancies.

806.7 Trim

TRIM - Picture molds, chair rails, baseboards, handrails, door and window frames and similar decorative or protective materials used in fixed applications. Other than foam plastics.

- Crown molding?

- Limited to 10% of the specific wall **or** ceiling
- Class C flame spread index required

When does trim become interior wall finish?

Select 2021 IBC Chapter 4 Interiors Requirements

402 Covered Mall Buildings

- 402.6.2 Kiosks & similar structures
  - Temporary or permanent
  - Fire-retardant-treated wood
  - Foam plastics ≤ 100 kW per UL 1975
  - Aluminum composite materials – Class A
  - Sprinkler protected
  - 300 sq ft max
  - Separated by 20 ft
- 402.6.3 Play structures
  - Per Section 424
  - Separated by 20 ft

402.6 Plastic Signs in Covered Mall Buildings

- 402.6.4 Plastic signs limited to:
  - 20 % of tenant wall area facing mall
  - 36 inches max height if horizontal
  - 96 inches high by 36 inches wide if vertical
  - No closer than 18 inches to adjacent tenants
- 402.6.4.4 Non-foam plastic signs:
  - Edges and back incased in metal and
  - 2606.4 Light-transmitting plastics, or
  - Class B along with Ignition temp ≥ 650 °F
- 402.6.4.5 Foam plastic signs:
  - ≤ ½ inch thickness
  - ≥ 20 pound per cu ft density
  - ≤ 150 kW per UL 1975

Other Chapter 4 Interiors Requirements

- 404.8 Atria Interior Finish
  - Class B
- 410.2.6 Stage Scenery
  - NFPA 701
  - Foam plastics per 2603
- 411.7 Special Amusement Buildings
  - Class A
  - even when sprinklered (411.2)
- 424 Play Structures
  - Non-combustible materials, or
  - Materials regulated

Chapter 6 Allowances

- Chapter 6 – Types of Construction
  - 603 – Combustible materials in Non-Combustible Buildings
    - Fire-retardant-treated wood
    - Exposed thermal and acoustical insulation – Class A
    - Foam plastics in accordance with Chapter 26
    - Floor covering materials in accordance with Section 804
    - Millwork such as doors, door frames, window sashes and frames
    - Interior wall and ceiling finishes in accordance with Section 803
    - Trim in accordance with Section 806
    - Blocking such as for handrails, millwork, cabinets and window and door frames
    - Light-transmitting plastics as permitted by Chapter 26.
    - Materials exposed within plenums complying with the Mechanical Code

2/20/2024 EduCode 2024

Chapter 26

Although Chapter 26 governs the use of plastics for various aspects of building construction, the following overview is intended as guidance for the use of **plastics inside buildings**

2/20/2024 EduCode 2024

Chapter 26 Sections to discuss

- 2603 Foam Plastic “Insulation”
- 2604 Interior Finish and Trim
- 2605 Plastic Veneer
- 2606 Light-Transmitting Plastics
- 2611 Light-Transmitting Plastic Interior Signs

2/20/2024 EduCode 2024

Foam Plastic "Insulation"

- **Shortened Definition**
  - Intentionally expanded to produce a reduced-density plastic
  - For insulating or acoustical purposes
  - Density less than 20 pounds per cubic foot

2603 Foam Plastics

- 2603.1 Foam Plastic in buildings and structures
- 2603.2 Listed and labeled at the job site
- 2603.3 Surface-burning characteristics
  - Class B
- 2603.4 Thermal barrier
  - Required to separate foam from interior
  - Initially based on 1/2-inch (12.7 mm) *gypsum wallboard*

2603.4 - Thermal Barrier

- Required to separate foam from interior of building
- ½ inch gypsum wallboard or equivalent
- NFPA 275
  - Temp rise on unexposed surface limited to 250 ºF after 15 minutes
  - Encapsulation must remain in place
- Several construction approaches recognized to mitigate thermal barrier
- Exposed foam on interior of buildings essentially not allowed
- EIFS not allowed inside buildings
- 2603.9 Special tests allow exposed foam

2604 Plastics as interior finish and trim

- Meet Chapter 8
- Foam plastics in accordance with 2603.9
- Foam plastic trim
  - Density ≥ 20 pounds per cu ft
  - Thickness ≤ ½ inch
  - Width ≤ 8 inches
  - ≤ 10% the specific wall or ceiling
  - Class B or meets NFPA 286

2605 Plastic Veneer

- Interior finish must meet Chapter 8
- Exterior use limited

2606 Light-Transmitting Plastics

- 2606.4 Specifications
  - Self-ignition temp ≥ 650 °F
  - Smoke generation limited to:
    - 450 per E84 or 75 per ASTM D2843
  - Either CC1 or CC2 per ASTM D 635
    - CC1 - 1 inch burning extent
    - CC2 - 2.5 inches per minute burning rate
- In accordance with Sections 2607 – 2610 essentially only allowed on exterior of building

Light-Diffusing System Defined

Construction consisting in whole or in part of lenses, panels, grids or baffles made with light-transmitting plastics positioned below independently mounted electrical light sources, skylights or light-transmitting plastic roof panels. Lenses, panels, grids and baffles that are part of an electrical fixture shall not be considered as a light-diffusing system.

2606.7 Light-Diffusing Systems

- 2606.7.2 Shall comply with chapter 8
  - Unless fall from mounting at $\leq$ 200 ^{o}F below ignition temperature
  - Remain in place at 175 ^{o}F for 15 minutes
- 2606.7.3 Size limitations
  - 10 feet long nor
  - 30 square feet in area
- 2606.7.4 Sprinkler protection
  - Above and below
  - Unless not adversely affect sprinklers
  - Area unlimited

2611 Light-Transmitting Plastic Interior Signs

- Must comply with 2606
- Size limitations:
  - 24 square feet maximum
  - 100 square feet if CC1 and protected by sprinklers
    - Separation by 4 feet horizontal and 8 feet vertical constitutes separate signs
- Non-illuminated portions fully encased in metal
- For malls see 402.6.4

2607 Light-Transmitting Plastic Wall Panels
2608 Light-Transmitting Plastic Glazing
2609 Light-Transmitting Plastic Roof Panels
2610 Light-Transmitting Plastic Skylight Glazing

These materials limited to use on exterior walls and roofs

SECTION 2612 PLASTIC COMPOSITES
exterior use where combustible construction is permitted

SECTION 2613 FIBER-REINFORCED POLYMER
Interior uses must meet Chapter 8

Fire Dynamics

The physics of how fires start, spread and develop.

The study of how chemistry, fire science, material science, fluid mechanics and heat transfer interact to influence fire behavior.

Conditions affecting Fire Dynamics

- Proximity to and significance of, ignition source(s) and adjacent fuel package(s)
- Magnitude and duration of heat energy the ignition source projects onto target
- Combustibility/Flammability characteristics of target
  - (Ignition temperature, heat release rate)
- Mass to Surface area ratio
  - Thin combustible materials
  - Density
- Orientation of material (horizontal vs. vertical)
- Floors vs. ceilings
- Assemblies vs. single materials
- Type of substrate and method of attachment.
- Size of the fire compartment

Heat Release Rate (HRR)

A common term used in fire dynamics

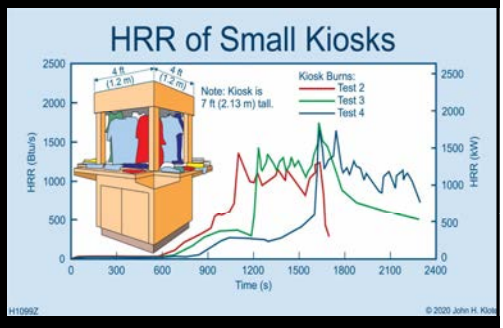
The rate at which fire releases energy (also known as power).
Measured in Btu/s or Watts (W) = Joule per second (J/s).
Also measured in Kilowatts (equal to 1,000 Watts) or Megawatts (equal 1,000,000 Watts).

- HRR is the driving force of fire development
- Measurement of "how big the fire is"
  - Quantity of heat energy being expended.

Examples of Peak Heat Release rate:

- Cigarette lighter: 50 - 100 W
- One candle: 80 W
- Tirril Burner (for small scale fire testing): 50 - 500 W (0.05 - 0.5 kW)
- Bunsen Burner: 1.5 kW
- Small waste basket: 20 - 50 kW
- Flashover in small room: 1 MW
- Polyurethane easy chair: 1.5 MW
- 100 sq. ft. cubicle & associated fuel load: 2 MW
- Polyurethane sofa: 3 MW
- Fully developed fire in compartment: 1 - 4 MW
- Motor home, Bus, 18 wheeled tractor trailer: 100-150 MW

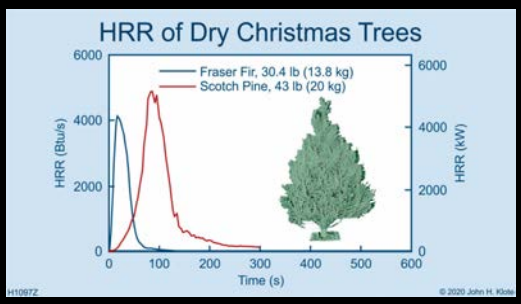
Wooden Kiosk with T-shirts ≈ 1.8 MW



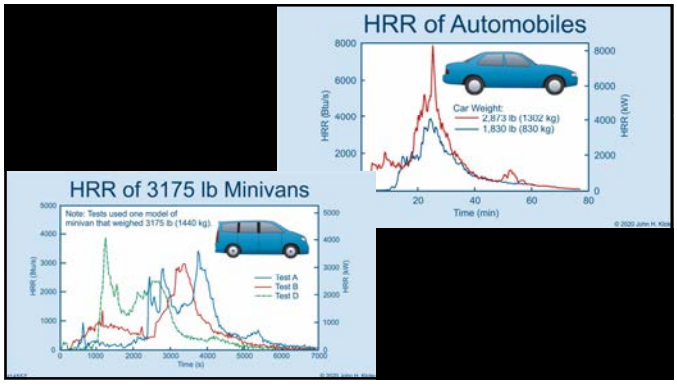
Polyurethane furniture: 2 - 3 MW

2/20/2024 EduCode 2024

Christmas Tree: 4+ MW



2/20/2024 EduCode 2024



Common Fire Tests for:

Decorative materials and Interior Finishes

- Small Scale
  - ASTM D 635
  - NFPA 701 Test Method 2
    - The preceding tests use a "Tirril" Burner (similar to a Bunsen Burner) 500 W = 0.5 kW max
  - UL 1975 (18 kW)
- Intermediate Scale
  - The Steiner tunnel test / ASTM E84 (88 kW)
- Large Scale
  - Room-corner tests (160 kW)
    - NFPA 265 (textiles)
    - NFPA 286 (non-textiles)

2/20/2024 EduCode 2024

Bench-scale Testing Vs. Larger Scale

- "Bench-type" testing should initially be conducted to determine if adverse behavior of the specific material can be predicted under actual fire conditions.
- Failure to achieve ignition in small-scale tests is not substantial proof of non-combustibility.
- Many materials incapable of achieving self-supporting fire in bench test configurations prove to be very combustible when subjected to larger scale testing.

FM Data Sheet 1-4

2/20/2024 EduCode 2024

ASTM D 635 for CC1/CC2 Plastics 0.5 kW Max

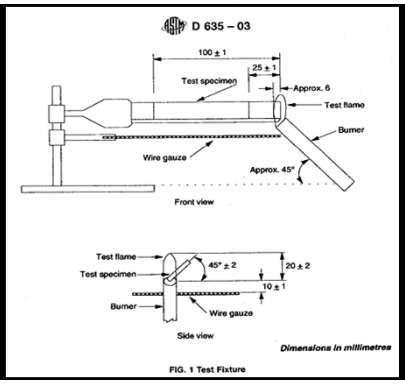


FIG. 1 Test Fixture

2/20/2024

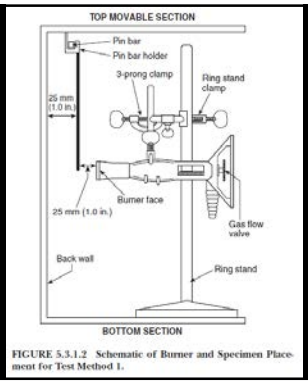
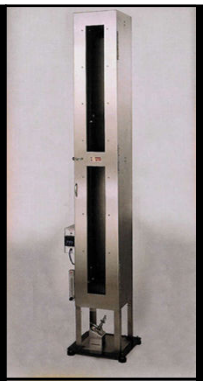


FIGURE 5.3.1.2 Schematic of Burner and Specimen Placement for Test Method 1.

NFPA 701 Test Method 1

50 W

Applications:
- Curtains/drapes
- Decorative materials
- Textiles



NFPA 701 Test Method 2

500 W = 0.5 kW max

Six foot high test chamber

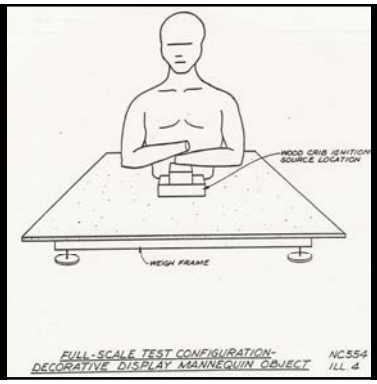
Applications:
- Fabrics in excess of 700 g/m²
- Tents/tarps/awnings
- Decorative materials
- Textiles

EduCode 2024

UL 1975

18 kW

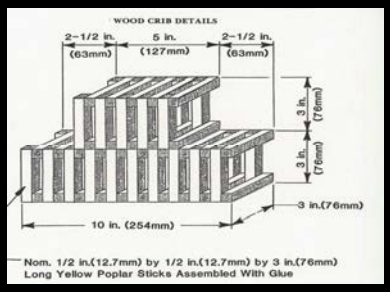
(20 kW)



FULL-SCALE TEST CONFIGURATION-DECORATIVE DISPLAY MANNEQUIN OBJECT NC554 ILL. 4

2/20/2024

UL 1975 Wood Crib (18 kW)



2/20/2024

Maximum 10 inches long and 6 inches high

Foam Plastic Decorative Object

Photo Courtesy Hughes Associates

Steiner Tunnel Test (ASTM E 84) (88 kW)

The most common fire test specified in US codes

Applications:

- Interior finish
- Building products
- Insulation
- Plenum materials

2/20/2024

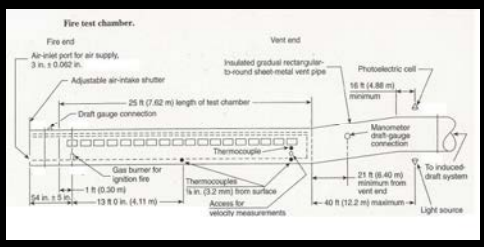
Photo Courtesy Hughes Associates

Used to Determine:
Flame Spread and
Smoke-Developed
Indices

Photo Courtesy Hughes Associates

EduCode 2024

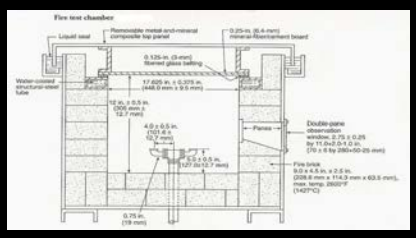
Steiner Tunnel Test



25 feet long

2/20/2024

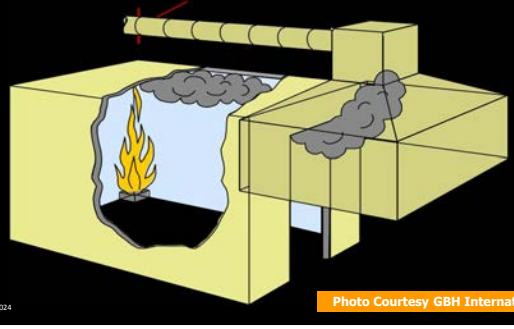
Steiner Tunnel Test



Fire Box one foot by 1.5 foot

2/20/2024

Room Corner Test (40 – 150/160 kW)



2/20/2024

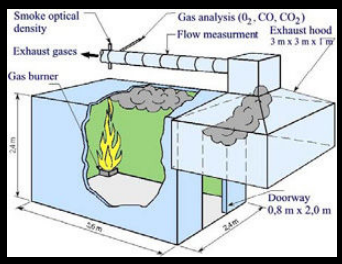
Photo Courtesy GBH International

Room Corner Test Standards:

NFPA 265-19
- Textile wall coverings

• NFPA 286-15
- Wall & ceiling interior finish
- Thermal barrier exemption

• UL 1715-97
- Interior finish for foam plastics
- Thermal barrier exemption



2/20/2024

EduCode 2024

Wood Crib Version

Photo Courtesy Hughes Associates

Overview of Recognized Test Methods

- Proximity to and significance of, ignition source(s) and adjacent fuel package(s)
- Magnitude and duration of heat energy the ignition source projects onto target
- Combustibility/Flammability characteristics of target
  - (Ignition temperature, heat release rate)
- Mass to Surface area ratio
  - Thin combustible materials
  - Density
- Orientation of material (horizontal vs. vertical)
- Floors vs. ceilings
- Assemblies vs. single materials
- Type of substrate and method of attachment
- Size of the fire compartment

2/20/2024 EduCode 2024

Wu dew we dew w/ the *weird* stuff ?

Wall Applications
Ceiling Applications
Artificial Plants and Statues
Decorative Structures within, on and adjacent to Buildings

2/20/2024 EduCode 2024

Primary Concept

The main concept of this portion of the presentation is:

When decorative materials exceed the intent of the fire code they can be constructed out of the same materials allowed for the building.

Q: When do decorative materials exceed the intent of the fire code?

Fire Code

Decorative materials inside buildings are regulated by the fire code as **fuel loading**.

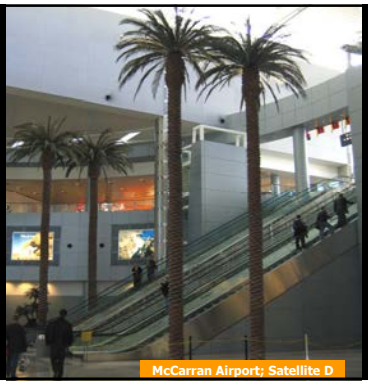
- Artificial plants
- Mannequins
- Table umbrellas
- Signs
- Pictures
- Draperies
- Murals

Building Code

The building code regulates what the **building components** are constructed out of.

- Floors
- Walls
- Columns
- Ceilings
- Interior finishes

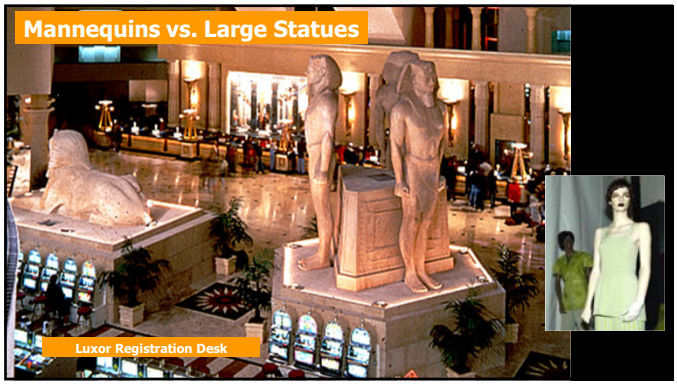
Artificial Plants



McCarran Airport; Satellite D

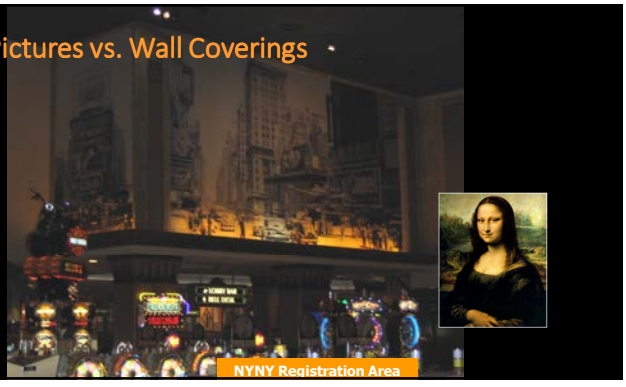
2/20/2024

Mannequins vs. Large Statues

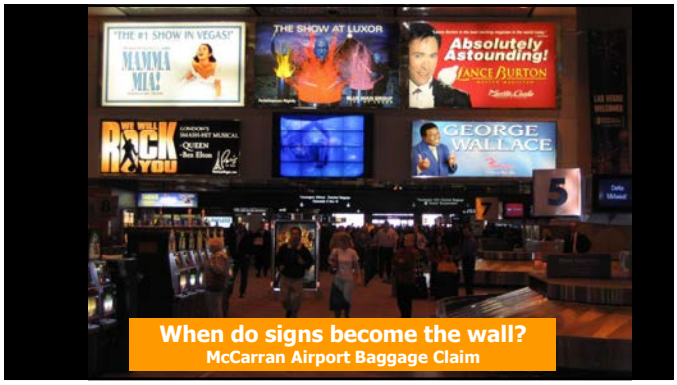


Luxor Registration Desk

Pictures vs. Wall Coverings



NYNY Registration Area


THE SHOW AT LUXOR
Absolutely Astounding!
LANCE BURTON
GEORGE WALLACE
When do signs become the wall?
McCarran Airport Baggage Claim


Umbrellas
vs. Ceilings


Child's Playhouse
vs.
Interior Structures
Luxor Atrium

Consideration Of The Potential Fire Hazard (Slide 1 of 2)

- Proximity to fire sprinklers.
- Obstruction to sprinkler discharge.
- Burning characteristics.
  - (Ignition temperature, heat release rate)
- Type of substrate and method of attachment.
- Physical properties of the decorative item.
  - (Size, thickness and product type)
- Properties of topical applications.
  - (Pigments, varnishes)

2/20/2024 EduCode 2024

Consideration Of The Potential Fire Hazard (Slide 2 of 2)

- Combustible concealed voids.
  - (compartmentation, sprinkler installation and plenums)
- Fire-retardant applications.
- Applicability of recognized fire tests.
- Temporary vs. Permanent.
- Proximity to, and significance of, ignition sources and adjacent fuel packages.
- Obstruction to occupant evacuation.

2/20/2024 EduCode 2024

Organizing the approach for unique interior applications

- Trim
- Wall Applications
- Ceiling Applications
- Artificial Plants and Statues
- Decorative Structures within, on and adjacent to Buildings

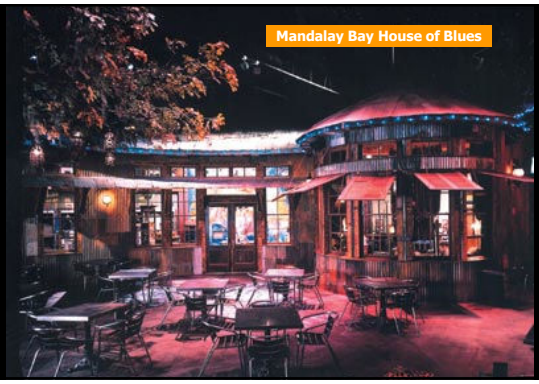
2/20/2024 EduCode 2024

Trim

- Limited in size and quantity
  - Baseboards
  - Chair rails
  - Crown molding
  - Door/window frames
  - Handrails
  - 10% of walls and ceiling
- When does trim become wall or ceiling finish?
  - 6 to 8 inches? (IBC Section 2604.2.2 – 8 inches)

Wall Applications

- Murals
- Tapestries
- Pictures
- Signs
- When does a picture become a wall covering?
  - 10 feet by 10 feet?



Mandalay Bay House of Blues

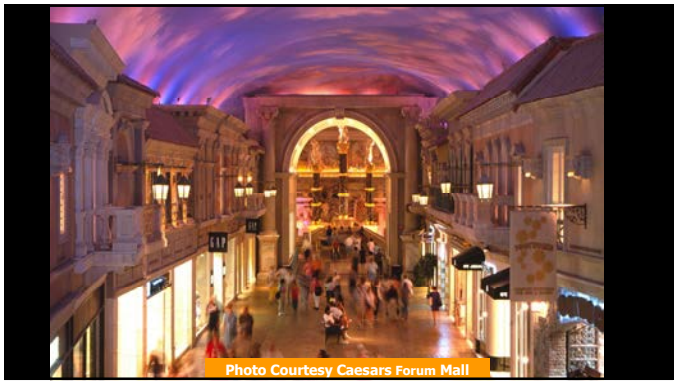


Photo Courtesy Caesars Forum Mall

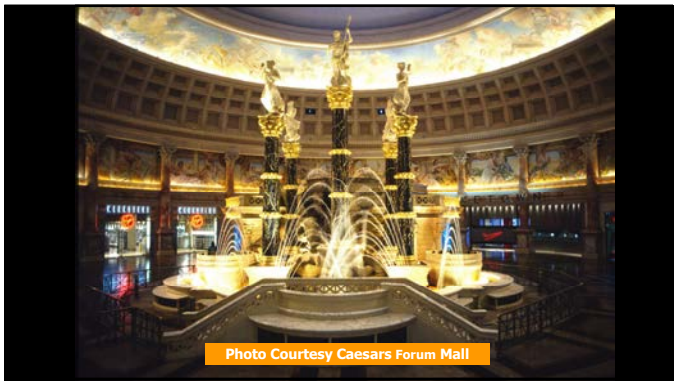


Photo Courtesy Caesars Forum Mall

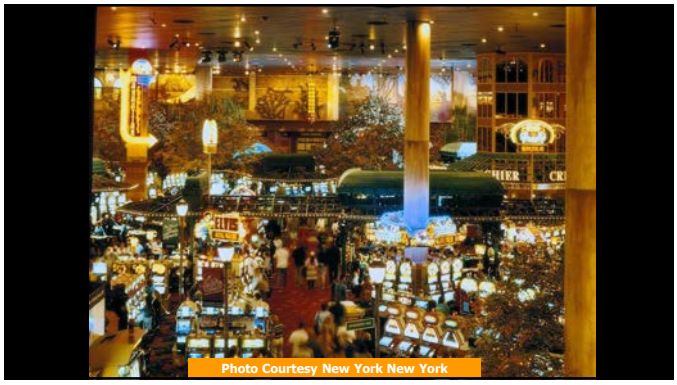
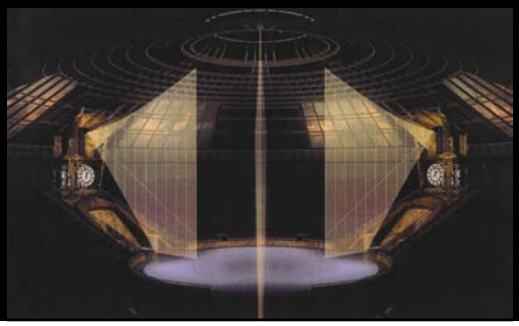
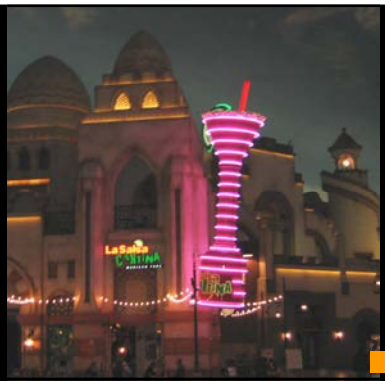


Photo Courtesy New York New York

Fabric Room Dividers



Interior Signage



Aladdin Desert Passage Mall

Ceiling Applications

- Umbrellas
- Awnings
- Canopies
- Non-occupiable/decorative balconies
- Interior eves/horizontal projections
- Lattice ceilings
- Roofs of interior structures

- When do these features become a ceiling?
  - 10 feet by 10 feet?

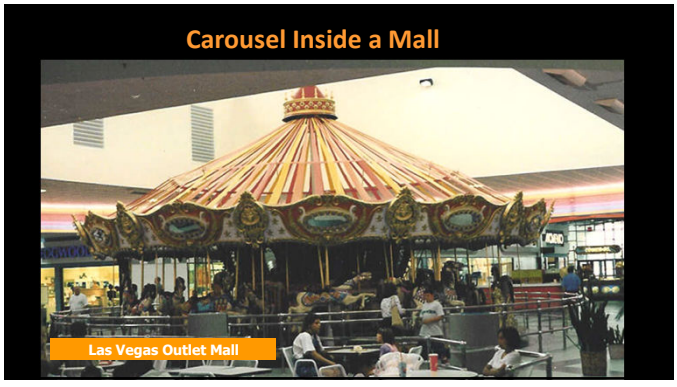

Obstruction to sprinkler discharge


Photo courtesy Caesars Forum Mall


Photo Courtesy Paramount Pictures

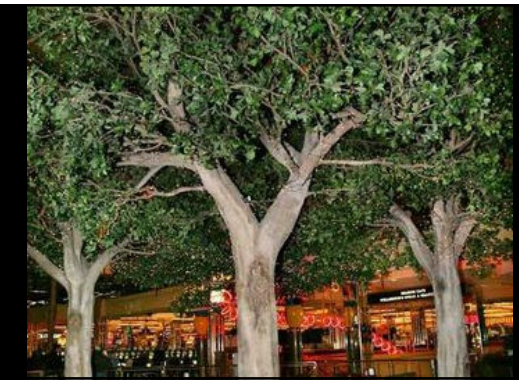

Wear Know Won Has Gone Bee 4


Thatched "Roofs" Under a Roof
Hawaiian Marketplace


Carousel Inside a Mall
Las Vegas Outlet Mall

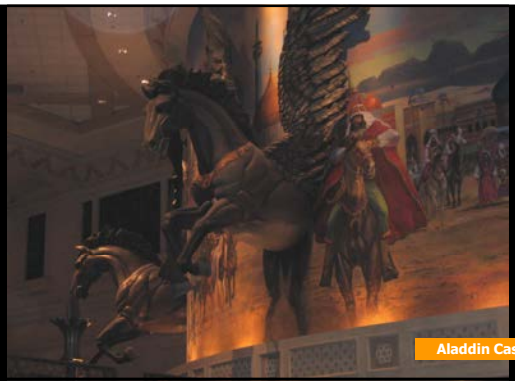
Artificial Plants and Statues

- Artificial plants
- Statues
- Preserved plants
- Mannequins
- Models
- Small, non-occupiable decorative structures
  - When do these features exceed the intent of the fire code?
    - 4 ft diameter and 10 ft high?



Foam Plastic Palm Trees

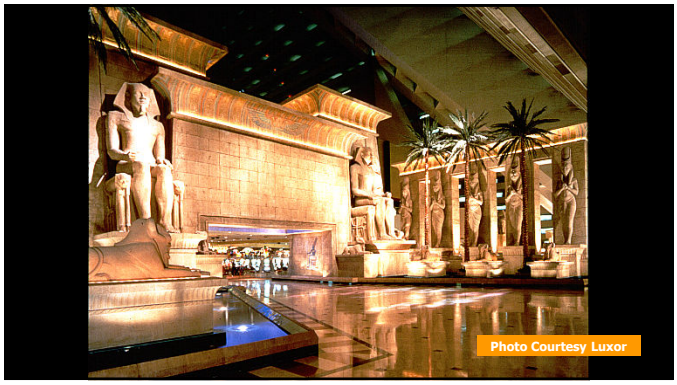
McCarran Satellite D

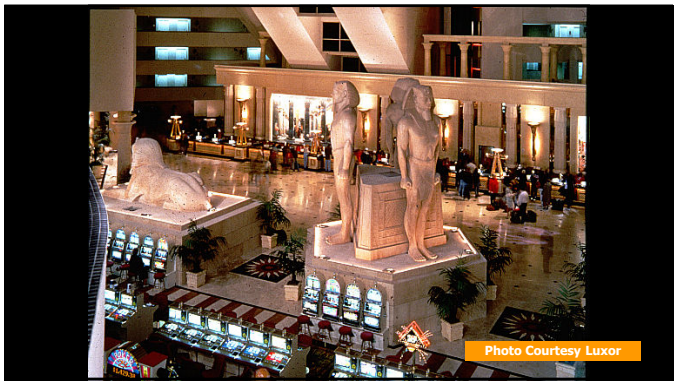


Aladdin Casino

Plastic Column Covers

Caesars Forum Mall





Decorative Structures Within Buildings

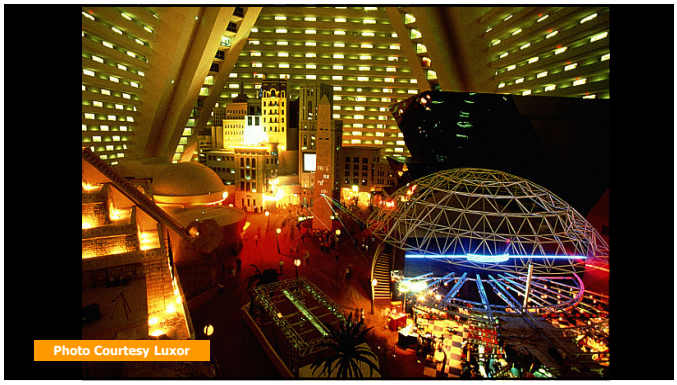
Break decorative structures into components

- Interior wall/ceiling finishes
- Decorative ceilings/roofs
- Nonbearing partitions
- Columns and bearing walls
- Mezzanines
- Occupiable floors/balconies

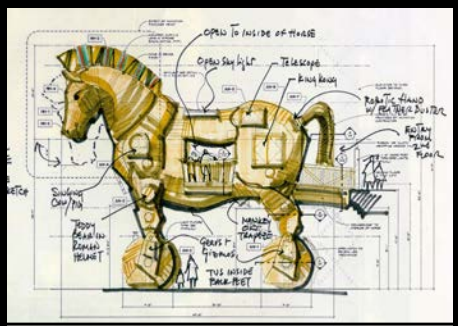
2/20/2024 EduCode 2024

Starship Bridge

Wear Know Won Has Gone Bee Four



FAO Schwarz in The Forum Mall



Decorative Features Summary

- When does fuel loading become building materials?
  - If anyone at anytime can pick it up and carry it inside the building, its likely fuel loading.
  - If the decorative item takes a crew of people to haul it inside the building and assemble it, it may be more appropriate to construct the decorative feature out of the same materials allowed for the base building.

2/20/2024 EduCode 2024

This Presentation Focused On

- The fire protection aspects of interior finishes and decorative features inside buildings
- Why these requirements exist
  - fire losses
- Applicable Code requirements
- Applicable fire tests, associated challenges, along with appropriate and inappropriate applications of those tests.
- Related fire dynamics
- How to use the same thought process to achieve fire safety for other unique decorative features.

2/20/2024 EduCode 2024