INTRODUCTIONS

Instructor Name

- About You Bullet 1
- About You Bullet 2
- About You Bullet 3
- About You Bullet 4
- About You Bullet 5
- About You Bullet 6
- Your email address

COURSE OBJECTIVES

Goal

By the end of this learning you will be able to, apply the critical concepts and provisions of the 2021 International Building Code®

DESCRIPTION

Why Does This Matter?

- This seminar focuses on 2021 IBC essential concepts
- Concepts provide a basis for correct code utilization
- Clear understanding of identified requirements allows code users to
  - Apply the IBC in specific situations
  - Build understanding of the code intent when asked to make code compliance judgments
COURSE OBJECTIVES

- Explain fundamental 2021 IBC provisions and intent
- Describe common provisions applicable to commercial building design
- Comprehend passive and active fire protection
- Identify how life safety and egress issues are addressed in design and construction
- Identify occupant health and safety safeguards with weather protection and interior environment controls

To achieve this goal you can.

1. Slides contain some text and iconic images to help you learn
2. Text and commentary is in the handout
3. Follow along in the course handout
4. Ask Questions, ask questions, ASK QUESTIONS!!!!

COURSE OUTLINE

- Administration
- Building Planning
- Fire Safety
- Life Safety
- Health Safety
- Structural Safety
229. “If a builder has built a house for a man, and has not made his work sound, and the house he built has fallen, and caused the death of its owner, that builder shall be put to death.”
COURSE BASIS

History of Building Codes

Codes are minimum requirements to safeguard:
- Health & Safety
- Welfare of the Public
- Occupants
- Users of Spaces or Buildings

U.S. Building Code History

Building Code Recommended by National Board of Fire Underwriters
- Published in 1905
- One of earliest U.S. model building codes

By the end of the 20th century there were 3 model building code groups
- Building Officials & Code Administrators International (BOCA)
- International Conference of Building Officials (ICBO)
- Southern Building Code Congress International (SBCCI)
U.S. Building Code History

In 1994, BOCA, ICBO and SBCCI agreed to develop one model code
- Together formed International Code Council (ICC)

Purpose of Building Codes

- Regulations adopted by governmental agencies to ensure that buildings are built in a safe manner
- People expect when entering a building to be safe from inherent dangers caused by natural or man-made disasters

ICC Code Development

Family of "I" Codes revised and published every 3 years
- Updated with constantly evolving
  - Construction technology
  - Methods
  - Materials
  - Equipment
  - Processes
ICC Code Development
Revised through open "Governmental Consensus Process" which provides for:
- Openness
- Transparency
- Balance of Interests
- Due Process
- Appeals Process
- Consensus
ICC Code Development

- New code published every three years
- 12-month cycle
- Codes divided into 2 groups
  A. IBC, IPC, IMC, IFGC, IPDC
  B. IRC, IFC, IEB, IEC, IPM, ISPSC, IAVC, ILC, ICCPC, Admin.

- Code Changes Submitted
- Code Changes Available
- Committee Action Hearing
- Report of Public Hearing
- Public Comments Submitted
- Public Comments Available
- Public Comment Hearing
- New Edition Published
cdpACCESS

- Cloud-based system for code development process (cdp)
- Developed to increase participation
- On code change proposals & public comments users can
  - Create
  - Collaborate
  - Review
  - Submit
  - Vote (if eligible)

Code Adoption

- IBC is a "model" code
  - Can be adopted by governmental agency and become law
  - Adopted by federal, state and local government agencies
  - Adopted through legislation or delegate to a board or state agency
  - Adopting legislation or ordinance is required to go through a public hearing process
  - Many jurisdictions develop amendments to model codes

Sample adoption ordinance included in all I-codes
- Jurisdiction must adopt a specific code edition
- Any appendix must specifically be adopted
- Code official is responsible for assuring substantial compliance with the adopted code and any state laws dealing with construction issues
Code Adoption

U.S. Constitution creates
- States that have constitutions that create
  - Legislatures that pass laws signed by governors that create
- 10th Amendment to U.S. Constitution
  - States granted authority to adopt laws to protect health, safety, morals and general welfare of its citizens
  - Known as “Police Powers”

International Building Code

Applies to every building, structure or appurtenance
- Construction
- Alteration
- Movement
- Replacement
- Repair
- Equipment
- Use and Occupancy
- Location
- Maintenance
- Removal
- Demolition
- Structural strength
- Means of egress facilities
- Stability
- Sanitation
- Light and ventilation
- Energy conservation
- Safety to life and property
  - Fire
  - Explosion
  - Other hazards
### International Building Code

**Minimum requirements for safety, health and general welfare**

- Applies to design, installation, maintenance, alteration and inspection of permanent mechanical systems installed within buildings
- Covers
  - Heating
  - Ventilation
  - A/C systems

### International Fuel Gas Code

**Minimum requirements for safety, health and general welfare**

- Regulates design, installation, maintenance, alteration and inspection of appliances that utilize natural gas and liquefied petroleum gas (LPG), gaseous hydrogen systems, and related accessories

### International Plumbing Code

**Minimum requirements for safety, health and general welfare**

- Provides regulations for design, installation, alteration and maintenance of plumbing systems
- Governs materials, sizing and installation of potable water supply and distribution plumbing fixtures, drain-waste-vent piping (DWV) and storm drainage systems
International Energy Conservation Code
Regulates energy use in buildings
• Provides requirements for insulation R-values and door and window insulation requirements, as well as air infiltration limitations
• Applies to all buildings that are either heated or cooled

International Fire Code
• Provides a reasonable level of life safety and property protection from hazards of fire, explosion or dangerous conditions in new and existing buildings and structures
• Provides regulations for safety of fire fighters and emergency responders during emergency operations

International Property Maintenance Code
• Provides for maintenance of existing buildings and properties
• Provides minimum requirements for premises, structures, equipment, and facilities
• Addresses lighting, ventilation, space, heating, sanitation, life safety, and safety from fire and other hazards and for safe and sanitary maintenance
### International Residential Code
- Regulates construction of 1- and 2-family dwellings and townhouse structures
- Designed to be a completely stand-alone code for residential construction
- Combines all regulations for building, energy, mechanical, fuel gas, plumbing and electrical into one document

### International Swimming Pool & Spa Code
- Comprehensive swimming pool code
- Developed with the Association of Pool & Spa Professionals (APSP)
- Coordinated with requirements in
  - International Codes
  - APSP standards
- Establishes minimum regulations for public and residential pools, spas, and hot tubs

- Intended to safeguard the environment, public health, safety and general welfare
- Establishes requirements to reduce negative potential impacts on the natural environment
- Works to conserve natural resources, materials and energy
International Existing Building Code

- Covers alteration, addition, repair, relocation or change of use of an existing building
- 3 methods that an owner can choose to show compliance with the codes
- Address work done and how codes are applied to historic buildings without affecting historical significance and character

Existing Buildings

- Existing buildings are permitted to continue without change if maintained in accordance with the code under which constructed

Existing Buildings

- IBC requires work to existing buildings comply with IEBC
Existing Buildings

IEBC provides 3 compliance methods for owners
1. Prescriptive
2. Work area
3. Performance

Each addresses repairs, alterations, additions and change of occupancy

Prescriptive vs. Performance

Prescriptive Compliance
- New work must comply with current code
- Building official can require dangerous conditions corrected
- Approve without current code compliance if new use is less hazardous than existing use

Performance Compliance
- Scoring system that evaluates
  - Fire safety
  - Means of egress
  - General safety
- Negative score in one category means non-compliance and additional upgrades needed

Work Area Compliance

Similar to prescriptive method
- Work area is that for which a building permit is obtained
- Maintain prior level of compliance
  - Fire protection systems
  - Means of egress
  - Accessibility
Using the IBC

Codes and Standards

- "Codes" are adopted by the legal authority in a jurisdiction
  - Establish minimum performance requirements to achieve life safety and property protection
  - Are written in "mandatory" language indicating what must be done
- "Standards" are referenced in the codes and indicate how to achieve what must be done

Authority

- Local jurisdiction creates Department of Building Safety
- Building official appointed to
  - Manage the department
  - Review plans
  - Issue permits
  - Inspect work for compliance with codes and plans
  - Issue Certificates of Occupancy
  - Interpret code requirements
Alternative Materials & Methods

- Designers can submit a request to meet code requirements with AM&M
- Building official reviews to determine compliance with purpose and intent of code
- Alternative must be at least equivalent in quality, strength, effectiveness, fire resistance, durability and safety
- ICC Evaluation Service (ICC-ES) reviews and provides reports

Permits

Required for:
- New construction
- Remodeling
- Building an addition
- Change of occupancy

Exempt projects:
- Storage sheds less than 120 square feet
- Fences not over 7 feet in height
- Retaining walls not over 4 feet in height
- Painting and wallpaper installation
- Playground equipment accessory to 1- and 2-family dwellings
- Other minor construction
- Permit exemption does not allow for nonconformance with code
Submittal Documents

Drawings
- Site plan
- Floor plans
- Elevations
- Details
Specifications
- Manufacturer installation instructions
- Minimum 2 sets submitted

Plan Review

- Building department reviews plans for code compliance and other applicable jurisdiction laws
- If plans are compliant, a permit can be issued
- If plans have discrepancies, a plan review report is provided to the applicant
- Applicant makes corrections and resubmits plans for review
- Permit is issued when plans are approved

Inspections

- Confirm compliance with plans and code
- Holder of permit requests inspection
- Work cannot be covered until inspection complete
**Footing & Foundation**

- Inspectors check forms and reinforcing steel to ensure correct size and proper location
- Concrete – inspection after forms are constructed and reinforcing steel installed
- Masonry – inspection for correct masonry, mortar, grout and reinforcing steel

**Concrete Slab and Under-floor**

Concrete slabs can contain
- Reinforcing steel
- Conduits
- Piping
- Other equipment

Inspection typically after
- Plumbing inspector checks plumbing installation
- Electrical inspector checks underground electrical equipment

**Lowest Floor Elevation**

- Where flooding is possible, buildings are to be elevated above 100-yr flood level
- Confirm lowest occupied floor elevated at or above design flood elevation
### Frame
- Structure of the building inspected
- Confirm correct size and installation of building’s structural members
- Frame inspection AFTER all plumbing, mechanical and electrical systems
  - Installed
  - Inspected
  - Approved

### Connection Fire Protection
- Types IV-A, IV-B, IV-C
- Connection fire-resistance ratings by wood cover
- Inspect wood cover before other finishes installed

### Lath and Gypsum
- Many buildings use gypsum board to provide fire protection or shear resistance
- Inspector confirms that materials are installed to provide
  - Level of specified fire protection
  - Shear resistance designed
Weather-exposed Balcony Waterproofing

- Inspection of moisture barrier required prior to membrane being concealed
- Balconies or other elevated walking surfaces exposed to water from direct blowing rain, snow or irrigation systems

Fire- and Smoke-resistant Penetrations

Penetrations (holes) in fire-rated components
- Protected with a material that fills them when piping or wiring melts out in a fire
Confirm installation per manufacturer’s instructions

Energy Efficiency

- Energy efficiency materials installed correctly
  - Insulation values
  - Sealing
  - Equipment installation
Special Inspections

Certain portions of buildings may require 3rd party special inspections:
- Expertise in particular materials and designs
- Hired by building owner
- Report findings to building department

Third-party inspections required on materials such as:
- Structural concrete
- Structural steel
- Masonry
- Tall mass timber
- Helical piers
- Fire-resistive penetrations/joints

Final

- Confirm all work covered by permit is completed according to plans and applicable code
- When final inspection approved
  - Owner receives Certificate of Occupancy
  - Allows building use

Board of Appeals

- Building official is responsible for code interpretation
- Designer or contractor may disagree with interpretation
  - Can request a hearing with board of appeals
- Board of appeals
  - Evaluates information against code intent
  - Renders a decision regarding code interpretation
Definitions

- IBC includes definitions for specific terms
- Undefined terms
  - Other I-Code definitions apply
  - Normal use of a term as it applies to the code
- Defined terms are italicized in code text

Poll Question

1. A building design can never stray from requirements found in the building code.
   a. True
   b. False

Poll Question

2. Who is responsible to arrange for inspections of completed work?
   a. Registered design professional
   b. General contractor
   c. Owner
   d. Building permit holder
Poll Question

3. How long must work remain open for inspection after it is requested?
   a. One week
   b. Two weeks
   c. One month
   d. Until work is inspected

Discussion

Building Planning
Basic Occupancies

- 10 occupancy classifications
- Subdivisions lead to 26 classifications
- Based on use and function
- Most important part of plan review process

Occupancy Classification

- Where a space is to be occupied for different purposes at different times, all requirements applicable to each use is considered
- Buildings with two or more distinct occupancy classifications must comply with Section 508 for mixed-occupancy buildings

Group A (assembly) – civic, social or religious

<table>
<thead>
<tr>
<th>OCCUPANCY CLASSIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
</tr>
<tr>
<td>...usually fixed seating, intended for production and viewing of performing arts or motion pictures</td>
</tr>
<tr>
<td>A-2</td>
</tr>
<tr>
<td>...food and/or drink consumption</td>
</tr>
<tr>
<td>A-3</td>
</tr>
<tr>
<td>...worship, recreation, or amusement and other uses not classified elsewhere in Group A</td>
</tr>
<tr>
<td>A-4</td>
</tr>
<tr>
<td>...indoor sporting events and activities with spectator seating</td>
</tr>
<tr>
<td>A-5</td>
</tr>
<tr>
<td>...participation in or viewing outdoor activities</td>
</tr>
</tbody>
</table>
OCCUPANCY CLASSIFICATIONS

Group B (business)

- Office, professional, or service-type transactions, including storage of records and accounts

Group E (educational)

- 6+ persons at any one time for educational purposes through 12th grade and child-care facilities
- 5+ children older than 2½ who receive educational, supervision or personal care services < 24 hrs/day (Day Care)

Group F (factory)

- Assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing not classified H (hazard) or S (storage)
  - F-1: Industrial uses not classified as F-2 Low Hazard
  - F-2: Industrial uses involving fabrication or manufacturing of noncombustible materials which during finishing, packing, or processing do not involve a significant fire hazard
Group H (high hazard)

Group H (high hazard) – manufacturing, processing, generation or storage of materials that constitute a physical or health hazard in quantities in excess of those allowed in control areas

- Materials that pose a detonation hazard (H-1)
- Materials that pose a deflagration hazard or a hazard from accelerated burning (H-2)
- Materials that readily support combustion or that pose a physical hazard (H-3)
- Materials that are health hazards (H-4)
- Semiconductor fabrication facilities and comparable research and development areas in which hazardous production materials (HPM) are used (H-5)

Group I (institutional)

Group I (institutional) – care/supervision for persons who
- May not be capable of self-preservation without physical assistance
- Are detained for penal/correctional purposes or liberty is restricted

- 16+ persons, excluding staff, who reside on a 24-hr basis in a supervised environment and receive custodial care (I-1)
- Medical care on a 24-hr basis for 5+ persons who are incapable of self-preservation (I-2)
- 5+ persons who are under restraint or security, generally incapable of self-preservation due to security measures not under occupants' control (I-3)
- Persons of any age who receive custodial care for less than 24 hrs by individuals other than relatives in a place other than the home of the person cared for (I-4)

Group M (mercantile)

Group M (mercantile) – display and sale of merchandise which involves stocks of goods, wares or merchandise incidental to such purposes and publicly accessible
Occupancy Classifications

Group R (residential) – for sleeping purposes when NOT
- Classified as Institutional Group I
- Regulated by IRC

R-1: Sleeping units with primarily transient occupants
R-2: Sleeping units or 2+ dwelling units with primarily permanent occupants
R-3: Primarily permanent occupants not classified as Group R-1, R-2, R-4, or IR-3
R-4: 5 to 16 persons, excluding staff, who reside on a 24-hr basis in a supervised residential environment and receive custodial care

Group S (storage) – not classified as hazardous

S-1: Uses that are not classified as Group S-2
S-2: Noncombustible materials such as products on wood pallets or in paper cartons with or without single thickness divisions; or in paper wrappings. Such products are permitted to have a negligible amount of plastic trim, such as knobs, handles, or film wrapping.

Group U (utility)

U: Accessory and miscellaneous structures not classified in any specific occupancy shall conform to IBC commensurate with fire and life hazard incidental to their occupancy
Types of Construction

Buildings’ fire resistance based on
- Key building elements
  - Combustible or noncombustible
  - Protected by recognized level of fire resistance
- Permitted building size directly related to construction type

Types of Construction (Continued)
- Buildings must be classified as single construction type
- Based on full compliance with minimum requirements for intended construction type
- Unlike mixed-occupancy conditions where multiple uses occur

Fire-Resistance Rating Requirements for Building Elements (hours)

Refer to Code Book
Automatic Fire Sprinkler Systems

- **NFPA 13**
  - Sprinklers required in all rooms of a building
  - Also provided in concealed spaces
- **NFPA 13R**
  - Limited to residential uses <4 stories and <60 feet
  - Sprinklers can be omitted from concealed combustible spaces and small closets and restrooms
- **NFPA 12D**
  - Limited to 1- and 2-family dwellings
Determine Average Grade Plane

\[ \frac{100 + 100 + 116 + 116}{4} = 108' \]

Determine Average Roof Height

\[ \frac{125 + 135}{2} = 130 \]

Determine Building Height

\[ 130 - 108' = 22' \]

The bottom story is a basement because the floor of Story "A" is <6' above grade plane.
Allowable Number of Stories

<table>
<thead>
<tr>
<th>OCCUPANCY CLASSIFICATION</th>
<th>TYPE OF CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type A</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>9</td>
</tr>
<tr>
<td>D</td>
<td>13</td>
</tr>
</tbody>
</table>

Height and Area Limitations

- Occupied roof occupancy based on Table 504.4 for story immediately below.
- Roof area not added to building area regulated by §506.
Mezzanines

Do not count as a story when evaluating building area or number of stories

- < 1/3 floor area below
- ≤ 2/3 area for special industrial Type I or II
- ≤ 1/2 area in Type I and II
  - Sprinklered
  - EV/AC system

If area below upper level is not enclosed:

\[
\frac{8,750}{30,000} = 0.29
\]

Upper level considered mezzanine

If area below upper level is enclosed:

\[
\frac{8,750}{21,250} = 0.41
\]

Upper level considered second story

---

Allowable Building Area Factor (SF)

\[
A_a = A_t + (NS \times \iota)
\]

(5-1)

where:

- \(A_a\) = Allowable building area per story (ft²)
- \(A_t\) = Allowable area factor per Table 506.2
- \(NS\) = Allowable area factor per Table 506.2 for nonsprinklered building
- \(\iota\) = Area increase factor due to frontage per §506.3

Refer to Code Book

---
Area Increase for Frontage ($I_f$)

- >25% of perimeter on public way or open space

Interpolation permitted
- Lowest value in "Open Space" range
- Highest value in "% Building Perimeter" range

OR use $I_f = \frac{[F/P - 0.25]}{30}$ based on 2018 IBC Eq. 5-5

Minimum Frontage Distance ($W$)

- Right angle to building
- $W \geq 20$ feet
  - Closest lot line
  - Width of public way
  - Exterior of adjacent building
Area Increase for Frontage

Building perimeter = 1500'
- W ≥ 20 feet
  - 500
  - 500
  - 250
- W < 20 feet
  - 250

1250/1500 = 83%

FOR EXAMPLE

Area Increase for Frontage (I_f)

- 83% of building perimeter with ≥30' open space

FOR EXAMPLE

Allowable Area for Frontage

Given
- Type II A Business occupancy
- With sprinklers
- Single story with single occupancy
- \( A_s = 31 \times 150,000 \)

\[ A_a = A_s + (NS \times I_f) \]
\[ A_a = 150,000 + (37,500 \times 0.75) \]
\[ A_a = 150,000 + 28,125 \]
\[ A_a = 178,125 \geq 125,000 \] OK
Single Occupancy – Multi-story

\[ A_o = [A_t + (NS \times I)] \times S_a \quad (\text{Eq 5-2}) \]

where terms defined earlier except:

\[ S_a = \text{Actual number of stories above grade plane} \leq 3 \]

For buildings with NFPA 13R sprinkler system, \( S_a \leq 4 \)

Refer to Code Book

Floor Area in Multi-story Building

Type IIA Group B Office – Nonsprinklered
Table 506.2: \( NS = 37,500 \text{ ft}^2 \)

- 1-story building
  - Max. 37,500 ft²
- 2-story building
  - Max. 75,000 ft²
- 3-story building
  - Max. 75,000 ft²
- 4-story building
  - Max. 112,500 ft²

Interior Dimensions

- Habitable rooms
  - Room width ≥ 7'
  - Exception for kitchens with ≥ 3' clear passageway
  - Ceiling height ≥ 7'-6'
  - Barrier required to protect occupants from objects protruding into clear height
- Egress path
  - Ceiling height ≥ 7'-6'
  - Door height ≥ 80'
  - Door width ≥ 32'

106

107

108
Mixed-use and Occupancy

Mixed Use – Separated Occupancies

- Designer’s option
- Separation based on Table 508.4
- Ratio calculation to determine allowable area

**FOR EXAMPLE**

Given:
- Mixed occupancy building shown
- One story
- Type IV-S construction
- No fire sprinklers
- No frontage increase

- Group A-2: 1,500 SF
- Group B: 1,250 SF
- Group M: 3,750 SF
- Group S-1: 500 SF

Evaluate Allowable Area:
- Ratio Calculations:
  - Group A-2: 1,500/6,000 = 0.25
  - Group B: 1,250/9,000 = 0.14
  - Group M: 3,750/9,000 = 0.42
  - Group S-1: 500/9,000 = 0.06
- Total Ratio = 0.87 < 1.0
- OK
Mixed Use – Nonseparated Occupancies

Most restrictive requirement of each occupancy applied to entire building

- Height
- Area
- Chapter 9 requirements

No Separation Required Between Any Occupancies

Mixed Use – Accessory Occupancies

- Subsidiary occupancy to main use of building
- Aggregate area accessory occupancy ≤10% of floor area/story
- Not exceed nonsprinklered tabular area for accessory occupancy
- Allowable height & stories cannot exceed Table 504
- Accessory occupancy individually classified

Live/Work Units

- Classified as R-2
- Floor area ≤ 3,000 square feet
- Non-residential portion ≤ 50 percent of floor area
- Commercial portion on 1st floor
- ≤ 5 workers or employees
Mixed Use – Incidental Uses

- Ancillary functions
- Higher hazards
- Protection per Table 509.1
  - Fire-rated construction, or
  - Fire sprinklers
    - Room constructed to resist smoke passage

Mixed Use – Incidental Uses

<table>
<thead>
<tr>
<th>Room or Area</th>
<th>Separation (feet) and/or Sprinkler Protection (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace &gt;400,000 Btu/hour input</td>
<td>1 or S</td>
</tr>
<tr>
<td>Boiler(s) 150-1,000 Btu/hour input</td>
<td>1 or S</td>
</tr>
<tr>
<td>Refrigeration machinery room</td>
<td>1 or S</td>
</tr>
<tr>
<td>Incinerator rooms</td>
<td>2 or 5</td>
</tr>
<tr>
<td>Paint shops</td>
<td>2 or 2 (1 and S)</td>
</tr>
<tr>
<td>Group E laboratories and vocational shops</td>
<td>1 or S</td>
</tr>
<tr>
<td>Group I-2 laboratories</td>
<td>1 or S</td>
</tr>
<tr>
<td>Group I-2 facilities over 100 SF</td>
<td>1</td>
</tr>
<tr>
<td>Group I-2 facilities and Group I-2 patient rooms with padded surfaces</td>
<td>1</td>
</tr>
<tr>
<td>Group I-2 physical plant maintenance shops</td>
<td>1</td>
</tr>
</tbody>
</table>

High-rise Buildings

- Smokeproof enclosure
- Smoke detection in elevators
- Standby/emergency power
- Fire alarm
- Sprinklers
- Standpipes
High-rise Buildings

- Additional stairway required in high-rise > 420'
- Other than Group R-2
- Fire service access elevator when floor level > 120' above LLFDVA
- Smoke removal
  - Operable windows, OR
  - Mechanical system
- Egress path marking

Atriums

- Fire sprinklers required throughout building
- Smoke-control system to provide safe path of egress
- Areas adjacent to atrium protected with minimum 1-hr fire-resistance-rated walls

Garages

- Private garages
- Parking garages
  - Enclosed
    - Mechanical ventilation
    - Fire sprinklers required
  - Open
    - Natural ventilation
    - Type I, II or IV construction
Repair Garages

- **Definition**
  - A building, structure, or portion thereof used for servicing or repairing motor vehicles
- **Solvents**
- **Vehicle fluids**
  - Must stay below exempt amounts or classified Group H
- **Vehicle fuel**
  - Gasoline, diesel
  - Liquified natural gas
  - Hydrogen, electric
- **Mechanical ventilation**

Hazardous Materials

- **Maximum Allowable Quantity (MAQ) per Control Area of Hazardous Materials Posing a Physical Hazard**

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Storage Liquid gallons (pounds)</th>
<th>Gas (cubic feet @ NTP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible liquid</td>
<td>II A III B</td>
<td>100</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,000</td>
<td>13,000</td>
</tr>
<tr>
<td>Combustible fiber</td>
<td></td>
<td>100</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Loose Baled</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Flammable gas</td>
<td>Gasous Liquefied</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>(150)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Hazardous Materials – Footnotes

- **b** – Aggregate quantity shall not exceed storage
- **d** – Increase 100% for automatic sprinkler system
- **e** – Increase 100% if stored in approved storage cabinets, day boxes, gas cabinets, gas rooms or exhausted
- **f** – Not limited in automatic sprinkler buildings
- **g** – Allowed only in buildings equipped throughout with an automatic sprinkler system
Hazardous Materials – Control Areas

- Control Areas are NOT considered an H occupancy
- Up to MAQ in each control area
- Number of control areas limited

Hazardous Materials – Control Areas

<table>
<thead>
<tr>
<th>STORY</th>
<th>PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA</th>
<th>NUMBER OF CONTROL AREAS PER FLOOR</th>
<th>FIRE RESISTANCE RATINGS FOR FIRE BARRIERS &amp; HOLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above grade plane</td>
<td>Higher than 9</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>7-9</td>
<td>5</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Below grade plane</td>
<td>0</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>0</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>0</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
</tr>
</tbody>
</table>

FOR EXAMPLE

- Given: One-story building used for storage of acetic acid, (Class II combustible liquid)
- Sprinklered building with one exhausted control area
- Determine MAQ

Tabular MAQ = 120
Footnote d = 100% increase
120 x 2 = 240 gallons/control area

Footnote e = 100% increase
240 x 2 = 480 gallons/control area
Healthcare Occupancies

Classified as Group I occupancies

- Code official needs to know
  - Amount of time people are receiving care
  - Level of care people are receiving
  - Are people capable of responding to emergency situations on their own

Group I-1: >16 persons living 24/7
- Assisted living facilities, halfway houses, alcohol and drug centers, group homes and congregate care facilities

Group I-2: medical care 24/7 for >5 people
- Condition 1 – nursing and medical care
- Condition 2 – emergency care, surgery, obstetrics or in-patient stabilization units for psychiatric or detoxification
Ambulatory Health Care Facilities

- Medical, surgical, psychiatric, nursing or similar care <24-hour basis
- >4 individuals not capable of self-preservation
- Classified as Group B
- Fire sprinklers required
- Smoke compartments
  - When one story >10,000 ft²

Storm Shelters

- ICC 500 standard
  - Tornado and hurricane
  - Dedicated – Group A-3
- Emergency shelters
  - Table 1604.5
  - Risk Category IV structures
Poll Question

4. Which of the following is classified as a Group I-2 occupancy?
   a. High School
   b. Hospital
   c. Office in a high-rise
   d. Warehouse storing plastic cups

Poll Question

5. In Type IIA construction what is the minimum fire-resistance rating for interior walls?
   a. 0 hours
   b. 1 hour
   c. 2 hours
   d. 3 hours

Poll Question

6. The maximum height of a building is controlled by type of construction type, occupancy classification, and the installation of fire sprinklers.
   a. True
   b. False
Poll Question
7. What is the allowable area for a non-sprinklered Type IIIB Group M occupancy without any frontage increase?
   a. 12,500
   b. 18,500
   c. 37,500
   d. 50,000

Poll Question
8. A building with multiple occupancies can be designed using which of the following methods?
   a. Accessory occupancies
   b. Non-separated mixed-use occupancies
   c. Separated mixed use occupancies
   d. A combination of all of the above

Poll Question
9. Hazardous materials are only allowed in Group H occupancies?
   a. True
   b. False
Determining Fire Resistance

- Fire testing of assemblies and materials
- Prescriptive details
- Calculation based on specific materials

Fire Testing

- Relative comparison between different construction methods and materials
- Standard Time-Temperature Curve
  - UL 263
  - ASTM E119

Prescriptive Details
Calculated Fire Resistance – Mass Timber

Table 722.7.1(1): Protection Required from Noncombustible Covering Material

<table>
<thead>
<tr>
<th>Required Fire-Resistance Rating of Building Element per Tables 601 and 705.5 (hours)</th>
<th>Minimum Protection Required from Noncombustible Protection (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>3 or more</td>
<td>120</td>
</tr>
</tbody>
</table>

Table 722.7.1(2): Protection Provided to Noncombustible Covering Material

<table>
<thead>
<tr>
<th>Noncombustible Protection</th>
<th>Protection Contribution (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2-inch Type X gypsum board</td>
<td>25</td>
</tr>
<tr>
<td>3/4-inch Type X gypsum board</td>
<td>40</td>
</tr>
</tbody>
</table>

Protection of the Structure

- Masonry and concrete walls encase rebar and provide protection
- When required to provide a fire-resistance rating, exposed steel must be protected
Protection of Structural Frame

Mass Timber
- Types IV-A, IV-B & IV-C
- \( \text{FRR}_{\text{tot}} = \text{FRR}_{\text{MT}} + \text{FRR}_{\text{NC}} \)
- Exposed MT permitted in IV-B & IV-C

Exterior Wall Protection

- Fire separation distance
  - Measured at right angles to walls
  - Table 601 – based on construction type
  - Table 705.5 – based on distance to property line

Interior Fire-rated Walls

<table>
<thead>
<tr>
<th>Fire Wall</th>
<th>Fire Barrier</th>
<th>Fire Partition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building separation</td>
<td>Shafts &amp; occupancy separation</td>
<td>Dwelling unit separation &amp; corridors</td>
</tr>
<tr>
<td>Openings protected &amp; limited</td>
<td>Openings protected &amp; limited</td>
<td>Openings protected</td>
</tr>
<tr>
<td>Continuous from foundation through roof &amp; exterior walls</td>
<td>Continuous from floor through concealed space at each level</td>
<td>Can terminate at fire-rated horizontal assembly</td>
</tr>
<tr>
<td>Structural stability</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fire Walls
- Structure on each side considered separate building for determining
  - Height and area
  - Construction type
  - From foundation to >30” above roof (alternatives)
  - Extends >18” beyond exterior walls (alternatives)
  - Structural stability
    - Structure on either side can collapse but fire wall must remain for fire rating duration

Fire Wall and Opening Ratings (hrs)
- Opening limits
  - Individual size <156 ft²
  - Aggregate width <25% of fire wall length

Party Walls
Required on lot lines dividing building ownership
- Constructed as fire wall
Fire Wall Example

FOR EXAMPLE

Fire Barriers

- Examples
  - Shaft enclosures
  - Separation of fire areas
  - Separated occupancy
  - Incidental use
  - Control areas
  - Supporting construction and structure requires fire-resistance rating equal to or better than fire barrier

Fire Barrier Opening Ratings (hrs)

<table>
<thead>
<tr>
<th>FIRE BARRIER RATING</th>
<th>FIRE DOOR/SHUTTER RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>1/2</td>
</tr>
<tr>
<td>1</td>
<td>1/2</td>
</tr>
</tbody>
</table>

[Ref. Table 716-1(1)]

a. Openings in shafts, interior exit stairways and exit passageway walls are required to have a 1-hour fire rating.
Fire Partitions

- Separate
  - Dwelling/sleeping units
  - Mall tenant spaces
  - Rated corridor walls
  - Elevator lobbies
  - Egress balconies

Horizontal Assemblies

- Floor/ceiling assembly
- Roof/ceiling assembly
- Uses
  - Dwelling separation
  - Exit enclosure
  - Fire area separation
  - Mixed-use separation
  - Control area enclosure
  - Smoke barrier enclosure

Vertical Openings

- Shaft enclosures
- Escalators
- Penetrations
- Joints
- Ducts
- Atriums
- Chimneys
- Mezzanines
- Skylights
Shaft Enclosures

- Fire-resistance rating
  - 1-hr if connecting > 2 stories
  - 2-hr if connecting ≥ 4 stories
- Fire barrier construction
  - Continuity
- Openings and penetrations protected

Penetrations

- Pipes, tubing, conduit, and cables passing through fire assemblies
- Through penetrations
  - Entire assembly
- Membrane penetrations
  - One surface
- Listed penetration firestop system installed per manufacturers’ instructions

Opening Protection

- Doors and windows installed in fire-resistance-rated assemblies require fire protection rating
- Fire door assemblies include door, frame and all associated hardware
Interior Finish Requirements

- Flame spread is the propagation of flame over a surface

<table>
<thead>
<tr>
<th>Group</th>
<th>Sprinklered Corridors</th>
<th>Nonsprinklered Corridors</th>
<th>Stair enclosures/penthouses</th>
<th>Rooms &amp; enclosed spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1 &amp; A-2</td>
<td>B</td>
<td>B</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>A-3, A-4, A-5</td>
<td>B</td>
<td>B</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>B-4</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>C</td>
<td>C</td>
<td>C</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>H</td>
<td>B</td>
<td>B</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>I-4</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>I-1</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>I-2 &amp; I-4</td>
<td>A</td>
<td>A</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>A-3</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>R-3</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>R-2 &amp; S</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>R</td>
</tr>
<tr>
<td>No restrictions</td>
<td>No restrictions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Flamespread Index

<table>
<thead>
<tr>
<th>Class</th>
<th>Flamespread Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-25</td>
</tr>
<tr>
<td>B</td>
<td>26-75</td>
</tr>
<tr>
<td>C</td>
<td>76-200</td>
</tr>
</tbody>
</table>

Fireblocking

- Cuts off
- Concealed openings
- Openings between walls and floors or attics
- Floor levels
- Top floor and attic
- Required in wall spaces
- Vertically at ceiling and floor
- Horizontally at intervals ≤10’
Draftstops

- Large concealed floor spaces and attics with combustible construction (≤1,000 ft²)
- Attics, mansards and concealed roof spaces subdivided into maximum 3,000 ft²
  - Fire sprinklers in these spaces eliminate requirement
- Group R exceptions

Automatic Fire Sprinklers

- React to heat
- Apply water directly to fire area
- Normally operate independently

Automatic Fire Sprinklers

- Required based on
  - Occupancy classification
  - Use or materials handled
  - Number of occupants
  - Fire areas
  - Floor level in building
- Also required in
  - Buildings with no exterior wall openings
  - Rubbish/linen chutes
Fire Areas

- Created with ≥1-hour fire-resistance-rated construction
- Single occupancies separated into smaller fire areas eliminate sprinklers

<table>
<thead>
<tr>
<th>OCCUPANCY GROUP</th>
<th>FIRE-RESISTANCE RATING (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-1, M-1</td>
<td>4</td>
</tr>
<tr>
<td>F-1, H-3, S-1</td>
<td>3</td>
</tr>
<tr>
<td>A, B, E, F-2, H-4, H-5, J, M-2, S-2</td>
<td>2</td>
</tr>
<tr>
<td>L</td>
<td>1</td>
</tr>
</tbody>
</table>

[Ref. Table 107.5.6(b)]

Automatic Fire Sprinklers – Stories without Openings

- T1 = sprinkler or additional sprinkler requirement
- No 30's x 40's openings
- Total must be a total of 30 square feet
- Basement openings must be 30 feet in length
Automatic Fire Sprinkler Credits

- Credit and modifications allowed for added protection sprinkler systems provide
- Standards
  - NFPA 13
  - NFPA 13R
  - NFPA 13D

Standpipes

- Classes
  - Class I – 2½” connection for FD
  - Class II – 1½” connection with hose
  - Class III – combination of both I & II
- Types
  - Wet standpipe
  - Dry standpipe
  - Must comply with NFPA 14

Standpipes

- In buildings with a floor level
  - >30 feet above LLFDVA
  - >30 feet below HLFDVA
  - Covered malls
  - Stages
Fire Alarm Systems

- Activation
  - Manual
  - Automatic
- Required based on
  - Occupancy classification
  - Occupant load
  - Floor level
  - Operations conducted
  - Materials handled
- Must comply with NFPA 72

Fire Alarm Systems

- Occupant notification
  - Audible
    - 15 dBA above ambient
    - 5 dBA above max 60 second sound level
    - Maximum 110 dBA
  - Visual
    - Public and common areas
  - Emergency voice/alarm communication system
    - Provide voice instructions

Smoke Alarms

- Per UL 217 & NFPA 72
- Multiple units interconnected so when one device senses smoke all devices sound-off
- Required in
  - R-1 – sleeping areas, egress path and each floor
  - R-2, R-3, R-4, I-1 – sleeping rooms, common area outside of sleeping rooms and each floor
Smoke Control Systems

- Smoke barriers
  - Restrict passage of smoke
- 1-hr fire-resistance rated
- Smoke-protected assembly seating
- Smoke control system
  - Mall or atrium with 3 levels
  - Underground buildings
  - Large arenas

Cross-corridor doors with magnetic hold-open device released by smoke detectors or fire alarm

Carbon Monoxide Alarms

- Group E, I-1, I-2, I-4 and R occupancies with
  - Fuel-burning appliance
  - Attached garage
  - Installed
    - Immediate vicinity of bedrooms
    - Every occupied level
      - Including basements
      - Excluding attics & crawl spaces

Poll Question

10. A 3-hr fire-resistance-rated fire wall is required to separate two Group M occupancies.
   a. True
   b. False
Poll Question
11. A door in a 2-hr fire-resistance-rated fire barrier must have a minimum fire-resistance rating of _____ hours.
   a. ¾
   b. 1
   c. 1½
   d. 2

Poll Question
12. The flame spread index of interior finishes placed into the corridor of a sprinklered Group A-2 restaurant must be at least Class _____.
   a. A
   b. B
   c. C
   d. No restriction

Poll Question
13. Fire area, rather than building area, is used to determine the size of occupancies when fire sprinklers are required.
   a. True
   b. False
Poll Question

14. Fire sprinklers may be required based on which of the following criteria?
   a. Occupancy classification
   b. Use or materials handled
   c. Number of occupants
   d. Size of fire areas
   e. Floor level in the building
   f. Any of the above

Poll Question

15. A Group I-1 Assisted Living Facility with an attached garage must be equipped with both smoke alarms and carbon monoxide alarms?
   a. True
   b. False

Discussion
Egress System Design

Areas without fixed seating
- Occupant load = Area/OLF
- Gross
- Entire floor area excluding vent shafts and courts
- Net
- Actual occupied area

Areas with fixed seating
- Occupant load based on number of fixed seats
- Benches
  - Pews = 18”/person
  - Dining = 24”/person
Occupant Load Calculation

- Restaurant with 1,200 ft² of chairs and booths
- 8 booths (16 benches) – 6’ wide each
- 200 ft² kitchen
  - Kitchen 200/200 = 1
  - Dining Area 1,200/15 = 80
  - Booths 6’/24” = 3/bench = 48
  - Total 1 + 80 + 48 = 129

FOREXAMPLE

Exits from Spaces

- Each room or space is evaluated
- Exit access is 1st portion of egress system
- Minimum of 2 exits required
  - Limited occupancy allows one exit

Number of Exits

- Additional exits required if occupant load
  - 501-1,000 requires ≥3 exits
  - >1,000 requires ≥4 exits
- Also evaluated
  - Each floor
  - Entire building
  - Each use
Common Path of Egress Travel

Multiple exits based on travel distance

<table>
<thead>
<tr>
<th>OCCUPANCY</th>
<th>WITHOUT SPRINKLER SYSTEM (FEET)</th>
<th>WITH SPRINKLER SYSTEM (FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, E, M</td>
<td>OL ≤ 30</td>
<td>OL &gt; 30</td>
</tr>
<tr>
<td>I</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td>H1, H2, H4</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td>S</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

OL = Occupant load; NP = Not permitted

Means of Egress (MOE) Systems

- Exit Access
- Exit
- Exit Discharge
Exit

Occupants either
• Leave the building
• Enter protected egress path
  • Stair enclosure
  • Exit passageway
  • Horizontal exit

Exit Discharge

• From exit to public way
• At grade or direct access to grade
• Access public way without obstructions

Making it Wide Enough

• Egress doors/corridors/paths
  • Occupant Load x 0.2"
• Stairs
  • Occupant Load x 0.3"
  • If one path lost total width >½
• Maintained to public way
• Reductions for
  • Sprinklers
  • EV/AC
Exit Width Calculation

- 6,000 ft² dining area
- Determine Dining Occupant Load
  - 6,000 ft² ÷ 15 ft²/occupant = 400 occupants
- Determine exit path width
  - 400 x 0.2”/occupant = 80”
  - Minimum 2 exits required
  - 3’-0” doors installed
  - 3 doors = 108”
- Determine stair width
  - 400 x 0.3”/occupant = 120”
  - 2 stairs ≥ 60” each

FOR EXAMPLE

Exit Width Calculation

- Add Sprinklers and EV/AC
  - Exit path width
    - 400 x 0.15”/occupant = 60”
    - Minimum 2 exits required
    - Clear door width ≥ 32”
    - 2 doors = 64”
  - Stair width
    - 400 x 0.2”/occupant = 80”
    - 2 stairs ≥ 44” width = 88”

FOR EXAMPLE

Horizontal Travel

When >2 exits required
- Separated by ½ longest diagonal
- With sprinklers
  - Separation reduced to 1/3
Horizontal Travel

Exit access travel distance

<table>
<thead>
<tr>
<th>OCCUPANCY</th>
<th>WITHOUT SPRINKLER SYSTEM (ft)</th>
<th>WITH SPRINKLER SYSTEM (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, E, C, M, S, T</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>750</td>
<td>300</td>
</tr>
<tr>
<td>H, I</td>
<td>500</td>
<td>400</td>
</tr>
<tr>
<td>H</td>
<td>250</td>
<td>75</td>
</tr>
</tbody>
</table>

Vertical Travel

- 1½-hr doors
- 2-hr when >4 stories
- 1-hr when <3 stories

Exit Access Stairs and Ramps

- Open stairways and ramps used as part of MOE
- Travel distance measured to an exit
- Limited use
Egress Path Identification

Exit signs required if >2 exits
- Additional floor-level exit signs in R-1
- Illuminated from internal or external light source

Egress path must be illuminated
- Emergency lighting required if >2 exits

Doors

All egress doors must be side-hinged swinging
- Some exceptions
Minimum clear height >80"

Door Hardware

- Readily openable without a key or special knowledge or effort
- Forces required consistent with accessibility standards
Minimum 34" Maximum 48"
Panic Hardware

Required on doors in
- Group H
- Group A & E >50 occupants

Fire exit hardware = panic hardware listed for fire door assemblies

Installation
- Fire exit hardware
  - UL 10C and UL 305
- Panic Hardware
  - UL 305

Stairways

Minimum width
- 36" for < 50 OL
- 44" for > 50 OL
- 0.3" x OL for > 146 OL
- With sprinklers and EV/AC
  - 0.2" x OL for > 220 OL

Ramps

- Slopes < 1:12
- Ramps not part of MOE < 1:8
- Width
  - 36" minimum
  - 0.2" x OL
  - 0.15" x OL
  - With sprinklers and EV/AC
Accessibility

IBC requirements similar to
- ADA Accessibility Guidelines
- Federal Fair Housing Act

Referenced standard
- ICC A117.1 – Accessible and Usable Buildings and Facilities

Areas not requiring accessibility
- Construction sites
- Detached 1- & 2-family dwellings
- Spaces containing equipment
- Coolers and freezers

Accessible Path Into a Building

Accessible path from points where people arrive
- Public transportation stops
- Parking spaces
- Passenger loading zones
- Public streets or sidewalks

60% of public entrances must be accessible

Accessible Path Through a Building

- Accessible route throughout from accessible entrance
- Route to other floors
  - Ramps
    - Slope < 1:12
  - Elevators
    - Cars sufficient for wheelchair and one extra person
    - Controls reachable from a wheelchair
Accessible Toilet Facilities

- Toilet rooms
  - All accessible
  - Family or assisted-use toilet room in Groups A and M

- Water closets
  - >1 water closet wheelchair accessible

Accessible Lavatories and Sinks

- >5% of lavatories accessible
  - >1 in each toilet facility

Accessible Kitchens

- Commercial kitchen route
  - Approach, enter and exit
  - In break room type areas throughout
Accessible Seating Areas

Dining
- Total area for seating, interior/exterior, with some exceptions
- 5% dining surfaces

Other than dining
- Dispersed throughout

R-1 Accessible Dwelling/Sleeping Units

<table>
<thead>
<tr>
<th>TOTAL NUMBER OF UNITS PROVIDED</th>
<th>MINIMUM REQUIRED NUMBER OF ACCESSIBLE UNITS WITHOUT FALL- IN SHOWERS</th>
<th>MINIMUM REQUIRED NUMBER OF ACCESSIBLE UNITS WITH ROLL-IN SHOWERS</th>
<th>TOTAL NUMBER OF REQUIRED ACCESSIBLE UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 4</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5 to 20</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>21 to 50</td>
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<td>3</td>
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<tr>
<td>51 to 100</td>
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<td>101 to 199</td>
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<tr>
<td>200 to 999</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>1,000 to 9,999</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

Non Sprinklered buildings requiring
- One exit needs 1 accessible MOE
- > 2 exits needs 2 accessible MOE

>4 stories
- Elevator as 1 accessible MOE

Accessible MOE must continue to public way or Area of Assisted Rescue
Accessible Areas of Refuge

One wheelchair space for every 200 occupants
- Not required in sprinklered buildings

Location:
- Stairway enclosure
- Elevator lobby

2-way communication required

Guards

- Required along open-sided walking surfaces
  - >30" above floor or grade below

Stairway Guards and Handrails

Guard – system of posts, handrails and balusters/panels

Handrail
- 42" minimum
- 34" to 38"

Openings <4"
Window-sill Height

Regulated in R-2 and R-3 residential

Options
1. ASTM F2006 fall prevention devices
2. Window openings <4"
3. ASTM 2090 fall prevention devices
4. Opening control devices

No requirement if sill height is <6' above grade

Safety Glazing

- Laminated glass
- Tempered glass
- Must be labeled
- Required locations
  - Doors
  - Within 24" of doors
  - Along walking areas with size thresholds

- Tub or shower enclosures
- <60" of pool or spa
- Stairway guard or railing
- <36" of stairway or landing
- <60" of walking surface
Swimming Pools

International Swimming Pool and Spa Code
- Any structure intended for swimming
- Water depth > 24"
- In-ground, above-ground and on-ground pools
- Hot tubs and spas
- Fixed-in-place wading pools

Poll Question
16. In a Group A-2 restaurant with tables and chairs, the occupant load is determined based on a factor of _____ per person.
   a. 5 net
   b. 7 net
   c. 15 net
   d. 150 gross

Poll Question
17. In a Group A-2 restaurant, 2 exit doors are required when the occupant load is _____ or more.
   a. 11
   b. 21
   c. 30
   d. 50
Poll Question
18. In a non-sprinklered Group B office building with an occupant load of 95, the common path of egress travel is limited to _____ feet.
   a. 25
   b. 75
   c. 100
   d. NP

Poll Question
19. Exit access travel distance is limited to _____ feet in a Group M occupancy equipped with a fire sprinkler system.
   a. 75
   b. 200
   c. 250
   d. 300

Poll Question
20. Doors must swing in the direction of egress when the occupant load is _____ or more.
   a. 25
   b. 50
   c. 75
   d. 100
Poll Question

21. In buildings with more than 1 required means of egress, at least _____ of the means of egress must be accessible.
   a. 1
   b. 2
   c. 3
   d. All

Discussion

Health Safety
Keeping Water Out

Weather-resistant exterior wall envelope
- Water-resistive barrier
  (WRB)
- Flashing

Vapor Retarders

Many materials available
IBC Table 1404.2 specifies minimum thickness
Siding

3 coat stucco

4" above grade or 2" above paving

Roofing

- Roof coverings must meet
  - Chapter 15
  - Manufacturer’s instructions
  - Code prevails if conflicts arise
- Minimum slope dependent on roof covering chosen
- Roof drains or scuppers required if water cannot drain off roof edge

Flashing

Installed at
  - Wall and roof intersections
  - Gutters
  - Change in roof slope or direction
  - Around roof openings
Parapets coped with weatherproof materials
  - FRR parapet coping materials
  - Weatherproof
  - Maintain required FRR
Low-slope Roofs

Slope can be as low as ¼:12

Roof covering systems
- Built-up
  - Asphalt
  - Coal tar pitch
- Modified bitumen
- Thermoset single-ply roof covering (EPDM)
- Thermoplastic single-ply roof covering (PVC, TPO, CSPE)

Steep Roofs

Slopes > 3:12

Common roof covering materials
- Asphalt shingles
- Wood shakes
- Wood shingles
- Clay tiles
- Concrete tiles
- Metal roof panels

Flashing

Required at
- Roof and wall intersections
- Valleys
- Drip edge
Clay and Concrete Tiles

Installed over solid sheathing or spaced sheathing
Minimum slope of 2\(\frac{1}{2}:12\)
- Double underlayment <4:12
- Single underlayment >4:12

Light and Ventilation

Lighting
- Natural
- Artificial

Ventilation
- Natural
- Mechanical
  - Installed per IMC
  - Ventilation of attics and crawl spaces also required

Natural and Artificial Lighting

Natural lighting
- Openings/windows in exterior walls that allow sunshine in

Artificial lighting
- Electrical-powered

If natural light inadequate
- Artificial light installed
- Must provide >10 foot-candles at 30" height
Natural Lighting

Openings >8% of floor area

- Rooms combined when open to each other

- Opening must be
  - >8% of floor area of noncompliant room
  - >25 ft²

Floor area = 500 ft²
500 x 4% = 20 ft²
3 windows = 37.5 ft²
>4% provided - OK

Floor area = 600 ft²
600 x 4% = 24 ft²
4 windows = 50 ft²
>4% provided - OK

Floor area = 800 ft²
800 x 4% = 32 ft²
1 window = 12.5 ft²
<4% provided - Inadequate

Floor area = 1400 ft²
1400 x 4% = 56 ft²
5 windows = 62.5 ft²
>8% provided - OK

Openable windows
>50% open

Natural Ventilation

- Openings ≥4% of floor area
- Rooms combined when open to each other
- Opening must be
  - ≥8% of floor area of noncompliant room
  - ≥25 ft²
Exhaust Systems

Moisture created inside buildings removed
- Bathrooms with bathtubs, spas, etc.
Contaminants removed
- Contaminants in naturally ventilated spaces
- Flammable and combustible hazards
- Per IMC and IFC

Temperature

Interior space for human occupancy
- Requires heating system
  - Active or passive
- Min indoor temperature
  - 68°F at 3' above floor

Design temperature
- Outdoor temperature
  - Used for design
- IPC Appendix D

Moisture Control in Attics

- Net free area of attic vents
  - >1/150 attic area
  - >1/200 when
    - 40-50% of openings in top 3' of attic
    - Remainder at eave or cornice vents
  - >1/300 with Class I or II vapor barrier
Under-floor Ventilation

- Ratio of 1 ft² of opening for 150 ft² of under-floor space
- Class I vapor retarder
  - Ratio of 1 ft² of opening for 1,500 ft² of under-floor space

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Plumbing Facilities

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Location of Toilet Facilities

- Toilet facilities provided for
  - Employees
  - Public – if public building
- Public access
  - Accessible
  - Cannot pass through kitchens, storage rooms, or closets
- Distance <500'
  - Longer distances for factory, storage and industrial
  - Building official approval
Toilet/Bathing Room Finishes

- Minimum height of 4'
- Smooth, hard, non-absorbent finish
- Extends up wall >4" Privacy partitions

Poll Question
22. Buildings must be designed with a water-resistant barrier in the exterior wall envelope behind the exterior veneer.
   a. True
   b. False

Poll Question
23. Minimum roof slope must be \( :12 \)
   a. 0
   b. \( \frac{1}{4} \)
   c. 2\%
   d. 3
24. Either natural light or artificial light can be utilized to meet the minimum lighting requirements.
   a. True
   b. False

25. Attics and under-floor areas must be provided with ventilation at a ratio of 1 ft² of vent area for every __ ft² of area.
   a. 150
   b. 300
   c. 500
   d. 1500

   a. 3
   b. 4
   c. 5
   d. 6
Poll Question

27. Except in mall buildings, the maximum travel distance to a water closet cannot exceed _____ feet.
   a. 200
   b. 300
   c. 400
   d. 500

Discussion
**Structural Design**

- Loads determined per ASCE 7
- Risk categories based on building use
  - Category I
    - Agricultural and minor storage
  - Category II
    - Most common classification
  - Category III
    - Assemblies with occupant load >300 and hospitals without emergency treatment
  - Category IV
    - Hospitals with emergency treatment

---

**Basic Loads**

- Gravity loads
  - Applied vertically down through a structure
- Uplift loads
  - Applied vertically up through a structure
- Lateral loads
  - Applied horizontally to a building
- Uniform loading
  - Applied equally across a structural member
- Concentrated load
  - Applied in a single location of a member
  - Example: column bearing in the middle of a beam

---

**Live Loads**

<table>
<thead>
<tr>
<th>OCCUPANCY OR USE</th>
<th>UNIFORM (psf)</th>
<th>CONCENTRATED (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential 1 &amp; 2-family dwellings</td>
<td>50</td>
<td>1,000</td>
</tr>
<tr>
<td>Other area</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>Rv Park</td>
<td>100</td>
<td>1,000</td>
</tr>
<tr>
<td>Storage warehouses</td>
<td>100</td>
<td>1,000</td>
</tr>
<tr>
<td>Must be designed for live loads if required for structural loads</td>
<td>70</td>
<td>300</td>
</tr>
<tr>
<td>Note: Live loads are determined for the unobstructed area</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

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Dead Loads

- Actual weight of construction materials
- Considered permanent loads

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>LOAD (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double wood floor supported in 2 x 12 joints 10 inches on center</td>
<td>7</td>
</tr>
<tr>
<td>Hardwood flooring, 1/2 inch</td>
<td>4</td>
</tr>
<tr>
<td>Linoleum 1/8 inch</td>
<td>3</td>
</tr>
<tr>
<td>Wood stud walls with 5/8-inch gypsum board each side</td>
<td>8</td>
</tr>
<tr>
<td>5/8-inch gypsum board ceiling</td>
<td>3</td>
</tr>
<tr>
<td>Asphalt shingles</td>
<td>5</td>
</tr>
</tbody>
</table>

(Refer Table C.3.1-1 of ASCE 7)

Snow Loads

- Ground snow loads
- "CS" = case study
- Elevation influence
- State-specific tables
- Drifts and sliding must be considered
Wind Loads

- Typically lateral and uplift loads
- Positive and negative pressures
- Based on wind speed
- Affected by surface roughness and exposure

Earthquake Loads

- Based on severity of site’s design earthquake ground motion
- Seismic design categories
  - A, B, C, D, E, F
  - Low - High
- Design per ASCE 7

Flood Loads

- Methods to determine flood hazard areas
  - >1% chance of flooding annually (100-yr flood plain)
  - Designated on community flood hazard map
- FEMA Flood Insurance Rate Map (FIRM)
Soils

- Unified soil classification
- Building official can require a geotechnical investigation
  - Drilling into the ground and taking samples
  - Digging test pits
  - Evaluate
    - Soil strength
    - Bearing capacity
    - Effects of moisture
    - Compressibility
    - Liquefaction
    - Expansiveness

Excavation

- Proximity to existing structures may require underpinning
- Excavation slope controlled so dirt does not fall into the hole
  - 1:2 (50% slope)

Grading

Positive drainage away from buildings
Grading

Foundation must be 12" + 2% above street gutter

Concrete Construction

- Concrete is a mixture of cement, aggregate, and water
- American Concrete Institute’s (ACI) Standard 318 Building Code Requirements for Structural Concrete
  - Code-referenced standard
  - IBC Chapter 19 contains additional requirements and amendments to ACI 318

Concrete Durability

Exposure categories
- F – Moisture and freezing/thawing and deicer chemicals
- S – Sulfates in water or soil
- W – Water where concrete is intended to have low permeability
- C – Moisture and chlorides from (or spray from these sources)
  - Deicing chemicals
  - Salt
  - Brackish water
  - Seawater
Concrete Foundation Walls

- Prescriptive or engineering
- Seismic Design Categories C, D, E and F
  - Typically require RDP
- Wall thickness and steel reinforcement based on lateral loads
- High lateral loads require engineering

Concrete Formwork

- Designed, fabricated, erected and removed in accordance with ACI 318
- Substantially tight to prevent leakage of concrete
- Properly braced
- Remain in place until cured or shored

Concrete Steel Reinforcement

- Resists tension, or pulling apart, when concrete is subjected to loads
- Vertical and/or horizontal rebar may be required
Concrete Special Inspection

- Quality has direct relationship to strength
- Inspection by special inspection agency – with some exceptions
- Continuous inspections
  - Full-time observation of work
- Periodic inspections
  - Part-time or intermittent observation of work
- ASTM Standard C172 Practice for Sampling Freshly Mixed Concrete

Masonry Construction

TMS 402/602 Building Code Requirements and Specification for Masonry Structures

Masonry Foundation Walls

- Thickness determined by lateral loads
- Steel reinforcement typically required
- Cells of hollow or solid masonry units often grouted
Masonry Materials

- Concrete, clay or shale, stone, AAC, and glass
- Bonded with mortar
- Grout
  - Fine
  - Course
- Steel reinforcing per TMS 602

Masonry Special Inspections

- Level I, II or III quality assurance
  - Risk Category
  - Designed or prescriptive
- Testing
  - Unit strength
  - Prism

Steel Construction

- American Institute of Steel Construction (AISC)
  - ANSI/AISC 360 Specification for Structural Steel Buildings
  - ANSI/AISC 341 Seismic Provisions for Structural Steel Buildings
Protection of Steel

- Approved coating to protect from corrosion
- If scratched or chipped during erection
  - Approved paint or primer
  - SFRM
    - Bare steel
    - Approved primer
    - Often unprimed for better adhesion of fireproofing

Steel Connections

- Welding or bolting
  - Both require special inspections
- Bolted joints
  - Snug-tight
  - Twist-off
  - Slip-critical
  - Resist movement by friction
- Pretensioned
  - High-strength bolts tightened to specified minimum

Steel Special Inspections

- Connections
- Steel frame
  - Verify bracing, stiffening, member locations, and joint details at each connection
- Steel joists and girders
  - Inspection at fabrication facility
  - Approved fabricator
Wood Construction

- National Design Specification® (NDS®) for Wood Construction
- Special Design Provisions for Wind and Seismic

Wood Construction

- Conventional light-frame
  - Primary structural elements created by repetitive wood framing members
- Mass timber
  - Large-dimensioned wood members as structural elements

Protection of Wood

- Protection from moisture and insects
  - Naturally durable wood
  - Preservative-treated wood

- Wood post on metal pedestal 1" above concrete
- Preservative-treated wood or >8" above grade
Grade Marks
- Required for
  - Lumber
  - Wood structural panels
  - Engineered wood products
  - Treated products

Notching and Boring
- Joists and rafters
  - Notches
  - Holes

Notching and Boring
- Bearing Wall
- Non-bearing Wall
Floor Construction

• Joist span tables for common wood species
• Other species
  • Span Tables for Joists and Rafter's

Allowable Floor Joist Spans

Determine minimum joist size: Hem-Fir #2, 16" o.c., 15' span, 30 psf live load, 10 psf dead load

For Example

Floor Sheathing

• Designed for expected loads
• Most common
  • Wood structural panels

• Example
  • ¾" WSP_48/24 rated

Roof sheathing span  Floor sheathing span

298

299

300
### Walls

- **Studs**
  - Widest dimension perpendicular to wall
  - Continuous from bottom to top plates
  - Minimum 3 studs each exterior wall corner

- **Top plates**
  - Doubled in exterior and bearing walls
  - Overlapped at corners and partition intersections

---

### Wall Framing

- Bearing wall openings require headers to support loads
  - Single-ply to 4-ply tabulated
  - Equivalent single solid members permitted

---

### Wall Bracing Methods

- **W2** Wood Structure Panel
  - "W" in accordance with Table 2308.6-3.2
  - Minimum thickness: 1/2" or 23/32" in accordance with Table 2308.6-3.3

- **GB** gypsum board (double sided)
  - Note: Table 2308.6-2.1

---
Ceiling and Roof Framing

Determine minimum rafter size: Douglas Fir-Larch #2; 16" o.c.; 14' span; ceiling attached; 30 psf ground snow load; 10 psf dead load

Crawl Space and Attic Access

- Crawl spaces
  - Minimum 18" x 24" opening
- Attics with clear height >30"
  - Minimum 20” x 30” opening
  - Clear headroom >30” above access opening
- Large enough to remove largest appliance

Engineered Wood Products

- Prefabricated Wood I-Joists
- Glued-Laminated Timber
- Cross-Laminated Timber
- Structural Composite Lumber
  - Laminated Veneer Lumber (LVL)
  - Parallel Strand Lumber (PSL)
  - Laminated Strand Lumber (LSL)
  - Oriented Strand Lumber (OSL)
Trusses

- Floor and roof framing members
  - 2x4 up to 2x12
  - Typically fabricated with metal connector plates
- Installed per
  - Submitted truss drawings
  - TPI National Design Standard for Metal-Plate-Connected Wood Truss Construction

Gypsum Board

- Provides a smooth finished surface
- Can provide passive fire protection
- Can provide lateral resistance
- Various types
  - Type X
  - Type C
  - Water-resistant

Foam Plastics

- Foam plastic insulation
  - Flame-spread index <75
  - Smoke developed index <450
  - ASTM E84 and UL 723
**Interior Foam Plastics**

Separated by thermal barrier
- Single layer of ½” gypsum wallboard or equivalent
- Must remain in place for 15 minutes

**Interior Foam Plastic Trim**

- Density >20 pcf
- Thickness <⅛”
- Width <8”
- <10% of wall or ceiling area
- Flame-spread index <75

**Poll Question**

28. The 1st floor in a Group M retail store must be designed to carry a uniform live load of ____ psf.
   a. 50
   b. 75
   c. 100
   d. 125
29. When designing a building, each of the following loads are specific to the area where the building will be constructed except:
   a. Ground snow load
   b. Live loads
   c. Wind speeds
   d. Seismic loads

30. The ground must have a minimum slope of _____ percent for a minimum of 10 feet perpendicularly away from a building.
   a. 1
   b. 2
   c. 3
   d. 5

31. The exterior foundation of a building must be elevated to a point at least 2% plus _____ inches above the point of discharge.
   a. 6
   b. 12
   c. 15
   d. 18
Poll Question
32. Absolutely no holes or notches can be made in a 2 x 12 wood floor joist.
   a. True
   b. False

Poll Question
33. Foam plastic materials are prohibited as trim on the interior of a building.
   a. True
   b. False

Discussion
Accreditation

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- As a result of their Authorized Provider accreditation status, ICC is authorized to offer IACET CEUs for its programs that qualify under the ANSI/IACET Standard.
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