

Overview

- Instructor Introduction
- Exits
- Breaks and Schedule
- Cell Phones
- Student Introductions



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Presenter Instructions

- Many slides contain animation
- Review of this presentation should be done in the “presentation mode” so that you are aware of the timing and appearance of graphics on the slides
- On slides containing animation, you will see one or more dots at the bottom left corner of the slide. For example, there are 6 dots at the bottom of this slide
- Each dot represents a “click” which is needed for animation on the slide before the next slide will appear
- As an animation occurs, a dot will disappear
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Description

- This seminar focuses on the basic concepts of the 2015 *International Building Code*® (IBC®).
- Concepts provide a basis for the correct utilization of the code.
- A clear understanding of the identified requirements allows the code user to apply the IBC in specific situations and helps to build an understanding of the intent of the code when asked to make a judgment on code compliance.



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Goal

- This seminar is intended to familiarize participants with construction requirements which are common for most commercial buildings and to provide a basic understanding of the 2015 International Building Code® (IBC®)



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Objectives

- Upon completion, participants will be better able to:
 - Comprehend the use of passive and active fire protection
 - Identify how life safety and egress issues are addressed in design and construction
 - Identify how the health and safety of occupants is safeguarded with weather protection and interior environment controls



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Objectives

- Upon completion, participants will be better able to:
 - Explain the fundamental provisions of the 2015 IBC
 - Identify the intent of the building code
 - Describe common provisions applicable to the design of commercial buildings



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Part I

Code Administration and Enforcement

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Purpose of Building Codes

- Building codes are sets of regulations adopted by governmental agencies to ensure that buildings are built in a safe manner
- People have expectations that when they enter a building they will be safe from inherent dangers caused by natural or man-made disasters



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History of Building Codes

- Building Code Recommended by the National Board of Fire Underwriters
 - Published in 1905
 - One of the first model building codes
- By the end of the 20th century there were 3 model building code groups
 - Building Officials & Code Administrators International, Inc. (BOCA)
 - International Conference of Building Officials, Inc. (ICBO)
 - Southern Building Code Congress, International. (SBCCI)



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History of Building Codes

228. If a builder has built a house for a man, and finished it, he shall pay him a fee of two shekels of silver, for each SAR built on.

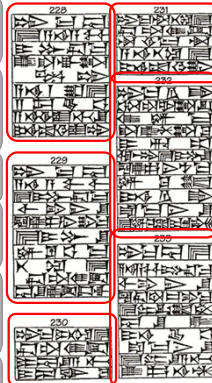
229. If a builder has built a house for a man, and has not made his work sound, and the house he built has fallen, and caused the death of its owner, that builder shall be put to death.

230. If it is the owner's son that is killed, the builder's son shall be put to death.

231. If it is the slave of the owner that is killed, the builder shall give slave for slave to the owner of the house.

232. If he has caused the loss of goods, he shall render back whatever he has destroyed. Moreover, because he did not make sound the house he built, and it fell, at his own cost he shall rebuild the house that fell.

233. If a builder has built a house for a man, and has not keyed his work, and the wall has fallen, that builder shall make that wall firm at his own expense.



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History of Building Codes

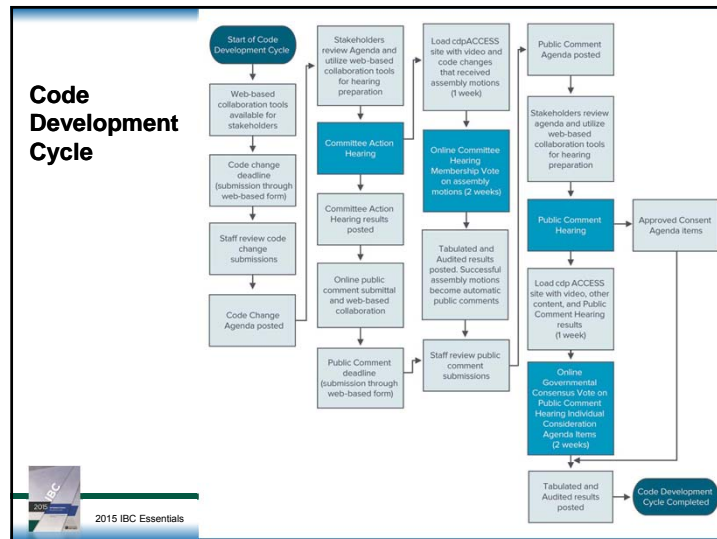
- In 1994, BOCA, ICBO and SBCCI agreed to develop one model code
- Together they formed the International Code Council
- The first *International Building Code* developed by the ICC was published in 2000



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cdpACCESS®

- After the Committee Action Hearings, ICC members can view and vote on motions for those code changes that received an assembly motion.
- After the Public Comment Hearings, ICC will post the Online Governmental Consensus Vote. The proposals and hearing testimony are available to be viewed by everyone; ICC Governmental Member Voting Representatives and Honorary Members will be able to vote.



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cdpACCESS®

- ICC's new cloud-based system for the code development process (cdp).
- It was developed to increase participation in the code development process.
- cdpACCESS allows users to create, collaborate, review, submit and vote (if eligible) on code change proposals and public comments.



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IBC – International Building Code

- Applies to the construction, alteration, movement, enlargement, replacement, repair, equipment, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures
- Provides safety to life and property from fire and other hazards in the built environment
- Provides safety to fire fighters and emergency responders during emergency operations
- References other I-Codes



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IMC – International Mechanical Code

- Applies to the design, installation, maintenance, alteration and inspection of permanent mechanical systems that are installed within buildings
- Covers:
 - Heating
 - Ventilation
 - Air-conditioning systems



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IPC – International Plumbing Code

- Provides regulations for the 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



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IGFC – International Fuel Gas Code

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



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IECC – 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



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IFC – International Fire Code

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



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IEBC – International Existing Building Code

- Covers the 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 to historic buildings and how the codes are applied to these buildings without affecting the historical significance and character of the building.



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IPMC – International Property Maintenance Code

- Provides for the 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



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IRC – 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 of the regulations for the building, energy, mechanical, fuel plumbing and electrical into one document



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IgCC –

International Green Construction Code

- 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 resource materials and energy



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Existing Buildings

- Existing buildings are permitted to continue without change as long as they are maintained in accordance with the code under which they were constructed



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ISPSC –

International Swimming Pool & Spa Code

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



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Existing Buildings

- IBC requires existing buildings to comply with the *International Existing Building Code* (IEBC).
- In previous editions of the codes, existing buildings were regulated in both the IBC and the IEBC. It was decided to remove the existing building provisions in the 2015 IBC. This eliminated any potential conflicts or confusion between the two regulations.



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Prescriptive vs Performance

- *Prescriptive* code requirements:

- Detail how to comply
- Must be specifically met

"Handrail height, measured above the stair tread nosings, or finish surface of ramp slope shall be uniform, not less than 34 inches and not more than 38 inches."

- *Performance* code requirements:

- Describe the intent of a provision
- Allow the architect to come up with a design
- Design must comply with the intent

"Fire walls shall have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall for the duration of the time indicated by the required fire-resistance rating."



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Using the IBC

- Format of the IBC

[Table of Contents](#)

- Process of using the IBC

[Chapter format](#)

[Index](#)

1. Classify the building
2. Review the building for occupancy requirements
3. Review type of construction requirements
4. Review the building for conformance with accessibility and means of egress requirements
5. Review the building or space for conformance with other detailed requirements in the IBC
6. Review the building or space for conformity with the structural engineering regulations and requirements for the construction materials



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Work Area Compliance Methods

- Option is similar to the prescriptive method but is more restrictive in some areas and less restrictive in others.
- Work area is the area of work that a building permit is obtained for.

Area of a building that is being altered is considered the work area. It does not include areas outside of the work that need to be altered due to the alteration of the main area of the work.



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Codes and Standards

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



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Authority – Section 103

- Local jurisdiction creates the Department of Building Safety
- A building official is appointed to manage the department
 - The building official reviews plans, issues permits, inspects work for compliance with code and plans and issues a Certificate of Occupancy
 - The building official interprets code requirements



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Permits – Section 105

- A permit is required to build a new building, remodel a building, or build an addition onto an existing building
- Exempt projects:
 - Storage sheds less than 120 square feet
 - Fences 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



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Alternative Materials and Methods – Section 104.11

- The designer can submit a request to meet the code requirements with alternative materials and methods
- The building official reviews alternate designs and products to determine if they comply with the purpose and intent of the code
- The alternative must be at least equivalent in quality, strength, effectiveness, fire resistance, durability and safety
- ICC Evaluation Service (ICC-ES) reviews and provides reports



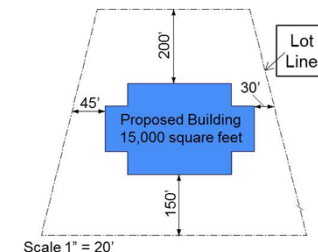
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Submittal Documents – Section 107

- Drawings
 - Site plan
 - Floor plans
 - Elevations
 - Details
- Specifications
- Manufacturer installation instructions



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Plan Review

- The building department reviews plans for compliance with the code and other applicable laws of the jurisdiction
- If plans are found in compliance, a permit can be issued for the work
- If plans have discrepancies, a plan review report is provided to the applicant
- The applicant makes corrections to the plans and resubmits them to the building department for review
- Permit is issued when plans are approved



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Inspections – Concrete Slab and Under-floor

- Concrete slabs can contain:
 - Reinforcement steel
 - Conduits
 - Piping
 - Other equipment
- This inspection is typically done after the plumbing inspector checks the plumbing installation and the electrical inspector checks underground electrical equipment



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Inspections – Footing and Foundation

- Inspectors check the forms and reinforcing steel to ensure that they are the correct size and in the proper location
- A concrete foundation is inspected after the forms have been constructed and the reinforcement steel installed
- Masonry foundations are checked for the correct masonry, mortar, grout and reinforcing steel



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Inspections – Lowest Floor Elevation

- In areas where flooding is possible, it is important that the building be elevated above the 100-year flood level
- This required inspection confirms that the lowest floor to be occupied will be elevated at or above flood elevation



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Inspections – Frame

- The structure or frame of the building be inspected
- An inspector confirms that the size and installation of the structural members in the building are correct
- A frame inspection is done after all of the plumbing, mechanical and electrical systems are installed, inspected and approved



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Inspections – Fire-resistant Penetrations

- Penetrations (holes) in fire-rated components must be protected with a material that fills them when piping or wiring melts out in a fire
- The fill materials used to provide this protection must be installed in a specific way
- These systems must be inspected to show that they are installed in accordance with the manufacturer's installation instructions



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Inspections – Lath and Gypsum Board

- Many buildings use gypsum board (drywall) to provide fire protection
- The proper installation of these materials must comply with specific installation standards and methods
- An inspector confirms that the materials have been installed to provide the level of protection needed



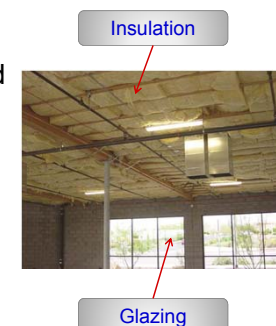
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Inspections – Energy Efficiency

- The materials installed in buildings for energy efficiency must be inspected to ensure that they are installed correctly
- Inspectors check for proper insulation values, sealing and equipment installation



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Inspections – Final

- Final inspection is done when the building is ready for occupancy
- Inspectors confirm that all of the work covered by the building permit has been completed according to the plans and applicable code
- When the final inspection is approved, the owner receives a Certificate of Occupancy, which allows him or her to use the building



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Board of Appeals – Section 113

- The building official is responsible for interpretation of the IBC
- Occasionally, an architect or contractor may disagree with a building official's interpretation
- The architect or contractor can request a hearing before the board of appeals
- The board of appeals evaluates the information against the intent of the code and renders a decision regarding the interpretation of the code



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Inspections – Special Inspections

- Certain portions of a building require special inspections by a third-party inspection company that has expertise in particular materials and designs
- The third-party inspector is hired by the building owner and is responsible for reporting his or her findings to the building department
- Third-party inspections are required on materials such as:
 - Structural concrete
 - Structural steel
 - Masonry



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Definitions – Chapter 2

- The IBC includes definitions for specific terms
- Terms not defined in the IBC shall:
 - Definitions in other I-Codes apply
 - The normal use of the term can be used as it applies to the code
- Defined terms are *italicized* in the code language



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ACTIVITY

Module I – Code Administration and Enforcement

1. T F A building design can never stray from the requirements found in the building code.

False
The design must meet the intent of the code; alternate methods approved by the code official are allowed.


2. T F All of the I-Codes work separately and independently of each other.

False
The I-Codes work as a set of codes, each applying to a specific portion of the construction.

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DISCUSSION

Code Administration and Enforcement Practice



Any questions regarding the practice?

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ACTIVITY

Module I – Code Administration and Enforcement

3. Who is responsible to arrange for inspections of the completed work?

The holder of the building permit shall notify the building official IBC §110.5

4. After the contractor or owner has notified the building official that their project is ready for inspection, how long must the work remain open for inspection?

Until the work is inspected IBC §110.6 – approval is required before the work is covered or concealed

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Part II

Building Planning

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Occupancy Classifications

- Group A (assembly) – the use of a building or structure, or a portion thereof, for the gathering of persons for purposes such as civic, social or religious functions; recreation, food or drink consumption or awaiting transportation.

Occupancy Classification	Description
A-1	Assembly uses, usually with fixed seating, intended for the production and viewing of the performing arts or motion pictures
A-2	Assembly uses intended for food and/or drink consumption
A-3	Assembly uses intended for worship, recreation, or amusement and other assembly uses not classified elsewhere in Group A
A-4	Assembly uses intended for viewing of indoor sporting events and activities with spectator seating
A-5	Assembly uses intended for participation in or viewing outdoor activities.



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Occupancy Classifications

- Group E (educational)

Occupancy Classification	Description
E	The use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade and child care facilities.
E Day Care	The use of buildings and structures or portions thereof occupied by more than five children older than 2½ years of age who receive educational, supervision or personal care services for fewer than 24 hours per day.



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Occupancy Classifications

- Group B (business)

Occupancy Classification	Description
B	The use of a building or structure, or a portion thereof, for office, professional, or service-type transactions, including storage of records and accounts.



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Occupancy Classifications

- Group F (factory) – the use of a building or structure, or a portion thereof, for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operations that are not classified as a Group H hazardous or Group S storage occupancy

Occupancy Classification	Description
F-1	Factory industrial uses which are not classified as Factory Industrial F-2 Low Hazard
F-2	Factory industrial uses that involve the fabrication or manufacturing of noncombustible materials which during finishing, packing, or processing do not involve a significant fire hazard



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Occupancy Classifications

- Group H (high hazard) – the use of a building or structure, or a portion thereof, that involves the manufacturing, processing, generation or storage of materials that constitute a physical or health hazard in quantities in excess of those allowed in control areas

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



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Occupancy Classifications

- Group M (mercantile)

Occupancy Classification	Description
M	Buildings and structures or a portion thereof, for the display and sale of merchandise, and involves stocks of goods, wares or merchandise incidental to such purposes and accessible to the public.



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Occupancy Classifications

- Group I (institutional) – the use of a building or structure, or a portion thereof, in which care or supervision is provided to persons who are or are not capable of self-preservation without physical assistance or in which persons are detained for penal or correctional purposes or in which the liberty of the occupants is restricted

Occupancy Classification	Description
I-1	Buildings, structures or portions thereof for more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised environment and receive custodial care.
I-2	Buildings and structures used for medical care on a 24-hour basis for more than five persons who are incapable of self-preservation.
I-3	Buildings and structures that are inhabited by more than five persons who are under restraint or security. An I-3 facility is occupied by persons who are generally incapable of self-preservation due to security measures not under the occupants' control.
I-4	Buildings and structures occupied by persons of any age who receive custodial care for less than 24 hours by individuals other than parents or guardians, relatives by blood, marriage, or adoption, and in a place other than the home of the person cared for.



Occupancy Classifications

- Group R (residential) – the use of a building or structure, or a portion thereof, for sleeping purposes when not classified as an Institutional Group I or when not regulated by the IBC

Occupancy Classification	Description
R-1	Residential occupancies containing sleeping units where the occupants are primarily transient in nature
R-2	Residential occupancies containing sleeping units or more than two dwelling units where the occupants are primarily permanent in nature
R-3	Residential occupancies where the occupants are primarily permanent in nature and not classified as Group R-1, R-2, R-4, or I
R-4	Buildings, structures or portions thereof for more than five but not more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised residential environment and receive custodial care.



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Occupancy Classifications

- Group S (storage) – the use of a building or structure, or a portion thereof, for storage that is not classified as a hazardous occupancy

Occupancy Classification	Description
S-1	Buildings occupied for storage uses that are not classified as Group S-2
S-2	Buildings used for the storage of 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.



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**Table 601–
Fire-Resistance Rating Requirements
for Building Elements (hours)**

§ - Section

Building Element	Type I		Type II		Type III		Type IV	Type V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame	3 ^a	2 ^a	1	0	1	0	HT	1	0
Bearing Walls									
Exterior ^{e,f}	3	2	1	0	2	2	2	1	0
Interior	3 ^a	2 ^a	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions (exterior)	See Table 602								
Nonbearing walls and partitions (interior)	0	0	0	0	0	0	See §602.4.6	0	0
Floor construction and secondary members	2	2	1	0	1	0	HT	1	0
Roof construction and secondary members	1½ ^b	1 ^{b,c}	1 ^{b,c}	0 ^c	1 ^{b,c}	0	HT	1 ^{b,c}	0

Occupancy Classifications

- Group U (utility)

Occupancy Classification	Description
U	Buildings and structures of an accessory character and miscellaneous structures not classified in any specific occupancy shall be constructed, equipped and maintained to conform to the requirements of this code commensurate with the fire and life hazard incidental to their occupancy.



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Comparison of Construction Types

Type of Construction	Subgroup	Combustible Materials	Fire Resistant Construction	Common Materials
I	A	No	Yes	Steel, concrete, masonry
	B	No	Yes	
II	A	No	Yes	Concrete & masonry exterior walls
	B	No	No	
III	A	Yes	Yes	Wood roof and floor systems
	B	Yes	No	
IV	HT	Yes	Yes	Large dimension lumber
V	A	Yes	Yes	Wood
	B	Yes	No	



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Allowable height in feet (based on IBC Table 504.3)

Occupancy classification	Type of construction									
	See footnotes	Type I		Type II		Type III		Type IV	Type V	
		A	B	A	B	A	B	HT	A	B
A, B, E, F, M, S, U	NS	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	86	75	85	70	60
R	NS ^a	UL	160	65	55	65	55	65	50	4
	S13R	60	60	60	60	60	2	60	60	60
	S	UL	180	85	75	85	4	85	70	60



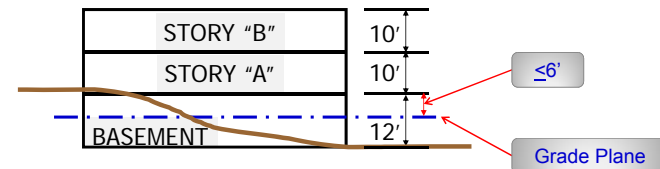
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Stories Above Grade Plane

- Determine Grade Plane
- Determine if bottom story is basement



The bottom story is a basement because the floor of Story "A" is $\leq 6'$ above grade plane



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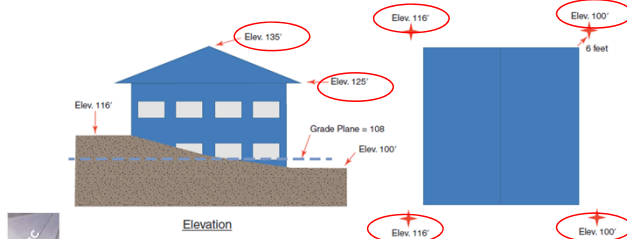
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Height of Building

Determine Grade Plane $100 + 100 + 116 + 116 = 432$
 $432 \div 4 = 108'$

Determine Average Roof Height $125 + 135 = 260$
 $260 \div 2 = 130'$

Determine Building Height $130 - 108 = 22'$



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Automatic Fire Sprinkler Systems

- NFPA 13
 - Designed for building protection
 - Sprinklers required in all rooms of a building
- NFPA 13R
 - Designed for occupant protection
 - Limited to residential uses <4 stories and <60 feet in height
 - Sprinklers can be omitted from concealed combustible spaces and small closets and restrooms
- NFPA 13D
 - Designed for occupant protection
 - Limited to 1- and 2-family dwellings



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Allowable height in stories (based on IBC Table 504.4)

Occupancy classification	Type of construction									
	See footnotes	Type I		Type II		Type III		Type IV	Type V	
		A	B	A	B	A	B	HT	A	B
A-2	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
M	NS	UL	11	4	2	4	2	4	3	1
	S	UL	12	5	2	5	3	5	4	2
R-2 ^a	NS	UL	11	4		4	4	4	3	2
	S13R	4	4	4						4
	S	UL	12	5	5	5	5	5	4	3

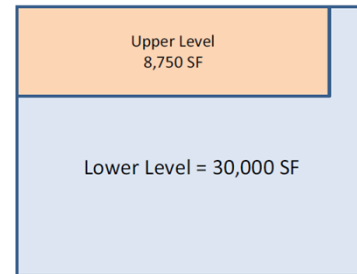


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Building Height



If area below upper level is not enclosed
 $8,750/30,000 = 0.30$
 Upper level considered a mezzanine

If area below upper level is enclosed
 $8,750/22,500 = 0.39$
 Upper level considered a second story



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Height Increase for Fire Sprinklers

- When building is protected with NFPA 13 sprinkler system:
 - Add one story and 20 feet to allowable height
- When building is protected with NFPA 13R sprinkler system:
 - Add one story and 20 feet to allowable height
 - Limited to residential uses <4 stories and <60' in height
 - Cannot exceed 60 feet in height
- When building is protected with NFPA 13R sprinkler system:
 - No increase in height allowed



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Allowable building area factor (based on IBC Table 506.2) (At = NS, S1, S13R or SM as applicable) in square feet

Occupancy classification	See Footnotes	Type of construction									
		Type I		Type II		Type III		Type IV	Type V		
		A	B	A	B	A	B	HT	A	B	
A-2	NS	UL	UL	15500	9500	14000	9500	15000	11500	6000	
	S1	UL	UL	62000	38000	56000	38000	60000	46000	24000	
	SM	UL	UL	46500	28500	42000	28500	45000	34500	18000	
B	S	UL	UL	37500	23000	28500	19000	36000	18000	9000	
	S1	UL	UL	150000	92000	114000	76000	144000	72000	36000	
	SM	UL	UL	112500	69000	85500	57000	108000	54000	27000	
M	NS	UL	UL	21500	12500	18500	12500	20500	14000	9000	
	S1	UL	UL	86000	50000	74000	50000	89000	56000	36000	
	SM	UL	UL	64500	37500	55500	37500	61500	42000	27000	
R-2 ^a	NS										
	S13R	UL	UL	24000	16000	24000	16000	20500	12000	7000	
	S1	UL	UL	96000	64000	96000	64000	82000	48000	28000	
	SM	UL	UL	72000	48000	72000	48000	61500	36000	21000	



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Area Increase for Frontage Equation 5-5

$$I_f = [F/P - 0.25] \times W/30$$

where:

I_f = Area increase due to frontage

F = Building perimeter that fronts on a public way or open space $\geq 20'$ wide

P = Perimeter of entire building

W = Width of public way or open space in accordance with §506.3.2



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Allowable Area – Equation 5-1

$$A_a = \{A_t + [NS \times I_f]\}$$

where:

A_a = Allowable building area per story (ft²)

A_t = Tabular allowable area factor in accordance with Table 506.2

NS = Tabular allowable area factor in accordance with Table 506.2 for nonsprinklered building

I_s = Area increase factor due to frontage as calculated in accordance with §506.3



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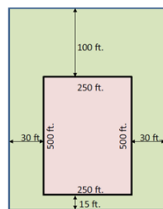
Area Increase for Frontage – Equation 5-5

- P = Perimeter of building
- F = Building perimeter that fronts on a public way or open space ≥ 2 feet wide
- W = Width of public way or open space
- $I_f = [F/P - 0.25] \times W/30$

1500'

1250'

30'



$$I_f = \left[\frac{1250}{1500} - 0.25 \right] \times \frac{30}{30}$$

$$I_f = 0.58\%$$



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Allowable Area for Frontage

- Given:
 - Single story with single occupancy

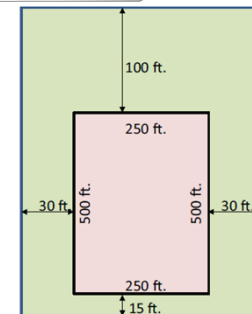
Actual area = 125,000

$$A_a = A_t + (NS \times I_f)$$

$$A_a = 112,500 + (37,500 \times 0.58)$$

$$A_a = 112,500 + 21,375$$

$$A_a = 134,250$$



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Interior Dimensions

- Habitable rooms
 - Room width >7 feet
 - Exception allows kitchens to provide a >3 feet 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 >7'-6"
 - Door width >32"



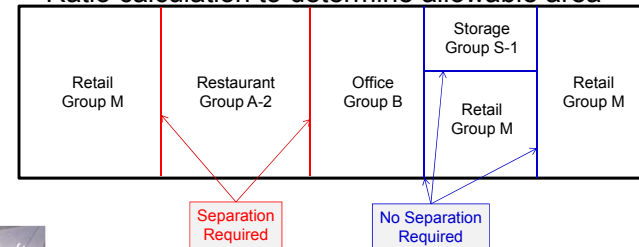
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Multi-use Buildings – Separated Occupancies

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



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Multi-use Buildings – Separated Occupancies

Table 508.4

Required Separation of Occupancies (hours)

Occupancy	A, E		I-1, I-3, I-4		I-2		R ^a		F-2, S-2 ^b , U		B ^c , F-1, M, S-1		H-1		H-2		H-3, H-4		H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A ^a , E	N	N	1	2	2	NP	1	2	N	1	1	2	NP	NP	3	4	2	3	2	NP
I-1, I-3, I-4	-	-	N	N	2	NP	1	NP	1	2	1	2	NP	NP	3	NP	2	NP	2	NP
I-2	-	-	-	-	N	N	2	NP	2	NP	2	NP	NP	NP	3	NP	2	NP	2	NP
R ^a	-	-	-	-	-	-	N	N	1 ^c	2 ^c	1	2	NP	NP	3	NP	2	NP	2	NP
F-2, S-2 ^b , U	-	-	-	-	-	-	-	-	N	N	1	2	NP	NP	3	4	2	3	2	NP
B ^c , F-1, M, S-1	-	-	-	-	-	-	-	-	-	-	N	N	NP	NP	2	3	1	2	1	NP
H-1	-	-	-	-	-	-	-	-	-	-	-	-	N	NP	NP	NP	NP	NP	NP	NP
H-2	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	1	NP	1	NP	NP
H-3, H-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 ^d	NP	1	NP	NP
H-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	NP

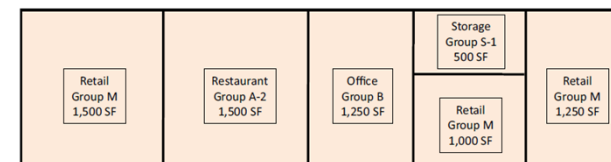


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Multi-use Buildings – Separated Occupancies



Given:
 Above mixed occupancy building
 One Story
 Type VB Construction
 No Fire Sprinklers
 No Frontage Increase
 Allowable Areas
 Group A-2 = 6,000 SF
 Group B = 9,000 SF
 Group M = 9,000 SF
 Group S-1 = 9,000 SF

Evaluate Allowable Area:
 Rao Calculation
 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-2 500/9,000 = 0.05
 Total Rao 0.86



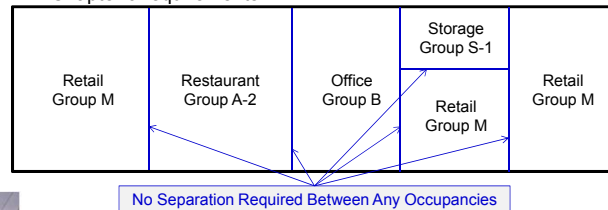
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Multi-use Buildings – Nonseparated Occupancies

- Most restrictive requirement of each occupancy is applied to entire building
 - Height
 - Area
 - Chapter 9 requirements



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Multi-use Buildings – Incidental Uses

- Uses and occupancies within a building which are incidental to the main operation
- Protection is required for incidental accessory occupancies identified in Table 509
 - Fire-rated construction; or
 - Fire sprinklers
- When the fire sprinkler option is used, the room must be constructed to resist the passage of smoke



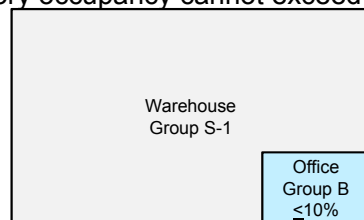
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Multi-use Buildings – Accessory Occupancies

- Subsidiary occupancy to main use of building
- Accessory occupancy <10 percent of floor area/story
- Accessory occupancy cannot exceed Table 503



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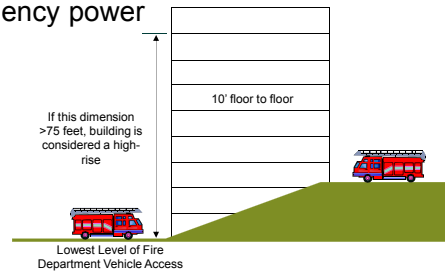
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Multi-use Buildings – Incidental Accessory Occupancies

ROOM OR AREA	SEPARATION AND/OR PROTECTION
Furnace room where any piece of equipment is over 400,000 Btu per hour input	1 hour or provide automatic sprinkler system
Rooms with boilers where the largest piece of equipment is over 15 psi and 10 horsepower	1 hour or provide automatic sprinkler system
Refrigerant machinery room	1 hour or provide automatic sprinkler system
Hydrogen cut-off rooms, not classified as Group H	1 hour in Group B, F, M, S and U occupancies; 2 hours in Group A, E, I and R occupancies
Incinerator rooms	2 hours and automatic sprinkler system
Paint shops, not classified as Group H, located in occupancies other than Group F	2 hours; or 1 hour and provide automatic sprinkler system
In Group E occupancies, laboratories and vocational shops, not classified as Group H	1 hour or provide automatic sprinkler system
In Group I-2 occupancies, laboratories not classified as Group H	1 hour or provide automatic sprinkler system
In ambulatory care facilities, laboratories not classified as Group H	1 hour or provide automatic sprinkler system
In Group I-2, laundry rooms over 100 square feet	1 hour
Group I-3 cells and Group I-2 patient rooms equipped with padded surfaces	1 hour
Group I-2 waste and linen collection rooms	1 hour
In Group I-2, physical plant maintenance shops	1 hour
In ambulatory care facilities or Group I-2 occupancies, waste and linen collection rooms with containers that have an aggregate volume of 10 cubic feet or greater	1 hour
In other than ambulatory care facilities and Group I-2 occupancies, waste and linen collection rooms over 100 square feet	1 hour or provide automatic sprinkler system
In ambulatory care facilities or Group I-2 occupancies, storage rooms greater than 100 square feet	1 hour
Stationary lead-acid battery systems having a liquid capacity of more than 100 gallons used for facility standby power, emergency power, or uninterrupted power supplies	1 hour in Group B, F, M, S and U occupancies; 2 hours in Group A, E, I and R occupancies

High-rise Buildings

- Smokeproof enclosure for stairways
- Smoke detection in elevator lobbies
- Standby/emergency power
- Fire alarm
- Sprinklers
- Standpipes



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Atriums

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



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High-rise Buildings

- Additional stairway required in high-rise >420 feet
- Fire service access elevator when a floor level >120 feet above LLFDVA
- Method of smoke removal
 - Operable windows, OR
 - Mechanical system
- Egress path marking



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Garages

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

Group U
≤3,000 ft²
Serving residential units

Group S-2
Serving public or private
parking use



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Repair Garages

- IFC defines a Repair Garage as:
 - “A building, structure, or portion thereof used for servicing or repairing motor vehicles.”
- Mechanical ventilation
- Solvents
- Vehicle fluids
- Type of fuel in vehicle
 - Gasoline, diesel
 - LPG, natural gas
 - Hydrogen, electric



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Hazardous Materials Maximum Allowable Quantities

- Read the Footnotes
- Table 307.1(1)
- Maximum Allowable Quantity (MAQ) per Control Area of Hazardous Materials Posing a Physical Hazard^{j,m,n,p}

Material	Class	Group when the MAQ is Exceeded	Storage ^b			Use-Closed System ^b			Use-Open Systems ^b	
			Solid Lbs. (cubic feet)	Liquid Gallons (pounds)	Gas Cubic Feet at NTP	Solid Lbs. (cubic feet)	Liquid Gallons (pounds)	Gas Cubic Feet at NTP	Solid Lbs. (cubic feet)	Liquid Gallons (pounds)
Combustible liquid ^{c,i}	II, IIIA, IIIB	H-2 or H-3	N/A	120 ^{d,e} 330 ^{d,e} 13,200 ^{e,f}	N/A	N/A	120 ^d 330 ^d 13,200 ^f	N/A	N/A	30 ^d 80 ^d 3,300 ^d
		NA								
Oxidizer	4	H-1	1 ^g	(1) ^{e,g} 10 ^{d,e}	N/A	0.25 ^g 2 ^d	(0.25) ^g (2) ^d	N/A	0.25 ^g 2 ^d	(0.25) ^g (2) ^d
	3 ^k	H-2 or H-3								
	2	H-3	250 ^{d,e} 4,000 ^e	(250) ^{d,e} (4,000) ^e	N/A	250 ^d 4,000 ^f	(250) ^d (4,000) ^f	N/A	50 ^d 1,000 ^d	(50) ^d (1,000) ^f
	1	NA								

Hazardous Materials Maximum Allowable Quantities

- Excerpt from Table 307.1(1)
- Table 307.1(1)
- Maximum Allowable Quantity (MAQ) per Control Area of Hazardous Materials Posing a Physical Hazard^{j,m,n,p}

Material	Class	Group when the MAQ is Exceeded	Storage ^b			Use-Closed System ^b			Use-Open Systems ^b	
			Solid Lbs. (cubic feet)	Liquid Gallons (pounds)	Gas Cubic Feet at NTP	Solid Lbs. (cubic feet)	Liquid Gallons (pounds)	Gas Cubic Feet at NTP	Solid Lbs. (cubic feet)	Liquid Gallons (pounds)
Combustible liquid ^{c,i}	II, IIIA, IIIB	H-2 or H-3	N/A	120 ^{d,e} 330 ^{d,e} 13,200 ^{e,f}	N/A	N/A	120 ^d 330 ^d 13,200 ^f	N/A	N/A	30 ^d 80 ^d 3,300 ^d
		NA								
Oxidizer	4	H-1	1 ^g	(1) ^{e,g} 10 ^{d,e}	N/A	0.25 ^g 2 ^d	(0.25) ^g (2) ^d	N/A	0.25 ^g 2 ^d	(0.25) ^g (2) ^d
	3 ^k	H-2 or H-3								
	2	H-3	250 ^{d,e} 4,000 ^e	(250) ^{d,e} (4,000) ^{e,f}	N/A	250 ^d 4,000 ^f	(250) ^d (4,000) ^f	N/A	50 ^d 1,000 ^d	(50) ^d (1,000) ^f
	1	NA								

Footnotes to Table 307.1(1)

- b – Aggregate quantity shall not exceed storage
- d – Increase 100 percent for automatic sprinkler system
- e – Increase 100 percent 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*



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Footnotes to Table 307.1(1)

- k – 200 pounds or 20 gallons of Oxidizer 3 for maintenance, operation or sanitation of equipment
- l – fireworks 1.4G based on 25 percent of gross weight
- m – 1 gallon = 10 pounds.
- n – storage and display in M, storage in S
- p – situations not included
 - Fuel in fuel tanks on vehicles
 - Fuel in fuel tanks on motorized equipment operated in accordance with IFC
 - Fuels in piping systems and fixed appliances regulated by the IFGC
 - Fuels in piping systems and fixed appliances regulated by the IMC
 - Alcohol-based hand rubs classified as Class I or II liquids in dispensers that are installed by IFC



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Control Areas

TABLE 6-3 Design and number of control areas (Based on IBC Table 414.2.2)

Floor Level	Percentage of the Maximum Allowable Quantity per Control Area ^a	Number of Control Areas per Floor	Fire-resistance Rating for Fire Barriers in Hours ^b
Above grade plane	Higher than 9	5	2
	7-9	5	2
	6	12.5	2
	5	12.5	2
	4	12.5	2
	3	50	1
	2	75	1
	1	100	1
	1	75	1
Below grade plane	2	50	1
	Lower than 2	Not Allowed	Not Allowed

^a Percentages shall be of the maximum allowable quantity per control area shown in Tables 307.1(1) and 307.1(2), with all increases allowed in the notes to those tables.

^b Fire barriers shall include walls and floors as necessary to provide separation from other portions of the building.



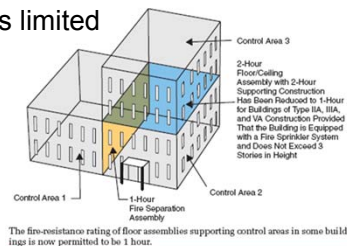
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Control Areas

- Control Areas are NOT considered an H occupancy
- Up to MAQ in each control area
- Number of control areas limited
- Table 414.2.2



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Allowable Quantity

- Given: A 1-story building to be used for the storage of toluene, (Class IC flammable liquid)
- Building is sprinklered throughout and is one control area
- Problem: Determine the MAQ using the requirements in Table 307.1(1)

Tabular MAQ = 120
 Footnote d = 100% increase
 $120 \times 2 = 240$ gallons/control area
 Footnote e = 100% increase
 $240 \times 2 = 480$ gallons/control area

Material	Class	Group when the MAQ is Exceeded	Storage ^b			Use-Closed System ^b			Use-Open Systems ^b	
			Solid Lbs. (cubic feet)	Liquid Gallons (pounds)	Gas Cubic Feet at NTP	Solid Lbs. (cubic feet)	Liquid Gallons (pounds)	Gas Cubic Feet at NTP	Solid Lbs. (cubic feet)	Liquid Gallons (pounds)
Flammable liquid ^c	IB and IC	H-2 or H-3	N/A	120 ^d	N/A	N/A	120 ^d	N/A	N/A	30 ^d



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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



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Healthcare Occupancies

- Group I-1 occupancies are those where more than 16 persons live on a 24-hour basis
 - Examples include assisted living facilities, halfway houses, alcohol and drug centers, group homes and congregate care facilities



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Healthcare Occupancies

- Classified as Group I occupancies
- Code official needs to know
 - Time that people are in the building receiving care.
 - Level of care that the person is receiving
 - Whether people are capable of responding to an emergency situation on their own



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Healthcare Occupancies

- Group I-2 occupancies are buildings that are used for medical care on a 24-hour basis for more than five people
 - Condition 1 includes those buildings where nursing and medical care are provided.
 - Condition 2 includes those facilities where emergency care, surgery, obstetrics or in-patient stabilization units for psychiatric or detoxification are provided.



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Ambulatory Health Care Facilities

- Facilities that provide medical, surgical, psychiatric, nursing or similar care on less than a 24 hour basis to individuals who are not capable of self-preservation
- Classified as B
- Fire sprinklers required
- Smoke-protected compartments
 - when >10,000 square feet



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Module II – Building Planning

3. T F The maximum height of a building is controlled by type of construction type, occupancy classification, and the installation of fire sprinklers.

True

IBC Table 503; Workbook Table 5-2

4. What is the allowable area for a non-sprinklered Group M occupancy of Type IIIB construction without any increases for frontage?

12,500 square feet

IBC Table 503; Workbook Table 5-2



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Module II – Building Planning

1. Classify the following occupancies:

- High School Group E
- Hospital Group I-2
- Business office in a high-rise Group B
- Warehouse storing plastic cups Group S-1

2. In Type IIA construction what is the minimum fire-resistance rating for interior walls?

1-HR

IBC Table 601; Workbook Table 4-1



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Module II – Building Planning

5. 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

D

IBC §508.1



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ACTIVITY

Module II – Building Planning

6. T F Hazardous materials are only allowed in Group H occupancies?

False
Hazardous materials can be found in nearly all occupancies, but the quantities are limited. When the quantity of hazardous materials exceeds the Maximum Allowable Quantity per Control Area, then the occupancy is classified as Group H.

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Module III


Fire Safety

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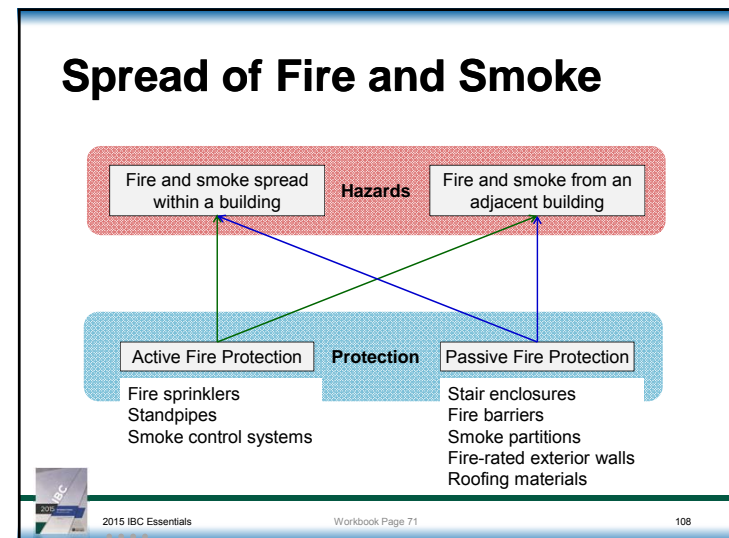
DISCUSSION

Building Planning Practice

- Any questions regarding the practice?



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Determining Fire-resistance

- Fire testing of assemblies and materials
- Prescriptive design – Section 721
- Fire-resistance rating can be calculated based on specific materials



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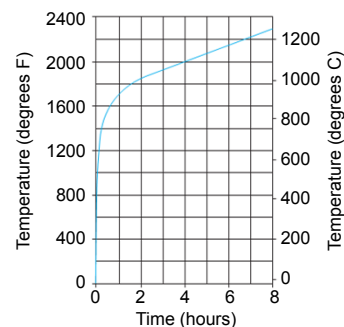
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Fire-resistance Ratings – Table 721.1(2)

Material	Item Number	Construction	Minimum Finished Thickness Face-to-Face (inches)			
			4 hour	3 hour	2 hour	1 hour
13. Noncombustible studs—interior partition with gypsum wallboard each side	13-1.1	0.018" (No. 25 carbon sheet steel gage) channel-shaped studs 24" on center with one full-length layer of 5/8" Type X gypsum wallboard applied vertically attached with 1" long No. 6 drywall screws to each stud. Screws are 8" on center around the perimeter and 12" on center on the intermediate stud. The wallboard may be applied horizontally when attached to 3 5/8" studs and the horizontal joints are staggered with those on the opposite side. Screws for the horizontal application shall be 8" on center at vertical edges and 12" on center at intermediate studs.	—	—	—	27/8

Fire Testing

- Provides relative comparison between different construction methods and materials
- Based on standard Time-Temperature Curve
 - UL 263
 - ASTM E119



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Protection of the Structure

- Primary structural frame members include:
 - Columns
 - Beams, girders and trusses directly attached to columns
 - Floor and roof construction connected directly to columns
 - Bracing members that are designed to support gravity loads
- Secondary members are structural members:
 - Not connected directly to columns
 - Floor and roof construction not connected to columns
 - Bracing members not supporting gravity loads



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Protection of Structural Frame

- Masonry and concrete walls encase the steel and provide protection
- When required to provide a fire-resistance rating, exposed steel must be protected

Spray-applied fireproofing



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Fire Walls



- A fire wall allows for the structure on each side of the wall is considered a separate building
- Extends from foundation to >30 inches above the roof (some exceptions)
- Must have structural stability
 - Structure on either side can collapse but the fire wall must remain in place for duration of the fire rating



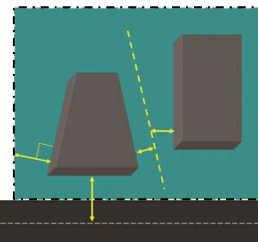
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Exterior Walls

- Fire separation distance
- Table 601 – based on type of construction
- Table 602 – based on distance to property line
- Distances measured at right angles to the building wall



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Fire Wall and Opening Ratings

- Openings in fire walls limited to:
 - Individual size <156 square feet
 - Aggregate of 25 percent of the fire wall

Group	Fire-resistance Rating (hours)	Opening Rating (hours)
A, B, E, H-4, I, R-1, R-2, U	3 ^a	3
F-1, H-3 ^b , H-5, M, S-1	3	3 ^c
H-1, H-2	4 ^b	3
F-2, S-2, R-3, R-4	2	1½

a. In Type II and V construction, walls shall be permitted to have a 2-hour fire-resistance rating with 1½-hour openings.

b. For Group H-1, H-2, or H-3 buildings, also see Sections 415.4 and 415.5.



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Fire Barriers

- Examples of fire barrier use:
 - Separated mixed-use occupancy
 - Incidental accessory occupancies
 - Control areas
- Extend from the top of the floor/ceiling assembly to the underside of the floor or roof sheathing above
- Construction and structure supporting a fire barrier must have a fire-resistance rating of equal to or better than the fire barrier



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Fire Partitions

- Provide separation of:
 - Dwelling units in apartments and condominiums
 - Guest rooms in hotels
- Must extend from the floor assembly to either the floor or roof sheathing above, or a fire-resistance-rated floor/ceiling or roof/ceiling assembly



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Fire Barrier Opening Ratings

Fire-resistance Rating (hours)	Fire Door/Fire Shutter Rating (hours)
4	3
3	3
2	1½
1	1½

a. Openings in shafts, exit enclosures, and exit passageway walls are required to have a 1-hour fire rating.



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Horizontal Assemblies

- Floor/ceiling assembly
- Roof/ceiling assembly
- Openings in fire-resistance-rated horizontal assemblies must be protected with shaft enclosures
- Vertical openings through horizontal assemblies must be protected to restrict the spread of heat and smoke vertically
 - Several exceptions and protection methods are found in Section 712



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Shafts

- Fire-resistance rating for shafts
 - 1-HR fire-resistance rated shaft connecting >2 floors
 - 2-HR fire-resistance rated shaft connecting more than 4 floors
 - 13 exceptions to these requirements
- Penetrations of shaft wall must be protected with fire dampers



Ductwork penetrating floor



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Opening Protection

- Doors and windows installed in fire-resistance-rated assemblies are required to have a fire protection rating
- Fire door assemblies include the door, frame and all associated hardware



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Penetrations

- Pipes, tubing, conduit, and cables passing through fire assemblies are penetrations
- Through penetrations
 - Passes through entire assembly
- Membrane penetrations
 - Penetrates through one surface



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Interior Finishes

Table 803.9

- Flame spread is the propagation of flame over a surface

Group	Sprinklered ¹			Nonsprinklered		
	Exit enclosures and exit passageways ^{a,b}	Corridors	Rooms and enclosed spaces ^c	Exit enclosures and exit passageways ^{a,b}	Corridors	Rooms and enclosed spaces ^c
A-1 & A-2	B	B	C	A	A ^d	B ^e
A-3 ^f , A-4, A-5	B	B	C	A	A ^d	C
B, E, M, R-1	B	C	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		



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Fireblocking

- Fireblocking is used to separate:
 - Concealed openings within a wall
 - Openings between a wall and floor or attic spaces
 - Floor levels
 - The top floor and the attic
- Required in wall spaces:
 - Vertically at ceiling and floor
 - Horizontally at intervals <10 feet



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Automatic Fire Sprinklers

- Sprinklers react to heat
- Sprinklers apply water directly to the fire area
- Sprinklers normally operate independently



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Draftstops

- Required in large concealed floor spaces and attics with combustible construction
- Group R requires draftstops within concealed spaces in line with dwelling unit and guest room separations
- Attics, mansards and concealed roof spaces >3,000 square feet must be subdivided into maximum 3,000 square foot areas
 - Fire sprinklers in these spaces eliminate the draftstop requirement



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Automatic Fire Sprinklers – Where Required

- Required based on:
 - Occupancy classification
 - Use or materials handled
 - Number of occupants
 - Size of fire areas
 - Floor level in the building
- Section 903.2 will require sprinklers to be installed in one of the following:
 - Fire area
 - Floor level, plus all floors to the level of exit discharge
 - Entire building



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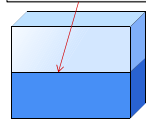
Fire Areas

- Any floor area enclosed and bounded by fire walls, fire barriers, exterior walls or horizontal assemblies of a building



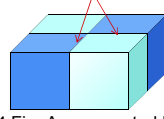
Every building is at least 1 Fire Area

Horizontal Fire-rated Assembly



2 Fire Areas created by horizontal assembly

Fire Walls or Fire Barriers



4 Fire Areas created by fire walls or fire barriers

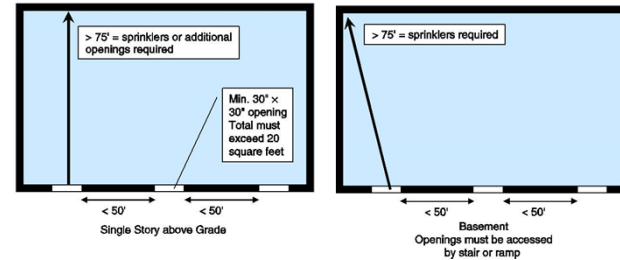


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Automatic Fire Sprinklers – Floors without Openings



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Fire Areas

- Fire Areas are created with fire-resistance-rated construction of 1-hour or greater
- When separating a single occupancy into smaller fire areas to eliminate fire sprinklers, Table 707.3.10 specifies the minimum rating

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
H-1, H-2	4
F-1, H-3, S-1	3
A, B, E, F-2, H-4, H-5, I, M, R, S-2	2
U	1



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Automatic Fire Sprinklers – Modifications of Code Requirements

- When fire sprinklers are installed in a building, the IBC gives credit, and allows modifications, for the added protection the system provides
- Standards used in the design of sprinkler system
 - NFPA 13
 - NFPA 13R
 - NFPA 13D



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Standpipes

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



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Fire Alarm Systems

- Alarm activation
 - Manual
 - Automatic
- Required based on
 - Occupancy classification
 - Occupant load
 - Floor level
 - Operations conducted
 - Materials handled
- Fire alarms must comply with NFPA 72



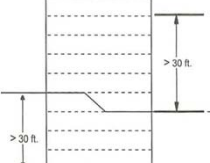
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Standpipes – Where Required

- In buildings with a floor level:
 - >30 feet above the LLFDVA
 - >30 feet below the HLFDA
- Covered malls
- Stages



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Fire Alarm Systems

- Occupant notification
 - Audible
 - 15 dBA above ambient
 - Maximum 110 dBA
 - Visual
 - Public and common areas
 - Emergency voice/alarm communication system
 - Provide voice instructions



Courtesy of Cooper Notification, Inc.



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Smoke Alarms

- Smoke alarms include the detector, control equipment, and alarm-sounding device in a single unit
- Multiple smoke alarms are interconnected so when one device senses smoke, all of the devices sound an alarm
- Smoke alarms are 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



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Carbon Monoxide Alarms

- Group E, I-1, I-2 and R occupancies must be provided with CO alarms when:
 - The building contains a fuel-burning appliance
 - The building includes an attached garage
- Listed in accordance with UL 2034 AND UL 217
- CO alarms must be installed in the following locations:
 - Outside of each separate dwelling-unit sleeping area in the immediate vicinity of the bedrooms
 - On every level of a dwelling unit that can be occupied, including basements but excluding attics and crawl spaces



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Smoke Control Methods

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



Cross corridor doors as part of smoke barrier held in place with magnetic hold-open device released by smoke detectors or fire alarm



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Module III – Fire Safety

1. T F A 3-HR fire-resistance rated fire wall is required to separate two Group M occupancies.

True
IBC Table 706.4; Workbook Table 8-6

2. A door in a 2-HR fire-resistance rated fire barrier must have a minimum fire-resistance rating of

1½-HR
IBC Table 716.5; Workbook Table 8-7



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ACTIVITY

Module III – Fire Safety

3. The flame spread rating of interior finishes placed into the corridor of a sprinklered Group A-2 restaurant must be at least Class ____ .

B
IBC Table 803.9

4. T F Fire area, rather than building area, is used to determine the size of occupancies when fire sprinklers are required.

True
IBC §903.2

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ACTIVITY

Module III – Fire Safety

6. T F A Group I-1 Assisted Living Facility with an attached garage must be equipped with both smoke alarms and carbon monoxide alarms?

True
IBC §907.2.11.2 – smoke alarms
IBC §908.7 – CO alarms

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ACTIVITY

Module III – Fire Safety

5. 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
- G. None of the above


F
IBC §903.2

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DISCUSSION

Fire Protection Systems Practice

- Any questions regarding the practice?



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Module IV

Life Safety

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Design of Exit System

- Areas with fixed seating
 - Occupant load is based on the number of fixed seats installed
 - Benches/pews for sitting or viewing = 18 inches per person
 - Benches for dining = 24 inches per person
- Areas with BOTH fixed seating and non-fixed seating



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Design of Exit System

- The potential number of people in a building is determined by calculating the design occupant load
 - Areas without fixed seating
 - Occupant load factor from Table 1004.1.1
 - Gross floor area is the entire floor area within the exterior walls, exclusive of vent shafts and courts
 - Net floor area is the actual occupied area within the exterior walls



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Occupant Load Calculation

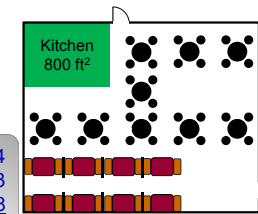
- Given:
 - Restaurant with 5,000 square feet of area of tables and chairs
 - 8 booths 6 feet wide each
 - 800 square feet kitchen

$$\text{Kitchen: } 800 \div 200 = 4$$

$$\text{Dining Area: } 5,000 \div 15 = 333$$

$$\text{Booths: } 6' \div 24" = 3/\text{bench} \\ 3 \times 16 = 48$$

$$\begin{array}{r} 4 \\ 333 \\ + 48 \\ \hline 385 \end{array}$$



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Exits from Spaces

- Each room or space is evaluated
- Exit access is 1st portion of egress system
- Minimum of 2 exits required
- Table 1015.1 allows one exit

Table 1015.1
Spaces with One Exit or Exit Access Doorway

Occupancy	Maximum Occupant Load
A, B, E ^a , F, M, U	49
H-1, H-2, H-3	3
H-4, H-5, I-1, I-3, I-4, R	10
S	29

a. Day care maximum occupant load is 10.



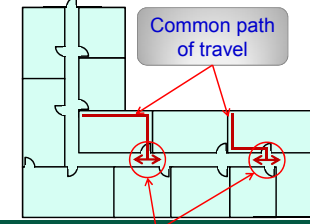
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Common Path of Egress Travel

- Maximum of 75 feet for most occupancies
 - 25 feet for H-1, H-2 and H-3
 - 100 feet for sprinklered B, F or S
 - 100 feet for B, F or S with occupant load ≤ 30
 - 125 feet for sprinklered R-2
 - 100 feet for I-3



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Choice of two directions 151

Number of Exits

- Additional exits or exit access doorways may be required
 - Occupant load is 501 to 1,000 requires a minimum of 3 exits or exit access doorways
 - Occupant load exceeds 1,000 requires at least 4 exits or exit access doorways
- Each room or space is evaluated
- Each floor is evaluated
- The building is evaluated



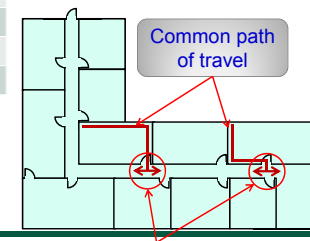
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Common Path of Egress Travel

Occupancy	Without sprinkler system (feet)		With sprinkler system ^a (feet)
	OL ≤ 30	OL ≥ 30	
A, E, M	75	75	75
B	100	75	100
I-1, I-2, I-4	NP	NP	75
R-2	NP	NP	125
Sb	100	75	75



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Choice of two directions 152

Exit

- An "exit" is where the occupant has either:
 - Left the building; or
 - Entered a protected egress path, such as a:
 - Stair enclosure
 - Exit passageway
 - Horizontal exit



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Making it Wide Enough

- The width of the means of egress doors, corridors, and other egress paths, other than stairways, is calculated by multiplying the occupant load by 0.2 inches
- The width of stairs is based on 0.3 inches per occupant
- The width must be arranged so that if one of the paths is lost, the total width is not reduced by more than 50 percent
- These widths must then be maintained to the public way
- Widths can be reduced to 0.2 inches for stairs and 0.15 inches for other locations if the building is equipped with an:
 - Automatic fire sprinkler system
 - Emergency voice/alarm communication system



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Exit Discharge

- The portion of the egress system from the exit to a public way
- Must be at grade or provide direct access to grade
- Occupants must be able to directly access the public way without obstructions



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Exit Width Calculation

- Given:** Restaurant with 5,000 square feet dining area
- Determine Dining Occupant Load:

$$5,000 \div 15 \text{ ft}^2/\text{occupant} = 334 \text{ occupants}$$

- Determine exit path width:

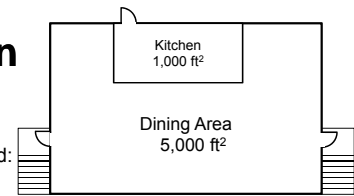
$$334 \times 0.2"/\text{occupant} = 66.8"$$

Minimum 2 exits required
Clear door width $\geq 34"$
2 doors = 68"

- Determine stair width:

$$334 \times 0.3"/\text{occupant} = 100.2"$$

2 stairs $\geq 50.1"$ width = 100.2"



- Add Sprinklers and Emergency Communication System

$$334 \times 0.15"/\text{occupant} = 50.1"$$

Minimum 2 exits required
Clear door width $\geq 32"$
2 doors = 64"

$$334 \times 0.2"/\text{occupant} = 66.8"$$

2 stairs $\geq 44"$ width = 88"



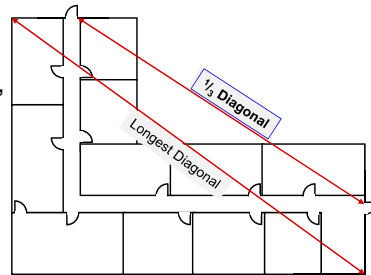
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Horizontal Travel

- When 2 or more exits are required, they must be separated by $\frac{1}{2}$ the longest diagonal of the room, space or floor
- When sprinklered, separation is reduced to $\frac{1}{3}$



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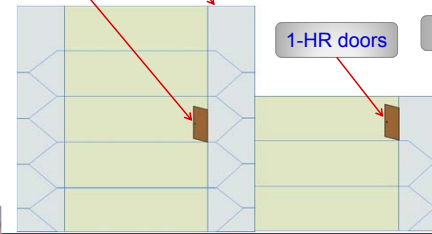
Vertical Travel

2-HR when ≥ 4 stories

$1\frac{1}{2}$ -HR doors

1-HR doors

1-HR when ≤ 3 stories



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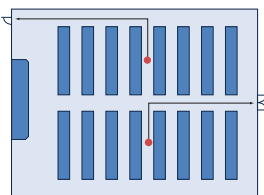
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Horizontal Travel

- The distance a person has to travel in a building to get to an exit is limited
- Table 1016.2-Exit Access Travel Distance

OCCUPANCY	WITHOUT SPRINKLER SYSTEM (feet)	WITH SPRINKLER SYSTEM (feet)
A, E, F-1, M, R, S-1	200	250
I-1	Not Permitted	250
B	200	300
F-2, S-2, U	300	400
H-1	Not Permitted	75
H-2	Not Permitted	100
H-3	Not Permitted	150
H-4	Not Permitted	175
H-5	Not Permitted	200
I-2, I-3, I-4	Not Permitted	200



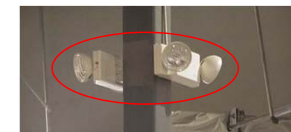
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Egress Path Identification

- Exit signs are required whenever 2 exits or exit access doors are required
 - Additional floor-level exit signs in R-1
 - Illuminated from either an internal or external light source
- Egress path must be illuminated
 - Emergency path lighting is required in areas and buildings that are required to have 2 or more exits



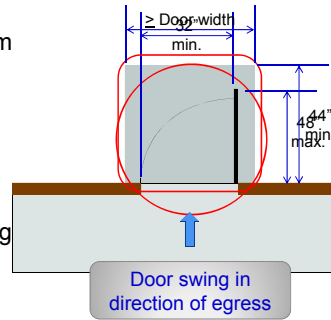
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Doors

- All doors in an egress system must be side-swinging
 - Some exceptions
- Doors must provide a minimum clear width of 32 inches measured at 90°
- Maximum width of a swinging door leaf is 48 inches
- Doors serving an occupant load of 50 or more, must swing in the direction of travel
- Floor or landing required



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Panic Hardware

- Required on doors in:
 - Group H
 - Group A – 50 or more occupants
 - Group E - 50 or more occupants



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Door Hardware

- Readily openable from the egress side without the use of a key or special knowledge or effort
- Operated without tight grasping, tight pinching, or twisting of the wrist in areas where people with physical disabilities may be present



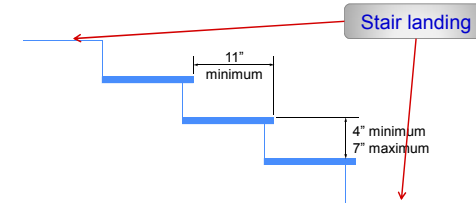
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Stairways

- Minimum width
 - 36 inches for <50 persons
 - 44 inches for ≥50 to 146 persons
 - Number of people multiplied by 0.2 inches
 - If sprinklers and emergency voice/alarm communication system, with is number of people multiplied by 0.2 inches



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Ramps

- Slopes are limited to a maximum of 1:12
- Ramps not used as a part of the means of egress can slope at 1:8
- Width is number of persons multiplied by 0.2inches



Accessible Path Into the Building

- Accessible path from points where people arrive to the business
 - Public transportation stops
 - Accessible parking spaces
 - Accessible passenger loading zones
 - Public streets or sidewalks
- 60 percent of public entrances must be accessible



Accessibility

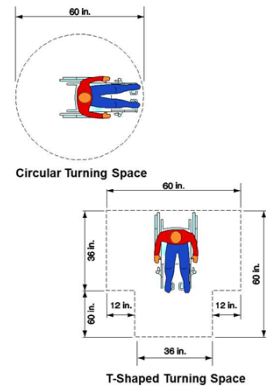
- IBC has accessibility requirements for buildings
- IBC requirements are similar to Americans with Disabilities Act Accessibility Guidelines and the Federal Fair Housing Act
- Referenced standard ICC A117.1 – Accessible and Usable Buildings and Facilities
- Areas not required to be accessible:
 - Construction sites
 - Detached 1- and 2-family dwellings
 - Spaces containing equipment

Accessible Path Through the Building

- Accessible route to each portion of the building from the accessible entrance
- Accessible route to other floors
 - Ramps
 - Maximum slope of 1:12
 - Elevators
 - Cars must be large enough for a person in a wheelchair and one additional person
 - Controls must be placed so that a person in a wheelchair can reach them to operate the elevator

Toilet Facilities

- Toilet rooms
 - Must be accessible
 - Provide an accessible family-use or assisted-use toilet room in Groups A and M
- Water closets
 - At least 1 water closet must be wheelchair accessible



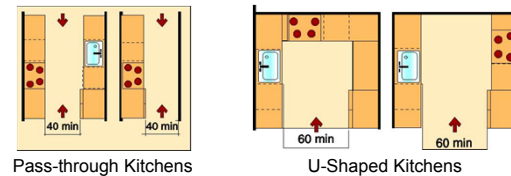
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Kitchens

- Commercial kitchens must provide accessible route to approach, enter and exit the kitchen area
- Kitchens in break room type areas must provide accessibility throughout



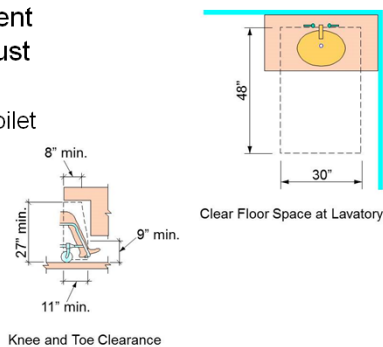
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Lavatories and Sinks

- Minimum of 5 percent of the lavatories must be accessible
 - At least 1 in each toilet facility
- Access must be provided to the lavatory



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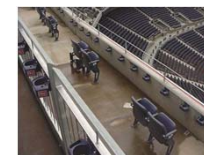
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Assembly Seating Areas

- Dining
 - The total area for seating must be accessible with some exceptions
- Other than dining
 - Based on Table 1108.2.2.1
 - Dispersed throughout seating areas

CAPACITY OF SEATING IN ASSEMBLY AREAS	MINIMUM REQUIRED NUMBER OF WHEELCHAIR SPACES
4 – 25	1
26 – 50	2
51 – 100	4
101 – 300	5
301 – 500	6
501 – 5,000	6, plus 1 for each 150, or fraction thereof, between 501 through 5,000
5,001 and over	36 plus 1 for each 200, or fraction thereof, over 5,000



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Group R-1 Accessible dwelling units and sleeping units (a portion of IBC Table 1107.6.1.1)

Total number of units provided	Minimum required number of Accessible units without roll-in showers	Minimum required number of Accessible units with roll-in showers	Total number of required Accessible units
1 to 25	1	0	1
26 to 50	2	0	2
51 to 75	3	1	4
76 to 100	4	1	5
101 to 150	5	2	7
151 to 200	6	2	8
201 to 300	7	3	10



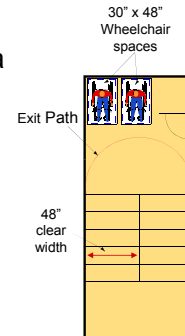
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Areas of Refuge

- One wheelchair space for every 200 occupants served by the area of refuge
 - Not required in sprinklered buildings
- Located in:
 - Stairway enclosure
 - Elevator lobby
- 2-way communication required



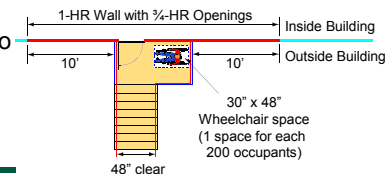
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Accessible Means of Egress

- Spaces or buildings requiring only one exit must have one accessible means of egress
- Spaces or buildings requiring ≥ 2 exits must have 2 accessible means of egress
- In buildings > 4 stories, an elevator must serve as one of the required accessible means of egress
- Accessible means of egress must continue to public way or Area of Assisted Rescue



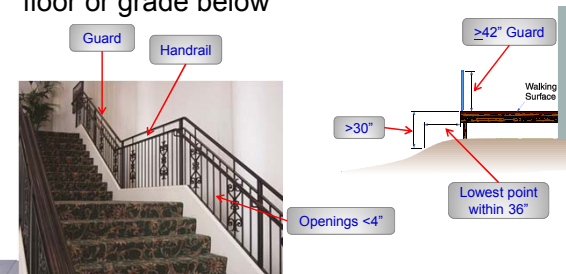
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Guards

- Guards are required along open-sided walking surfaces located more than 30 inches above the floor or grade below



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Stairways

Guard

Handrail

Openings <4"

42" minimum
34" to 38"

Handrail extension

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Safety Glazing

- Laminated glass
- Tempered glass
- Safety glazing must be labeled
- Required locations:
 - Doors
 - Within 24 inches of doors
 - Along walking areas and meets size thresholds

16 ft²

18 ft²

20 ft²

9.3 ft²

34"

6"

12"

24"

Not required
Top of bottom
panel <36" AFF
Bottom of top
panel >18" AFF

Safety
glazing
required

Not required
Bottom panel
>18" AFF

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Window-sill Height

- Regulated in R-2 and R-3
- Provide ≥ 36 inches sill or fixed windows

$\geq 36"$ to bottom
of opening

No requirement
if opening is <6"
above grade

Options:
1. ASTM 2006 fall prevention devices
2. Window openings <4"
3. ASTM 2090 fall prevention devices
4. Opening control devices

>6"

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Safety Glazing

- Required:
 - Tub or shower enclosures
 - Within 60 inches of pool or spa
 - Guard or railing on stairway
 - Within 36 inches of stairway or landing
 - Within 60 inches of walking surface

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Swimming Pools

<ul style="list-style-type: none"> Public pool <ul style="list-style-type: none"> Enclosed with barrier <ul style="list-style-type: none"> 48" in height 4" sphere cannot pass through 4" clearance between barrier and grade Gates close and latch automatically Suction outlets with entrapment avoidance 	<ul style="list-style-type: none"> Residential pool <ul style="list-style-type: none"> Enclosed with barrier <ul style="list-style-type: none"> 48" in height 4" sphere cannot pass through 2" clearance between barrier and grade Not climbable Power safety cover in lieu of barrier Gates <ul style="list-style-type: none"> Close and latch automatically Latch $\geq 54"$ above bottom of gate or on pool side of gate and $\geq 3"$ below top of gate Gates open outward Suction outlets with entrapment avoidance
--	---

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Module IV – Life Safety

3. In a non-sprinklered Group B office building with an occupant load of 95, the common path of egress travel is limited to _____ feet.

75
IBC §1014.3

4. Exit access travel distance is limited to _____ feet in a Group M occupancy equipped with a fire sprinkler system.

250
IBC Table 1016.2; Workbook Table 10-3

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Module IV – Life Safety

1. In a Group A-2 restaurant with tables and chairs, the occupant load is determined based on a factor of _____ per person.

15 ft² net
IBC Table 1004.1.2; Workbook Table 10-1

2. In a Group A-2 restaurant, 2 exit doors are required when the occupant load is _____ or more.

50
IBC Table 1015.1; Workbook Table 10-2

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Module IV – Life Safety

5. Doors must swing in the direction of egress when the occupant load is _____ or more, or the occupancy is Group _____.

50; H
IBC §1008.1.2

6. In buildings with more than 1 required means of egress, at least _____ of the means of egress must be accessible.

2
IBC §1007.1

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DISCUSSION

Life Safety Practice

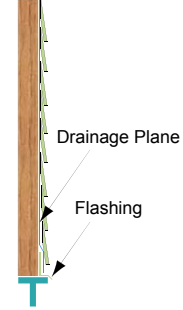


Any questions regarding the practice?

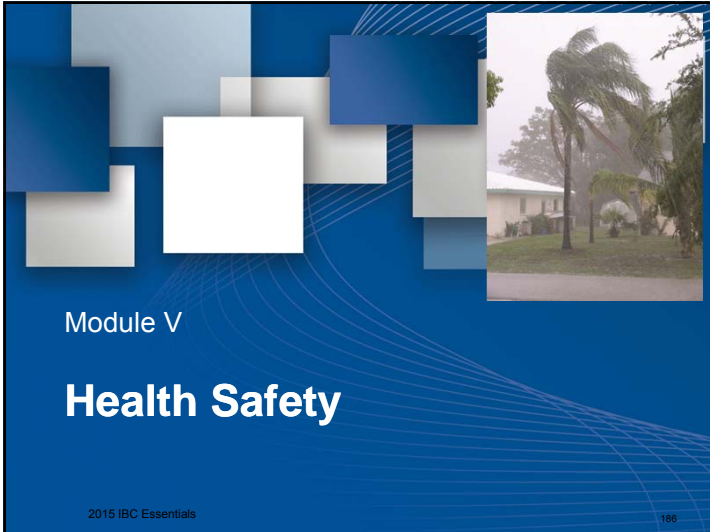
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Keeping the Water Out

- Weather-resistant exterior wall envelope
 - Water-resistive barrier
 - Flashing
- Vapor retarder
 - Located between the water-resistive barrier and the interior of the building
 - IECC-identified climate zones applied as specified in Class I, II or III vapor retarders



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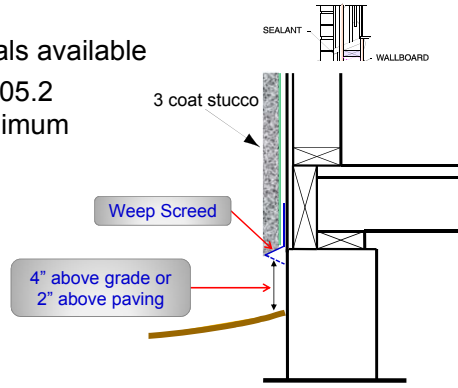
Module V

Health Safety

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Siding

- Many materials available
- IBC Table 1405.2 specifies minimum thickness
- Masonry
 - Adhered
 - Anchored
- Stucco



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Roofing

- Roof covering must meet Chapter 15 and manufacturer's instructions
 - When there is a conflict, the code requirements take precedence
- Minimum slope is dependent on roof covering chosen
- The roof system must drain
 - Roof drains and scuppers are required when the roof design does not allow for water to drain off the edge of the roof



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Low-slope Roofs

- Slope can be as low as 1/4:12
- Roof covering systems
 - Asphalt built-up roof covering
 - Coal tar pitch built-up roof covering
 - Modified bitumen
 - Thermoset single-ply roof covering (EPDM)
 - Thermoplastic single-ply roof covering (PVC, TPO, CSPE)



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Flashing

- Flashing must be installed at:
 - Wall and roof intersections
 - Gutters
 - Change in roof slope or direction
 - Around roof openings
- Parapets must be properly covered (coped) with noncombustible, weatherproof



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Steep Roofs

- Slopes with a greater than 3:12
- Common roof covering materials
 - Asphalt shingles
 - Wood shakes
 - Wood shingles
 - Clay tiles
 - Concrete tiles
 - Metal roof panels



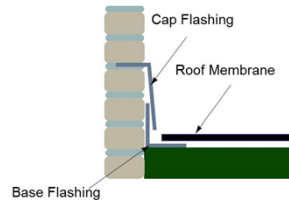
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Flashing

- Flashing is required at:
 - Roof and wall intersections
 - Valleys
 - Drip edge of the roof



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Light and Ventilation

- Lighting requirements include the use of natural and artificial light
- Ventilation is provided by either natural or mechanical ventilation
- Mechanical ventilation is designed and installed in accordance with the IMC
- Ventilation of attics and crawl spaces is also required



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Clay and Concrete Tiles

- Installed over solid sheathing or spaced sheathing
- Minimum slope of 2½:12



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Natural and Artificial Lighting

- Natural lighting is provided by openings and windows in exterior walls that allow sunshine into the building
- Artificial lighting is the electrical-powered lighting provided in a building
- If natural lighting is not adequate, artificial can be installed
 - Artificial lighting must provide ≥ 10 foot-candles at a height of 30 inches



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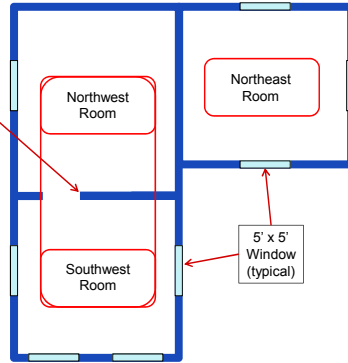
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Natural Lighting

- Openings $\geq 8\%$ of floor area
- Rooms can be combined when open to each other

Opening must be:
 Floor area = 800 ft²
 800 x 8% = 64 ft²
 1 window = 25 ft²
 <8% provided - **Inadequate** of

Floor area = 600 ft²
 600 x 8% = 48 ft²
 Floor area = 1400 ft²
 1400 x 8% = 112 ft²
 5 windows = 125 ft²
 $\geq 8\%$ provided - **OK**



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Exhaust Systems

- Exhaust moisture created inside the building
 - Bathrooms that contain bathtubs, spas, and similar bathing fixtures must be mechanically ventilated
- Exhaust contaminants
 - Contaminants in naturally ventilated spaces must be removed
 - Flammable and combustible hazards must also be exhausted
 - In accordance with the IMC and IFC



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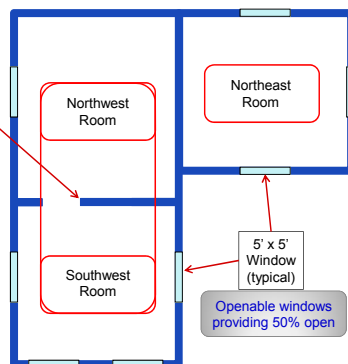
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Natural Ventilation

- Openings $\geq 4\%$ of floor area
- Rooms can be combined when open to each other

Opening must be:
 Floor area = 800 ft²
 800 x 4% = 32 ft²
 1 window = 12.5 ft²
 <4% provided - **Inadequate**

Floor area = 600 ft²
 Floor area = 1400 ft²
 1400 x 4% = 56 ft²
 5 windows = 62.5 ft²
 $\geq 8\%$ provided - **OK**



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Temperature

- Interior space intended for human occupancy must be provided with a space-heating system
 - Can be an active or passive system
 - Must be capable of maintaining a minimum indoor temperature of 68°F at 3 feet above the floor
- The *design heating day* is the outdoor temperature used to design the heating system
 - Found in International Plumbing Code (IPC) Appendix D

Location	Design Temperature
Minneapolis, MN	-12
Chicago, IL	-4
Buffalo, NY	6
Kansas City, MO	6
Dallas, TX	22
San Diego, CA	44



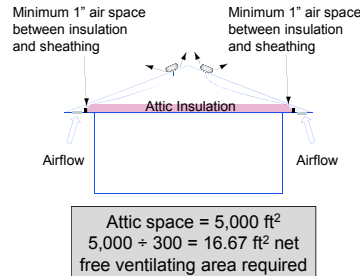
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Moisture Control in Attics

- The net free area of attic vents must be at least 1/150 of the area of the attic space
 - Reduced to 1/300 when 40 percent – 50 percent of the ventilation openings are in top 3 feet of attic with the balance of the ventilation openings are provided by eave or cornice vents
 - Reduced to 1/300 with Class I or II vapor barrier



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Plumbing Facilities

- The occupant load is divided in half to determine the number for each sex
- The number of plumbing facilities based on IBC Table 2902.1
- Urinals may be substituted for water closets
 - 67 percent for assembly and educational occupancies
 - 50 percent for other occupancies
- Separate facilities must be provided for each sex in most buildings
 - Separate facilities are not required in
 - Dwelling units in apartment buildings
 - Sleeping units in hotels
 - Buildings or tenant spaces that have a total occupant load ≤ 15 , including employees and customers
 - Mercantile occupancies that have an occupant load < 100



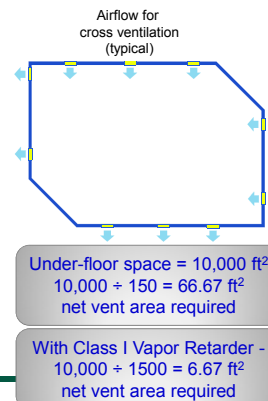
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Under-floor Ventilation

- Ventilation ratio of 1 square feet of opening for 150 square feet of under-floor space
- Installation of a Class I vapor retarder reduces ventilation ratio to 1 square feet of opening for 1500 square feet of under-floor space



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Location of Toilet Facilities

- Toilet facilities must be provided for:
 - Employees
 - Public – if the building is generally open to the public
- Access to the public toilet facilities
 - Must also be accessible
 - Cannot pass through kitchens, storage rooms, or closets
- Distance to toilet facilities ≤ 500 feet
 - Longer distances allowed in factory and industrial occupancies when approved by the building official



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Toilet/Bathing Room Finishes

Minimum height of 4'

Privacy partitions

Smooth, hard, non-absorbent finish

Extends up wall $\geq 4'$

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ACTIVITY

Module V – Health Safety

3. T F Either natural light or artificial light can be utilized to meet the minimum lighting requirements.

True
IBC §1205.1

4. T F Attics and under-floor areas must be provided with ventilation at a ratio of 1 ft² of vent area for every 500 ft² of area.

False, 1:150 is required with some exceptions
IBC §1203.2 – attics
IBC §1203.3.1 – under-floor areas

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ACTIVITY

Module V – Health Safety

1. T F Buildings must be designed with a weather-resistant exterior wall envelope to keep water out of the structure.

True
IBC §1403.2

2. Minimum roof slope must be ____.

$\frac{1}{4}$ " in 12" ($\frac{1}{4}$:12, 2%)
IBC §1015.1

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ACTIVITY

Module V – Health Safety

5. A Group A-3 gymnasium with an occupant load of 625 requires ____ water closets for male use.

5
IBC Table 2902.1; Workbook Table 14-2

6. Except for in covered malls, the maximum travel distance to a water closet cannot exceed ____ feet.

500
IBC §2902.3.2

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DISCUSSION

Health Safety



Any questions regarding the practice?

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Structural Design

- Buildings are designed according to American Society of Civil Engineers (ASCE) Standard 7, *Minimum Design Loads for Buildings and Other Structures*
- There are 4 levels of occupancy categories based on the use of the building
 - 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

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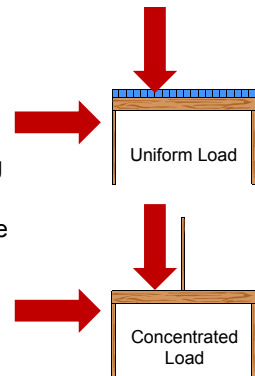
Module VI

Structural Safety

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Basic Loads

- *Gravity loads* are those loads applied vertically to the structure
- *Lateral loads* are applied in a horizontal manner to the building
- *Uniform loading* means that the load is applied equally across the structural member
- A *concentrated load* is applied in a single location of the member like a column bearing in the middle of a beam



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Live Loads

- Live loads are loads created by the use and occupancy of the building (Table 1607.1)

Occupancy or use	Uniform (psf)	Concentrated (lbs.)
Dining Rooms and Restaurants	100	–
Offices	50	2,000
Residential 1- & 2-family dwellings – Sleeping rooms	30	–
Residential 1- & 2-family dwellings – Other areas	40	–
Retail – First floor	100	1,000
Retail – Upper floors	75	1,000
Stairs – in 1- & 2-family dwellings	40	Load on 4 in ² of stair treads is 300 lbs.
Stairs – in all other occupancies	100	
Storage warehouses – Heavy	250	
Storage warehouses – Light	125	
Roof surfaces subject to maintenance workers		300
Ordinary flat, pitched, and curved roofs	20	
Roofs used for roof gardens or assembly purposes	100	

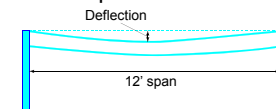


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Deflection

- Deflection is the amount that a structural member sags under the specified load without failing



Deflection Calculation
 $L/360 = 120" \div 360 = 0.33"$
 $L/240 = 120" \div 240 = 0.50"$

Construction	Maximum Deflection		
	Live Load	Wind or Seismic Load	Total Load
Roof members:			
Supporting plaster ceiling	L/360	L/360	L/240
Supporting non-plaster ceiling	L/240	L/240	L/180
Not supporting ceiling	L/180	L/180	L/120
Floor members	L/360	–	L/240
Exterior walls and interior partitions:			
With stucco and plaster	–	–	1/360
With brittle finishes	–	L/240	–
With flexible finishes	–	L/120	–



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Dead Loads

- Dead loads are the actual weight of the materials used in construction of the building
- They are considered permanent loads because they will always exist in a building

Table C3-1 of ASCE 7

Component	Load (psf)
Double wood floor supported on wood joists 16" on center	7
Hardwood flooring, 7/7-in.	4
Linoleum tile	1
Wood stud walls with 1/2" gypsum board each side	8
5/8" gypsum board ceiling	9
Asphalt Shingles	2



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Snow Loads

- Snow loads are vertical loads
- IBC Figure 1608.2
- Based on actual snow load data
- 'CS' = case study; the Building Official will determine the snow load
- The effect of drifts must be taken into account



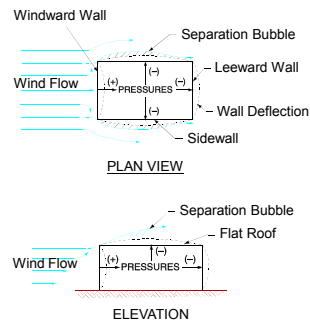
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Wind Loads

- Are typically lateral loads
- Create positive and negative pressures
- Are based on wind speed
- Can be affected by surface roughness and exposure



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Flood Loads

- There are 2 methods to determine flood hazard areas
 - Areas subject to a $\geq 1\%$ chance of flooding in any year (100 year flood plain)
 - Areas designated as a flood hazard area on a community's flood hazard map
- FEMA Flood Insurance Rate Map




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Earthquake Loads

- Seismic areas are based on the anticipated severity of the design earthquake ground motion at a site
- Seismic design categories
 - A, B, C, D, E, F
 - Low  High
- Seismic design according to ASCE 7



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Soils

- Condition and characteristics of soil must be considered
- Building official can require a geotechnical investigation
 - Conducted by drilling into the ground, taking samples or digging test pits
 - Must evaluate soil strength, bearing capacity, effects of moisture, compressibility, liquefaction and expansiveness



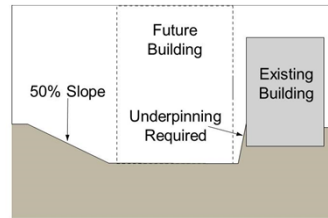
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Excavation

- Proximity to existing structures may require underpinning
- Slope of the excavation is controlled so dirt does not fall into the hole
 - Appendix J
 - 1:2 (50 percent slope)



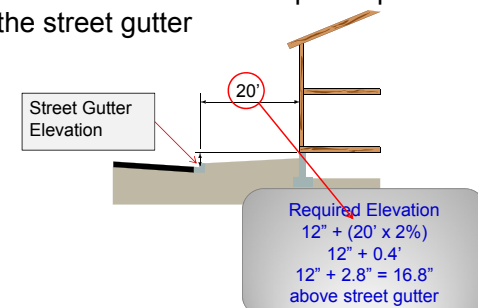
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Grading

- Foundation must be 12 inches plus 2 percent above the street gutter



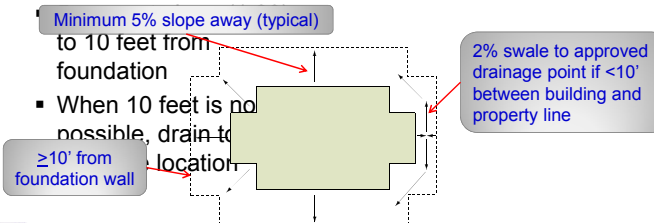
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Grading

- Positive drainage away from the building



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Concrete Construction

- Concrete is a mixture of portland cement, aggregate, and water
- The IBC References the American Concrete Institute's (ACI) Standard 318 *Building Code Requirements for Structural Concrete*
- IBC Chapter 19 contains additional requirements and amendments to ACI 318



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Concrete Durability

- There are conditions and elements that affect concrete based on:
 - Exposure to freezing and thawing in a moist condition or deicer chemicals
 - Exposure to sulfates in water or soil
 - Exposure to water where the concrete is intended to have low permeability
 - Exposure to chlorides from deicing chemicals, salt, saltwater, brackish water, seawater when the concrete has steel reinforcement
- The US has been divided into 3 different levels of exposure: negligible, moderate and severe



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Foundations

- Concrete foundations can be either prescriptively designed or engineered
- Buildings located in Seismic Design Categories C, D, E and F must generally be designed by a design professional
- The thickness of the concrete foundation wall and the amount of steel reinforcement required are based on this lateral soil load
- Soils that have a very high lateral load require an engineered design



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Concrete Durability

Based on IBC Table 1904.2
Minimum Specified Compressive Strength (f'_c)

Type or Location of Concrete Construction	Minimum Specified Compressive Strength (f'_c at 28 Days, PSI)		
	Negligible Exposure	Moderate Exposure	Severe Exposure
Basement walls and foundations not exposed to the weather	2,500	2,500	2,500
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500
Basement walls, foundation walls, exterior walls, and other vertical concrete surfaces exposed to the weather	2,500	3,000	3,000
Driveways, curbs, walks, patios, porches, carport slabs, steps, and other flatwork exposed to the weather and garage floor slabs.	2,500	3,000	3,500



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Formwork

- Formwork must be designed, fabricated and erected in accordance with ACI Standard 318, §6.1



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Steel Reinforcement

- The purpose of steel reinforcement in concrete is to resist any tension, or pulling apart, when a wall is subjected to a lateral load
- Rebar is
- Vertical and horizontal rebar must



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Masonry Construction

- Foundations
 - Thickness of the walls is determined by the lateral soil load against the foundation
 - Steel reinforcement is required in masonry foundations
 - In some cases, the cells of the hollow or solid masonry units must be filled with grout



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Concrete Quality Control

- The quality of the concrete has a direct relationship to its strength
- Concrete shall be inspected by a special inspection agency – with some exceptions
- Continuous inspections – full time observation of work
- Periodic inspections – part-time or intermittent observation of work
- The concrete is sampled as described in ASTM Standard C172 *Practice for Sampling Freshly Mixed Concrete*



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Masonry Materials

- Concrete, clay or shale, stone, and glass
 - All of these materials are bonded together with mortar
- Fine grout
 - Comprised of cement, fine aggregate and water
- Coarse grout
 - Comprised of cement, pea gravel and water
- Steel reinforcing must comply with the same requirements as it does for concrete structures



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Quality Control

- Special inspections required
- Testing of masonry construction
 - Unit strength
 - Prism test



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Protection of Steel

- Steel must be protected with an approved coating to protect the steel from corrosion
- If paint steel is scratched or chipped during erection an approved paint or primer should be applied
 - If the steel is going to be protected with sprayed applied fireproofing, it must be either bare steel or painted with an approved primer
- Steel is often left unprimed to ensure a better adhesion of the fireproofing



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Steel Construction

- Structural steel is a member consisting of rolled steel structural shape
- IBC requires steel construction be done in accordance with the American Institute of Steel Construction (AISC) Standard 360, *Specification for Structural Steel Buildings*



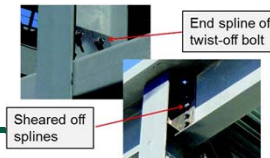
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Connections

- Two methods are used to connect structural steel members
 - Welding
 - Bolting
- Both methods require special inspections
- Slip-critical joints resist movement by friction on the contact surface of the connection
- Pretensioned joints are high-strength bolts tightened to the specified minimum pretension



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Quality Control

- Special inspection requirements for connections include:
 - Periodic inspections of the steel frame
 - Verify compliance with approved construction documents, such as bracing, stiffening, member locations, and joint details at each connection
 - Special inspection for the fabrication of steel joists
 - Inspection agency inspects at fabrication facility
 - or facility becomes an approved fabricator



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Protection of Wood

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



Preservative-treated
lumber or $\geq 8"$
above
grade



Wood post supported by
metal pedestal projecting
1" above concrete



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Wood Construction

- There are two types of wood construction
 - Conventional light-frame – primary structural elements are created by a system of repetitive wood framing members
 - Heavy timber construction – large-dimensional lumber as structural elements



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Grade Marks

- Grading required for:
 - Lumber
 - Wood structural panels used for sheathing on floors, walls, roofs, siding, diaphragms and built-up members



Lumber Grade Mark



Wood Structural Panel Mark



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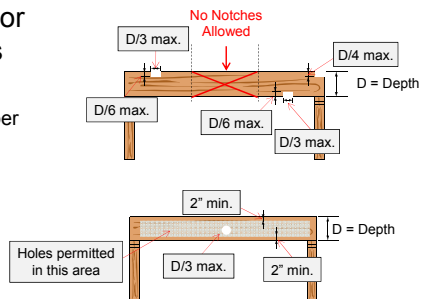
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Notching and Boring

- Ceiling joists, floor joists and rafters

- Notches
 - At end of member
 - On top side
 - On bottom side
- Holes



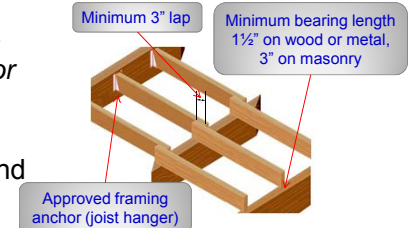
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Floor Construction

- Chapter 23 has span limits for common wood species
- For other materials see *Span Tables for Joists and Rafters* published by American Forest and Paper Association (AF&PA)



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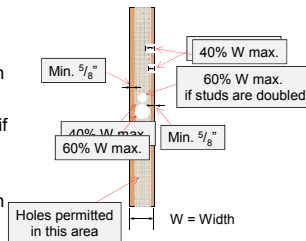
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Notching and Boring

- Wall studs

- Exterior walls and load-bearing walls
 - Cut or notch ≤ 25 percent of width
 - Bored hole ≤ 40 percent of width
 - Bored hole ≤ 60 percent of width if studs are doubled
- Non-load-bearing walls
 - Cut or notch ≤ 40 percent of width
 - Bored hole ≤ 60 percent of width
- Bored holes **NOT** permitted in the same section of stud as a cut or notch



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Allowable Floor Joist Spans

- Determine the maximum span size and maximum spacing of a floor joist of Hem Fir #2 with a span of 15 feet and supporting a 30 psf live load and 10 psf dead load.
- Refer to Workbook Table 16-4



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FOR EXAMPLE

12" span = 2 x 10
16" span = 2 x 10
19.2" span = 2 x 10
24" span = 2 x 12

Joist Spacing (inches)	Species and Grade	Dead Load = 10 psf			
		2 x 6	2 x 8	2 x 10	2 x 12
12	Douglas Fir #2	11-10	15-7	19-10	23-0
	Hem Fir #2	11-0	14-6	18-6	22-6
	Southern Pine #2	11-10	15-7	19-10	24-2
	Spruce-Pine-Fir #2	11-3	14-11	19-0	23-0
16	Douglas Fir #2	10-9	14-1	17-2	19-11
	Hem Fir #2	10-0	13-2	16-10	19-8
	Southern Pine #2	10-9	14-2	18-0	21-1
	Spruce-Pine-Fir #2	10-3	13-6	17-2	19-11
19.2	Douglas Fir #2	10-1	12-10	15-8	18-3
	Hem Fir #2	9-5	12-5	15-6	17-1
	Southern Pine #2	10-1	13-4	16-5	19-3
	Spruce-Pine-Fir #2	9-8	12-9	15-8	18-3
24	Douglas Fir #2	9-1	11-6	14-1	16-3
	Hem Fir #2	8-9	11-4	13-10	16-1
	Southern Pine #2	9-4	12-4	14-8	17-2
	Spruce-Pine-Fir #2	8-11	11-6	14-1	16-3

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Walls

- Studs must be installed with their widest dimension perpendicular to the wall and continuous from the bottom to top plate
- Minimum of three studs in each corner of an exterior walls
- Top plates must be doubled in bearing and exterior walls and overlapped at corners and intersections with other partitions

Stud Size (inches)	Bearing Walls				Nonbearing Walls	
	Stud Height (feet) ^a	Supporting Roof and Ceiling Only	Supporting 1 Floor, Roof, and Ceiling	Supporting 2 Floors, Roof, and Ceiling	Stud Height (feet) ^a	Spacing (inches)
2 x 4	10	24	16	NP	14	24
3 x 4	10	24	24	16	14	24
2 x 5	10	24	24	NP	16	24
2 x 6	10	24	24	16	20	24

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Floor Structure

- Sheathing used for the floor structure must also be designed to support the anticipated loads
- Common sheathing used is wood structural panels
- Thickness of the panel and the panel rating are used to determine its strength
- A common panel used for floor sheathing is $\frac{3}{4}$ " panel 48/24 rated

Thickness of Panel

Maximum span for roof sheathing with all of the edges supported

Maximum span for floor sheathing with all of the edges supported

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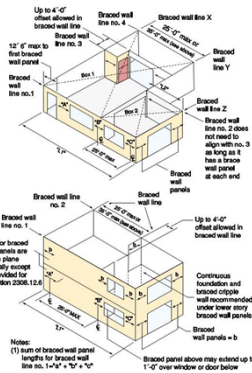
Wall Framing

- Openings in walls must be provided with headers to support the loads in bearing walls
- A single piece of lumber can be substituted for the header if it has the equivalent dimensions

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Wall Bracing

- Wall bracing must be provided to mitigate lateral loads
1. 1 x 4 continuous diagonal braces
 2. $\frac{5}{8}$ " thick wood boards diagonally on studs spaced $\leq 24"$ O.C.
 3. $\frac{3}{8}$ " thick wood structural panel sheathing
 4. $\frac{1}{2}$ " fiberboard sheathing panels
 5. $\frac{1}{2}$ " gypsum board on studs spaced $\leq 24"$ O.C. and nailed at 7" O.C.
 6. Particleboard wall sheathing panels
 7. Portland cement plaster on studs spaced 16" O.C.
 8. Hardboard panel siding




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Crawl Space and Attic Access

- Crawl spaces must be provided with a minimum 18 inches x 24 inches access opening
 - Attics that have a clear height >30 inches must have an opening that is at least 20 inches x 20 inches
 - Clear headroom height of ≥ 30 inches at or above the access opening
 - If mechanical equipment is installed in a crawl space or attic, the access opening to be large enough to remove the largest appliance
- 



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Ceilings and Roofs

- Determine the minimum size and maximum spacing for a Douglas Fir #2 rafter with a span of 14 feet with a ceiling attached to the bottom of the rafters
- The ground snow load is 30 psf and the dead load is 10 psf
- Refer to Table 16-8

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Raft Spacing (inches)	Species and Grade	Dead Load = 10 psf				
		2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
		Maximum Raft Spans (feet – inches)				
12	Douglas Fir #2	8-7	13-6	17-5	21-4	24-8
	Hem Fir #2	8-0	12-7	16-7	21-0	24-4
	Southern Pine #2	8-7	13-6	17-10	22-3	Note a
	Spruce-Pine-Fir #2	8-3	12-11	17-0	21-4	24-8
16	Douglas Fir #2	7-10	11-11	15-1	18-5	21-5
	Hem Fir #2	7-3	11-5	14-11	18-2	21-1
	Southern Pine #2	7-10	12-3	16-2	19-3	22-7
	Spruce-Pine-Fir #2	7-6	11-9	15-1	18-5	21-5
19.2	Douglas Fir #2	7-4	10-11	13-9	16-10	19-6
	Hem Fir #2	6-10	10-9	13-7	16-7	19-3
	Southern Pine #2	7-4	11-5	14-9	17-7	20-7
	Spruce-Pine-Fir #2	7-0	10-11	13-9	16-10	19-6
24	Douglas Fir #2	6-8	9-9	12-4	15-1	17-6
	Hem Fir #2	6-4	9-7	12-2	14-10	17-3
	Southern Pine #2	6-10	10-2	13-2	15-9	18-5
	Spruce-Pine-Fir #2	6-6	9-9	12-4	15-1	17-6

12" span = 2 x 8
16" span = 2 x 8
19.2" span = 2 x 10
24" span = 2 x 10

Based on Table 2308.10.3(5)
Rafter Spans for Common Lumber Species

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Engineered Wood Products

- Prefabricated I-joists
- Structural Glued-Laminated Timber
- Structural Composite Lumber
 - Laminated Veneer Lumber (LVL)
 - Parallel Strand Lumber (PSL)



Engineered Wood I-Joist

LVL Beam



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Gypsum Board

- Gypsum board is a common material used in buildings
 - Provides a smooth interior surface
 - Can provide passive fire protection
 - Easy to work with
- Various types
 - Type X
 - Type C
 - Water-resistant



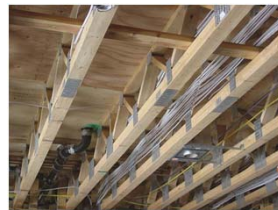
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Trusses

- Trusses are floor and roof framing members comprised of light-frame materials (2 x 4 and 2 x 6) typically joined together with metal connector plates
- The trusses must be installed in accordance with:
 - Submitted truss drawings
 - Truss Plate Institute's (TPI) National Design Standards for Metal-Plate-Connected Wood Truss Construction



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Plastics

- Foam plastic insulation is commonly used in building construction
 - Flame-spread index of ≤ 75
 - Smoke developed index ≤ 450
 - Tested in accordance with ASTM Standard E84 and Standard UL 723



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Plastics

- Foam plastic installed on the interior of a building must be separated from the interior by a thermal barrier
- A thermal barrier is a single layer of ½ inch gypsum wallboard or other equivalent thermal barrier
- Thermal barrier must remain in place for 15 minutes based on the reference standard



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Module VI – Structural Safety

1. The 1st floor in a Group M retail store must be designed to carry a uniform live load of ____.

100 pounds/square foot
IBC Table 1607.1; Workbook Table 15-1

2. T F When designing a building, the snow loads and wind loads are specific to the area where the building will be constructed.

True
IBC §1608.2 – snow loads
IBC §1609.2 – wind loads



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Interior Foam Plastic Trim

- The amount of foam plastic trim used is limited to reduce the potential of increased flame spread and smoke development
- The trim must have a **minimum** density of 20 pcf
- Maximum thickness of ½ inch
- Maximum width of 8 inch
- The interior trim can constitute ≤10 percent of the wall or ceiling area to which it is attached
- Flame-spread index for foam plastic trim is limited to 75



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Module VI – Structural Safety

3. The ground must have a minimum slope of ____ for a minimum of ____ perpendicularly away from a building.

1:20; 10'
IBC §1804.3

4. The exterior foundation of a building must be elevated to a point at least 2% plus ____ above the point of discharge.

12"
IBC §1808.7.4



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ACTIVITY

Module VI – Structural Safety

5. T F Absolutely no holes or notches can be made in a wooden 2 x 12 floor joist.

False; holes and notches are allowed, but limited in size and location
IBC §2308.9.10
IBC §2308.10.4.2

6. T F Foam plastic materials are prohibited as decorative components on the interior of a building.

False; they are allowed, but limited
IBC §2604.2

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Questions and Answers

Q&A

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DISCUSSION

Structural Safety

Any questions regarding the practice?

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Final Reflection

This slide will help the learner to reflect on the day and what they will take back to the job and apply.

- **What?** What happened and what was observed in the training?
- **So what?** What did you learn? What difference did this training make?
- **Now what?** How will you do things differently back on the job as a result of this training?




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